

**VOLUME 3**  
**EMPLOYER'S REQUIREMENTS**

**Section 3 - Civil Works**

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### **3 Section 3 - Civil Works**

#### **3.1. General Data**

##### **3.1.1 Introduction**

The works under the Contract include the design, execution and completion of the Works described in the Beneficiary's Requirements, in conformity with the Conditions of Contract, Specifications, Drawings and Schedule of Payments.

Notwithstanding the subdivision of the Specification under different headings, every part of it shall be deemed supplementary to and complementary of every other part.

##### **3.1.2 Location of Works, Accessibility and Site Fencing**

The Contractor shall make his own arrangements for the access to the Site(s), and proposals for providing additional access facilities shall be submitted for the approval of the Engineer.

The Contractor shall make his own arrangements for his Site compound(s) and shall set them up at the locations agreed with the Engineer. The Contractor shall make his own arrangements for the electricity, water supply and sanitary facilities and shall maintain the compounds to the satisfaction of the Engineer.

The Contractor shall erect temporary site fencing as soon as he is given possession of the relevant portion of the Site. The Contractor shall regularly inspect and maintain all such fencing, any defects being made good without delay. Access shall be provided in temporary site fencing as necessary for the use of the occupiers of adjacent lands. Temporary site fencing shall remain in position until either it is replaced by permanent fencing or the Works are sufficiently completely to enable that portion of the Site to be brought into use.

##### **3.1.3 Levels and Benchmarks**

Except where otherwise specified all levels shall be in metres above Sea Level with accuracy of two decimals. The data for all levels shall be based on bench marks approved by the Engineer.

The Contractor shall establish, construct and protect during the period of construction of the facilities necessary additional bench marks which shall be checked periodically.

Benchmarks and other points of reference in the vicinity of the Site(s) are not shown on the Drawings. The Contractor will be responsible for obtaining this information.

The Contractor shall maintain a record of the levels of all the bench marks and shall submit one copy of the records to the Engineer. The Datum for all levelling on the Site shall be the Datum used by the Beneficiary and it shall be related to the level of the benchmarks and approved by the Engineer.

##### **3.1.4 Dimensions**

All dimensions, distances and levels on the Drawings are shown in the metric system. When additional and/or working drawings are required, the Contractor shall prepare and submit these drawings in the metric system.

Should the dimensions shown on the Drawings fail to coincide with standard nominal sizes, materials or fittings available, reasonable substitutions shall be permitted but no extra payment will be allowed for such substitution without the specific approval by the Engineer.



### **3.1.5 Documentation**

#### **3.1.5.1 General**

The documentation to be submitted at the different stages of the project is summarised below. This includes but is not limited to, documentation to be submitted as part of the Tender, after award of the Contract and before handing over.

#### **3.1.5.2 Documentation after the Award of the Contract**

The Contractor shall prepare all Contractor's Documents necessary for the execution of the Works. The Contractor's Documents shall be executed in such detail that the Works can be executed on site, but also serve for later maintenance and fault finding.

All design documents, drawings and documents, submitted by the Contractor to the Engineer for review shall be checked by the Contractor before submission and shall be signed by a senior member of the Contractor's staff in accordance with approved QA procedures, to confirm that the check has been conducted. The Contractor shall likewise check submissions from his sub-Contractors or from any other source before passing such submissions to the Engineer.

Approval by the Engineer of the Contractor's Documents shall neither relieve the Contractor of any of his obligations under the Contract, nor relieve him of correcting any errors found subsequently in the approved working drawings and in the work on the site or elsewhere associated herewith.

All Contractor's Documents shall be submitted to the Engineer taking into consideration that a period of one month shall be allowed for the Engineer's checking and approval.

Additionally the Contractor shall prepare **main designs** (Main Design - glavni projekat in Serbian) for the application of the building permit in accordance with Serbian regulations.

All modifications requested by the Engineer shall be carried out through variation or instruction. In the event of the Contractor disagreeing with the alterations requested by the Engineer, the Contractor shall send written notice to the Engineer within seven days of receiving the altered drawing(s). In such a case the Contractor shall resubmit the particular drawing(s) and calculations if needed, in three copies to the Engineer subsequent to the Contractor's consideration of the Engineer's comments.

#### **3.1.5.3 Documentation before Handing Over**

During the execution of the Works on the site, the Contractor shall record all information necessary for preparing as-built drawings. Marked-up drawings and other documents shall be available to the Engineer at any time during construction. Marked up drawings shall be kept up to date.

Before the **performance tests**, the Contractor shall submit in Serbian language six complete sets of instructions and manuals describing the delivered equipment in order to facilitate operation and maintenance.

The manuals shall include, but not be limited to:

- A full description of the system installed, written to ensure that the operational staff fully understand the nature and scope of the equipment and facilities provided
- Specific operational instructions
- Diagrammatic drawings of each system indicating principal items of plant, equipment, valves, schematic and wiring diagrams, etc.
- The name, address and telephone number of the manufacturer together with catalogue list numbers

- Manufacturer's technical literature for the plant and equipment, assembled specifically for the project, excluding irrelevant matter and including detailed drawings, electrical circuit details and operating and maintenance instructions
- Detailed record of all types of tests including a copy of the Test Certificates (including but not limited to, electrical circuit tests, corrosion tests, type tests, work tests, start and commissioning tests) for the equipment, valves, etc., used in the installations
- Starting-up, operating and shutting down instructions
- Specific maintenance instructions and recommendations as to the preventative maintenance frequency and procedures to be adopted to ensure the most efficient operation of the systems
- A list of normal consumable items and a lubrication schedule
- A list of recommended spares to be kept in stock
- Procedures for fault finding

All information in these manuals shall apply specifically to the equipment being supplied and they shall be free from irrelevant matters such as might be contained in the manufacturer's general literature.

#### **3.1.5.4 As-Built Documentation**

The as-built documentation shall include all electrical, mechanical and building specifications and drawings. Six copies of each shall be provided (5 to the Beneficiary and one to the Engineer) before Provisional Acceptance Certificate is issued, incorporating all the modifications/revisions affected during construction. Each copy shall be printed on durable material in a volume or volumes depending on bulk. All material except drawings shall be A4 size. Drawings shall be on ISO A size sheets, folded and shall be bound into volumes. Volume titles shall be clearly inscribed on the front cover and on the spine of the cover. Drawings shall be marked **AS-BUILT**.

As Built Drawings will be required to be compiled in appropriate scales for all pipelines and structures (as defined by Construction and planning law) to enable the Beneficiary or the relevant utility company to maintain the newly laid pipes and installations at a later date. These as-built drawings for pipelines must contain but are not limited to:

- exact position of pipe axis and pipe depth
- all structures including manholes, valve chambers and associated structures
- position and specification of any connection to the pipe
- crossings with all other services including sewers, telephone, electricity cables and water pipes.
- reference points, e.g. buildings, for pipeline locations are to be included

For all the Works in the Contract, the Contractor shall either amend the Contract Drawings of plans and profiles to suit his proposed setting out dimensions and levels or prepare new drawings to the same level of details as the Contract Drawings and submit to the Engineer for his approval.

When the Drawings have been approved by the Engineer, the Contractor shall submit a set of electronic copies on CD to the Engineer for his use.

#### **3.1.5.5 Records**

The Contractor shall keep records of his activities stating the location, weather condition, type of work, personnel and equipment used as required under Serbian legislation and this technical specifications.

### **3.1.6 Handling of water**

Except as otherwise specified, the Contractor shall be responsible and bear all direct and indirect costs for dealing with water, whether from existing pipe or channel systems, lakes, rivers, watercourses, underground springs, precipitation or any other source or cause. The Contractor shall keep the whole of the Works free from water and shall provide all dams, cofferdams, pumping, piling, shoring, temporary drains, sumps, etc., necessary for this purpose. The Contractor shall, at his own expense, take all necessary precautions to prevent damage due to erosion and siltation during construction. Should any water accumulate on any part of the Works either during or after construction, until the end of the Defects Notification Period, thus giving rise to soaking or erosion conditions, the Engineer may order the Contractor to remove and replace, at the Contractor's expense, any material or Works that may have been so affected. Any damage to the Works or to adjacent properties resulting from the Contractor's failure to take the necessary precautions shall be made good at the Contractor's expense.

### **3.1.7 Climatic conditions**

No material in a frozen condition shall be incorporated in the Works, but shall instead be retained and subsequently used on Site, if suitable when unfrozen, to the approval of the Engineer.

Laying of concrete shall cease when descending air temperatures in the shade falls below 3 °C and shall not be resumed until the ascending air temperature in the shade reaches 3 °C.

### **3.1.8 Survey of roads, properties, lands and crops**

Where appropriate, the Engineer shall arrange for surveys to be carried out in conjunction with the Contractor and the Local Road Authority, owners or occupiers, of the condition of roads, properties, lands and crops which may be affected by the Works. Before any work affecting such roads, properties, lands or crops is commenced, the Contractor shall confirm in writing to the Engineer that the relevant survey is a true and accurate record of their condition.

### **3.1.9 Surveys of existing structures**

Prior to any construction works, the Contractor shall carry out a comprehensive survey of all walls, structures etc., adjacent to the proposed works.

Close up photographs shall be taken of all adjacent structures, walls, bridges etc.. All defects shall be identified and recorded (i.e. 'dilapidation survey'), and detail photographs taken of them. All photographs and records shall be properly catalogued.

## **3.2. Existing Cables and Pipelines**

### **3.2.1 Introduction**

The Authorities are public institutions responsible for the public utility services including electricity, water, sewerage, drainage, telephone and roads.

The Contractor is required by his own enquiries, investigations and actions to satisfy himself as to the sufficiency and position of any utilities which affect or may be affected by the Works.

The Contractor shall carry out exploratory excavations in the form of trial holes at adequate intervals in a manner so as not to damage the utilities and to explore all existing services in advance of his general excavation. Such exploratory excavations shall be carried out in consultation with the Authorities concerned and either be protected until the general excavation meets this excavation or be re-filled after recording the nature and position of the service according to the Engineer's instructions.

### **3.2.2 Information and instructions**

Further information and instructions on measures to be taken before and during the execution of the Works will, to the extent known to the Authorities, be submitted to the Contractor by the Beneficiary or the Engineer in co-operation with the relevant Authorities.

As soon as a service pipeline or cable is encountered in the excavation, whether previously located or discovered during the course of the excavation for the Works, the Contractor shall immediately inform the Engineer who will then inform the Authorities concerned.

In this case the Contractor shall follow the instructions given by the Beneficiary, the Engineer or the relevant authorities.

### **3.2.3 Precautions**

No excavating machines shall be used in the immediate surroundings of cables and/or pipelines unless approved by the Engineer. Special care shall be taken to ensure that the systems are accessible in cases of emergency.

Temporary Works which have to be made in the surroundings of the system during the execution of the Works, shall be maintained by the Contractor and shall be removed as soon as practicable. The Contractor shall be responsible for maintaining all such utilities encountered by him in the construction of the Works and shall bear the cost of making good any damage caused directly by his activities.

### **3.2.4 Existing Water Supply and Sewer Pipes for Connecting to New Works**

The precise lines, levels and locations of existing water supply and sewer pipes which are to be connected to the new Works to be constructed under this Contract shall be determined by the Contractor. Where information concerning the existing water supply system is not shown on the Drawings, the Contractor shall carry out investigations e.g. in the way of trial holes, opening covers of chambers to obtain the precise locations, lines and levels.

The Contractor's proposal for connecting an existing water supply to the new Works shall be submitted to the Engineer for his approval. No connection shall be made to the New Works until written approval has been obtained from the Engineer. No separate payment shall be made for the above mentioned works and the Contractor is deemed to have included the cost in his rates for the Works.

## **3.3. Setting Out of the Works**

### **3.3.1 General**

The Works shall be set out and tied to the National Co-ordinate System. The Contractor shall establish temporary benchmarks and survey stations at suitable locations on the Site(s) of the Works and during the progress of the Works shall periodically check the levels of the benchmarks and the co-ordinates of the stations against the original points lines and levels of reference given by the Engineer. Temporary benchmarks and survey stations shall unless otherwise approved be located clear of the Construction Works.

The Contractor shall submit to the Engineer for approval drawings in duplicate showing the locations and levels or co-ordinates as appropriate of each and every temporary benchmark and survey station used for the setting out of the Works.

The Contractor shall before commencing execution of any given section of the Works submit to the Engineer complete setting out details with supporting calculations and drawings (including drawings showing the locations and co-ordinates of the reference points used) in duplicate for approval.

The Contractor shall identify setting out dimensions for all structures by relating them to existing works and by interpretation of the Drawings.

The Contractor shall establish reference co-ordinate points at intervals of not more than 500 m along major pipelines and these points shall be located and clearly marked at approved locations either on existing buildings or by means of steel pins fixed in concrete.

The Contractor shall set out sections of the Works at such times as may be directed by the Engineer to enable Service Authorities to carry out temporary or permanent alterations to their equipment or buried services.

### **3.3.2 Preparatory works**

Preparatory works consist of setting out of the pipes routes, marking of all the existing installations within the area, application of adequate traffic solutions at the route, as well as of works which include installation of the fence around the construction site, manipulative surfaces and material, machines and equipment disposal area with the insurance of the surrounding areas and access during operational works.

Special attention has to be given to existing infrastructure routes. Before the beginning of the works, always in agreement with competent services, all existing infrastructure routes have to be checked, those predicted by the project for disintegration have to be marked, and work realization organization adjusted in a way that the conveyance of the existing sewerage to the next downstream manholes is ensured. Normal functioning of the water supply service has to be provided during the entire period of the Works Contract.

### **3.3.3 Execution and Workmanship**

The Contractor shall employ well qualified and experienced surveyors approved by the Engineer for the execution of the survey work and setting out as described in the Contract.

The survey instruments to be used by the Contractor shall be of the modern type and make, and suitable for the work to be executed and shall be maintained in a first class condition. The instruments and/or equipment shall be subject to the approval of the Engineer.

All field-books, calculations, maps, etc.. of the survey activities mentioned above shall be handed over to the Engineer immediately after the completion of the survey work.

## **3.4. Standards**

### **3.4.1 Standard Specification**

Materials and workmanship shall be according to approved Serbian Standards that prevail or acceptable international standards.

All materials, components and workmanship shall conform to the requirements of the latest editions and the strictest of the European and Serbian Standards and Codes of Practice and any other Standards which are referred to in the Specification. EU, Serbian, British and German Standards and Codes of Practice are quoted in this document but equivalent other EU Member State standards may be acceptable. Where a National standard and an international standard exist for the same material or workmanship the more stringent shall apply. The Contractor may propose alternative national standards to those specified; a copy (with English translation) of the proposed alternative must be submitted to the Engineer for review and approval. A copy (with English translation) of all approved standards shall be maintained on site by the Contractor.

The Standards and Codes shall be current at thirty days prior to the first date set for the delivery of Tenders. If necessary equivalent National Standards may be substituted for the Standards referred to in the Specification provided the Contractor shall have justified such substitution to the Engineer and only after written approval has been received from the Engineer.

### **3.4.2 Standards on Site**

The Contractor shall purchase and keep on site at least one copy of each of the relevant Standards, Codes and Manuals or approved National Standards which are referred to in the Specification. In addition, the Contractor shall keep on site a copy of any other Standard, Code, Manual, or National Standard, which applies to materials supplied.

Copies of the standards shall be made available for reference at all times at the office of the Engineer. Should the Engineer require an English or Serbian translation of any of the Standards or Manuals, the Contractor shall provide a typed copy of the translation within 7 days of receiving a written request from the Engineer.

Where proposed works connect to existing facilities the new materials must be compatible with the existing.

### **3.4.3 Matters Not Covered by Standards**

Any materials and workmanship not fully specified herein, or covered by the Standards, Codes or Manuals, shall be of such type and quality so as to produce first class work. In such circumstance the Engineer shall determine whether all or any of the materials offered or delivered to the Site are suitable for use in the Works and the Engineer's decision in this respect shall be final and conclusive.

### **3.5. Drawings, Maps and Calculations**

#### **3.5.1 Contract Drawings**

Drawings accompanying the present documents are for tender purposes only and show in principle, the Works to be constructed under the Contract. They may be modified or added to during the course of the Contract with the approval of the Engineer. These Drawings are given in Volume V.

#### **3.5.2 Additional Drawings**

The Contractor shall prepare and submit all additional drawings including and details for the construction and completion of the Works. These additional drawings shall be based on the format and principles adopted for the Contract Drawings and shall be submitted to the Engineer for his or any other further approval.

The drawings prepared by the Contractor shall cover the following aspects of the Works:

- Location and arrangement of the Contractor's buildings and offices, including access facilities and fencing
- Location and arrangement of work-yards, workshops, depots and stores for equipment, fuel and materials, including access facilities, electricity, water and telephone connections and fencing
- Location of, and proposals for the Temporary Works required for constructing the Works

An electronic copy of the Drawings shall be submitted on CD in PDF and open format too.

As described in the Contract the Contractor shall prepare the Main Design for parts of the works. Where indicated these Main Designs with drawings and documents shall be base for the issuance of the Building Permit. For that instance Main Design means the elaboration of the main design required for the issuance of the Building Permit according Serbian Regulations which is defined under the Serbian Building act (requirements for Main Design - Glavni Projekat).

Subject to the requirements of these Specifications the Contractor shall prepare the Shop Drawings necessary to execute the works. The calculations shall be submitted to the Engineer for approval prior to commencement of the relevant Sections of the works on site.

All dimensions in drawings, calculations and information furnished in connection with the Contract shall be expressed in metric SI units.

All drawings shall be ISO -sized to designations A0, A1, A2, A3, and A4. Each drawing shall carry the project title, the name of the Engineer, the Contractor and the Beneficiary together with the drawing title and number. Furthermore, each drawing shall have a title box in the bottom right corner showing:

- Date
- Scale and scale bar
- Separate revision box
- Signature of Contractor to the effect that the drawing, whether his own or from any other source, has been checked by him before submission to the Engineer

All layout and arrangement drawings submitted by the Contractor shall be drawn to scale and dimensioned. All clearances required for the installation, routine operation and maintenance of items of Works should be noted on the drawings.

The Contractor shall submit his drawings and documents to the Engineer for review or approval at least thirty (30) days prior to the execution of the work concerned with the said drawings and documents. Manufacturing drawings for items to be fabricated outside the country of the Works shall be submitted within one hundred twenty (120) days from the date of issue of the Notice of Commencement.

The procedure for the submission, review and/or approval of drawings and documents shall be understood to be as follows; provided that the Engineer shall reserve the right to make any changes to such procedure during the course of the works when the Engineer deems necessary. When the Contractor is ready to have the Engineer review and/or approve certain drawings and documents, he shall submit three (3) copies of clearly, readable copies of the drawings and documents. Within thirty (30) days after receiving copies of the drawings and documents from the Contractor, the Engineer will return one copy marked with one of the following classifications, depending upon whether the drawings and documents are to be "approved" or "reviewed":

- "APPROVED"
- "APPROVED EXCEPT AS NOTED - RE-SUBMITTAL NOT REQUIRED"
- "RESUBMIT AFTER CORRECTION"
- "NOT APPROVED"

Upon receipt of drawings and documents which have been marked as shown in 1 or 2 above, the Contractor may proceed with the work covered by such drawings and documents, making corrections if indicated there upon by the Engineer. Copies of all approved drawings shall be maintained at the Contractor's site office.

When returned drawings and documents have been marked as shown in 3 above, the Contractor shall make necessary corrections and/or revisions to the drawings and documents in a timely manner and shall resubmit three (3) copies of revised drawings and documents to the Engineer.

Any work done prior to the Engineer's approval of drawings and/or documents is not allowed and shall be at the Contractor's risk.

The Engineer's approval of the Working Drawings, Contract Records etc., shall not relieve the Contractor of the obligation to meet the terms of the Specification and any of the plant

which upon delivery to site is found to be incorrect or unsatisfactory, or which fails to perform its duty satisfactorily during commissioning or during the Defects Notification Period shall be replaced to the Engineer's satisfaction.

The Contractor shall be responsible for any discrepancies, errors, or omissions in the drawings and other particulars supplied by him, whether such drawings and particulars have been approved by the Engineer or not, provided that such discrepancies, errors, or omissions be not due to inaccurate information or particulars furnished in writing to the Contractor by the Beneficiary or the Engineer. The Beneficiary shall be responsible for drawings and information supplied in writing by the Beneficiary or the Engineer and for the details of special work specified by either of them.

### **3.5.3 Contractor's Documents**

The Contractor shall prepare and submit all Contractor's Documents (drawings, calculations, computer programs and software, manuals, models and other documents of technical nature) including details for the construction and completion of the Works.

These Contractor's Documents shall be produced and submitted to the Engineer for his approval, and shall comprise minimum the following when not already included in the Contract:

#### Pipelines:

- Hydraulic calculations, including determination of test pressures
- Site plan and general arrangement drawings
- Pipeline profiles
- Drawings and schedules showing all pipework, fittings, chamber and trench details and thrust blocks
- Reinforcement drawings and calculations for thrust blocks to pipework
- Drawings, calculations and method statements for all road, rail and river crossings and connections to existing pipework
- Landscaping, land drainage, top soiling and all ancillary works relating to reinstatement works

#### Civil and Structural:

- General arrangement and foundation drawings, complete with dimensions, for all buildings, tanks, plant and associated equipment
- Structural calculations and drawings including foundation design
- Reinforced concrete details, structural steelwork and masonry drawings
- Reinforcement drawings and calculations for in-situ and precast concrete
- Fabrication drawings for any structural steelwork
- Architectural and building works drawings including masonry, cladding, roofing, etc., and all specified fixtures and finishes both externally and internally
- Details of protective coating design
- Drawings of landfill construction details including all slopes, the position of individual rolls of HDPE liner on the side slopes and at the base, the leachate collection and extraction system, intermediate berms to denote cell boundaries, anchor trenches, landfill gas collection wells and any berms outside the landfill which alter the existing ground levels.
- Road construction drawings including kerbing and drainage details



- Drawings of fencing details and arrangements
- Landscaping, land drainage, sub and top soiling and all ancillary works

#### **3.5.4 Procedure for the Drawings and Calculations**

The drawings and calculations, which have to be produced by the Contractor, shall be made and submitted in accordance with the following requirements:

Sheet sizes shall be in accordance with international sizes unless otherwise agreed by the Engineer.

The drawings of all parts of the construction shall be clear and complete. The choice of scale will depend on the kind of drawing and/or details to be presented.

The Contractor shall submit three copies of all drawings and calculations to the Engineer when seeking his approval and the Engineer will return one copy of the drawings and calculations to the Contractor with his comments.

Alterations and/or remarks made by the Engineer on the drawings or calculation shall be incorporated immediately and the drawings and/or calculations re-submitted in three copies until final approval is obtained.

Four copies of each set of the approved drawings and calculations shall be submitted to the Engineer. The drawings shall be clearly rubber stamped as "WORKING DRAWING APPROVED BY THE ENGINEER" in English.

The Contractor shall design any Permanent Works for which he is responsible for in accordance with Serbian Law.

Commencement of work on any part of the Works construction will only be permitted after the approval by the Engineer of the Contractor's drawings and calculations.

The Engineer's approval of the Contractor's drawings and calculations including any alterations made by the Engineer shall not relieve the Contractor of his obligations to execute the Works in accordance with the Contract.

Variations requested by the Engineer shall be carried out. In the event of the Contractor disagreeing with the alterations requested by the Engineer, the Contractor shall send written notice to the Engineer within seven days of receiving the altered drawing(s). In such a case the Contractor shall resubmit the particular drawing(s) and calculations if needed, in three copies to the Engineer subsequent to the Contractor's consideration of the Engineer's comments.

#### **3.5.5 Record Drawings**

The Contractor shall prepare all necessary drawings and diagrams of the "as-fitted"/"as-built" Works as may be required for record and for care, maintenance, repair, etc., purposes and these shall include but not be limited to:

- Record plans. Mapping at a scale of 1:2,000 shall be used. The maximum coverage on any one sheet shall be 2 km x 1 km
- Pipe and appurtenances schedules
- Arrangement drawings of each complete installation to a scale of not less than 1:50
- Outline dimensioned drawings of each of the principal items of plant (e.g. pumping stations). Each shall carry or be accompanied by a schedule of fittings, instruments and components which shall include the maker's name, reference numbers, ratings and full particulars of all the component parts

- Sectional drawings of each of the major items of plant with the parts named and numbered to facilitate maintenance and overhaul as may be necessary for the manufacture of replacement components during the working lifetime of the plant
- Such electrical and operational diagrams as may be necessary
- Cable schedules, diagrams and route sections for cable installations
- Cable route plan of the Site and of each of the principal installations showing Sections through the cable groups and trenches

The Works shall not be deemed to be ready for issue of the Completion Certificate until the Record Drawings have been furnished.

### **3.6. General Requirements for Site Operations**

#### **3.6.1 Lighting and Electric Power**

The Contractor shall provide and maintain efficient temporary lighting and power supplies for all parts of the works as may be necessary and shall, in connection with such supplies adopt precautions to ensure the safety of all personnel.

The Contractor shall provide adequate lighting for the proper execution and inspection of the works. If the Engineer considers the intensity of lighting to be inadequate for the proper execution and inspection of the work being undertaken, the Contractor shall install such additional lighting as the Engineer may require.

#### **3.6.2 Sanitation**

The Contractor shall clean as necessary and maintain the site(s) in a hygienic condition and shall comply with the requirements and instructions of the Engineer.

The Contractor shall provide and maintain adequate toilet facilities including flushing W.C.'s, hot water and showers and additional suitable facilities as necessary for the use of his workmen.

#### **3.6.3 Use of Explosives and dangerous substances**

No explosive or other dangerous substance, e.g.: petroleum, highly flammable liquids and liquefied petroleum gases, shall be brought onto the Site or used for any purpose unless the Contractor has previously obtained the written approval of the Engineer.

The location of each explosives magazine and store of any other dangerous substance on the Site shall be approved in writing by the Engineer.

The storage of blasting explosives shall be in accordance with Serbian regulations and the conditions (if any) of the statutory license obtained by the Contractor and the relevant provisions of BS 5607.

### **3.7. Safety, Public Convenience and Environmental Protection**

#### **3.7.1 General**

The Contractor shall execute the Works in a manner complying with the best International and Serbian Safety Regulations and Standards. All Operations shall especially comply with occupational safety acts as per Serbian standards and norms.

Should the Engineer consider the Contractor's method of working unsafe or that there are insufficient or inadequate safety barriers or other devices or that there is insufficient safety or rescue equipment, the Contractor shall change his method of working or install or strengthen safety and rescue equipment if so instructed. Such instructions shall not relieve the Contractor of any of his responsibilities under the Contract.

Transportation of any material by the Contractor shall be in suitable vehicles which when loaded do not cause spillage and all loads shall be suitably secured. Any vehicle which does not comply with this requirement or any of the local traffic regulations and laws shall be removed from the site.

### **3.7.2 Fire Prevention**

The Contractor shall during the performance of the Contract make arrangements to comply with the current Serbian Fire Protection Act for the protection of the works and any adjacent property from fire, and if required shall give the Fire Authority all facilities periodically to inspect the fire prevention arrangements.

Particular care must be exercised in connection with the operation of electric-arc welding equipment, oxy-acetylene cutting equipment and other processes involving the use of open flames. Special arrangements will be necessary for the storage of highly flammable liquids on the site(s).

The Contractor must further comply with the Serbian Regulations on classification of structures, structural parts and areas to fire endangerment categories, the Regulation on changes of and amendments to regulation on classification of structures, structural parts and areas to fire endangerment categories, the Regulation on fire-protection access conditions, the Regulation on maintenance and selection of fire extinguishers, the Regulation on changes of and amendments to regulation on maintenance and selection of fire extinguishers and the Ordinance on technical norms for hydrant network for fire extinction.

### **3.7.3 Working Practices**

The Contractor shall take care and all reasonable precautions to ensure that roads and thoroughfares used by him either for the construction of the facilities or for the transport of equipment, labour and materials are not made dirty as a result of such construction or transport and in the event of their becoming thus dirtied in the opinion of the Engineer the Contractor shall take all necessary and immediate steps to clean them.

The Contractor shall take all measures to keep all public roads, pavings and hard standings clear of any spillage or droppings from his own and his sub-contractor's vehicles travelling to and from the site(s). All such spillage or droppings shall be immediately cleared to the satisfaction of the Engineer and appropriate Public Authority.

Generally, dust problems during the construction shall be reduced by spraying of water at the excavation sites and also before transport of dusty materials.

The method of working to be adopted shall be such as to permit the satisfactory completion of the facilities and to limit disturbance and damage.

Constructional equipment used in the execution of the facilities shall be of a design and be used in a manner that to the largest extent possible supports the adopted working method and ensures a satisfactory completion of the works. All equipment shall meet any requirements to maintenance and operational safety stated in these Technical Specifications or otherwise required under Serbian law.

If the Contractor fails to comply with stated requirements the Engineer may at any time request him to adopt another method of working. The Contractor shall respond to the Engineer's request immediately and shall have no claim against the Beneficiary for costs incurred by him in changing the method of working or in the provision and use of other equipment. The works shall be carried out in a way that prevents any damages to other construction works, buildings and other structures or any pipes or other utility lines, whether placed above or below ground level.

### 3.7.4 Noise and Vibration Nuisance

The Contractor shall within 30 days after having received the "Notice of Commencement" forward to the Engineer the following:

- a) A list of his plant and his Sub-Contractor's plant, equipment or procedures that may result in herein stated limits of noise and vibrations getting exceeded.
- b) A description of countermeasures to be carried out in case the noise and vibrations are not within limits stated below.
- c) A program for measuring noise and vibration levels. The program shall describe in detail for which work procedure measurements shall be carried out, and where and when the measurements take place.
- d) above items shall be corrected by the Contractor in case his scope of work is changed and in case of changes in his working method.

All above submitted material is subject for the Engineer's approval. Measurements shall be carried out by a company acceptable to the Engineer.

The Contractor shall organise his site and execute the work in such a way that the following noise and vibration levels are not exceeded.

Maximum Noise Levels:			
Period	Time of day	Type of areas	Noise Limit in Decibel
Monday – Saturday	07-18	Schools and Hospitals Residential areas Mixed residential, offices and small industries Industrial areas	60 dB 75 dB 80 dB 85 dB
	18-07	-	55 dB
Sundays, and National Holidays		-	40 dB

The noise limits shall be measured as the equivalent, normalised noise level at nearby houses and at other areas sensitive to noise.

Vibrations which may result in damages to buildings and other structures shall not exceed permitted values.

### 3.7.5 Traffic Arrangements and Access

The Contractor shall seek information on and comply with all requirements and recommendations of the police and the Local Road Authority regarding traffic arrangements and road safety measures. Before any work in or affecting the use of any highway is commenced, the Contractor's proposed method of working shall be agreed with, and confirmed in writing to, the Engineer and the Road and Police Authorities.

The Contractor shall provide all barriers and traffic signs as required by the Authorities or instructed by the Engineer. All signs shall comply with standard international practice or the requirement of the Local Road Authority and shall be displayed in both Serbian and English Languages.

The Contractor's operations shall cause no unnecessary inconvenience to the public. The access rights of the public shall be considered as important at all times. Unless otherwise authorised by the Engineer, Police or the Local Road Authority, the Contractor shall not obstruct traffic passing through streets on which the works are being carried out, unless an approved detour is provided and maintained and which is operational before interference with the existing way. Where ramps are required, they shall be provide and maintained to a

standard suitable in all respects for the class or classes of traffic or pedestrians requiring to use them.

### **3.7.6 Storage of Equipment, Construction and Excavation Materials in Public Streets**

Construction materials shall not be stored in streets and roads for more than five days after unloading. All materials or equipment not installed or used in the construction within five days after unloading shall be stored elsewhere by the Contractor at his expense unless additional storage time is authorised by the Engineer.

Excavated material shall not be stored in public streets, roads and public areas unless otherwise permitted by the Engineer. Such permissions may be granted only in case of excavated material to be used as backfill in adjacent trenches or areas, provided that ample space is available for the storage and after obtaining permission from the Local Road Authority, Police and Municipality.

All filth or other offensive matter met during the excavation of the works encountered shall be moved immediately to a suitable approved dump and shall not be deposited upon the surface of any street, or any place near a dwelling house or where it is likely to be a nuisance.

## **3.8. Demolition and Protection of the Works**

### **3.8.1 General**

The demolition works to be carried out under this Contract on the Sites for constructing the Works may comprise of retaining walls, concrete pavements, small concrete and brick structures, sheds and some small buildings or parts thereof, disconnected pipes and valves.

Details of the buildings and structures to be demolished by the Contractor shall be ascertained during the construction of the Works and shall be to the approval of the Engineer. The Contractor shall make necessary allowance in his Contract Programme for demolition works ordered by the Engineer.

No demolition of any existing building or structure or part thereof shall be carried out until it has been approved by the Engineer in writing.

### **3.8.2 Disposal of Demolition Materials**

All materials arising from the demolition and clearance of the structures shall be disposed of off Site. Pipes, fittings, valves, etc., which could be of value, shall be carted to the Water Company's depot or any other site prepared for by the Beneficiary at the Water Company's request.

### **3.8.3 Refilling and Finishing**

All voids shall be refilled with soil compacted to the same density as the surrounding soil and the surface shall be finished to the existing ground level and to the satisfaction of the Engineer.

### **3.8.4 Permission**

Permission for demolishing existing buildings and structures or parts thereof shall be applied in writing to the Engineer and shall be accompanied by a demolition programme. No demolition shall take place before obtaining the Engineer's permission and the area has been provided with all necessary relevant temporary Works and/or diversions which have been either requested or authorised by the Engineer.

### **3.8.5 Protection of Existing Objects**

The Contractor shall not demolish or remove any existing buildings, structures or other objects including trees, whether indicated on the Drawings or not, unless on a specific instruction from the Engineer. The Contractor shall take every care and precaution to protect from damage any of these objects, including houses, buildings, fences or trees, which are situated on or near the Site(s).

Any property situated in close proximity to the Works shall be protected against any damage which could be caused by vehicles, subsidence, vibration, etc.. Any damage caused shall be repaired by the Contractor to conform to the condition of the property prior to damage and to the satisfaction of the Engineer.

### **3.8.6 Filling and Sealing of Abandoned Pipelines**

Where new pipes are connected to the existing systems to replace the function of other pipe lengths, the length of the old pipes shall be dismantled and handled in accordance with 3.8.2

Disposal of Demolition Materials. On the Contractor's request the Engineer may agree to abandon old pipe structures. In that case buried pipelines to be abandoned shall be sealed with mass concrete plug of minimum length 1,000 mm at either ends.

Exposed pipelines to be abandoned shall be broken to a depth of 500 mm below the final ground level.

## **3.9. Preliminary Works**

### **3.9.1 General**

This section provides general information about temporary and preliminary works which shall be performed before the start of the permanent works.

Works encompassed by this section are: temporary works and preliminary works like site organization, setting out of works, clearing of ground and removal of topsoil.

### **3.9.2 Temporary works**

The Contractor shall design, arrange and provide at his own cost all temporary works needed in order to carry out the permanent works. The temporary works shall include the provision of road diversions, trench protections, pit protections, protection against flooding, protection for safety on site etc where considered necessary.

All temporary works shall be to the satisfaction of the Engineer, but this shall not relieve the Contractor of his responsibility for their design and adequacy. The Contractor shall obtain the approval of Ministries, service owners, local authorities and other third parties for the temporary works where required.

Temporary road diversions shall be designed and constructed to ensure that they perform satisfactorily in use and that there is no significant settlement, rutting or distortion of the running surface. They shall be surfaced and maintained to the satisfaction of the Engineer.

The structures shall be performed in accordance with valid Laws, Regulations and Standards of the Republic of Serbia. The Contractor is obligated to obtain all necessary permits required for execution of the Contract. All infrastructure facilities for site requirements (el. power, water, roads, drainage, etc.) are considered as Temporary Works and the Contractor shall provide them by itself.

The costs of the Temporary Works and facilities, the sampling costs and the costs of all tests on products and materials shall not be separately charged and they shall be considered to be included in the cost schedules of the Works.

### **3.9.3 Site organization**

The Contractor shall make a Site Organization Study identifying all technological features of the execution of the works, types and quantities of machinery and staff required. In the study the safety measures at work during the execution shall be worked out. Should the organization of the executions have any impact on nearby roads, a temporary traffic control study shall be made and submitted to a competent institution for approval. All the studies shall be submitted to the Engineer for approval and to the Authorities for claiming the start of the works ( prijava radova).

Such studies shall not be separately paid for, but they shall be deemed to be included in the costs of the Works.

### **3.9.4 Setting out of the works**

This section specifies the requirements for setting out of the Works and includes locating existing services, surveying the Site and establishment of temporary bench marks.

#### **Site information and inspection**

Before commencing the setting out of the Works the Contractor shall ascertain the location of all existing underground services within the Site boundary. The Contractor shall prepare a plan detailing the location of the services.

Any conflict between existing services and any part of the proposed Works shall be brought to the attention to the Engineer without delay.

Any re-work resulting from the Contractor's failure to locate and identify services shall be undertaken at the Contractor's cost.

Before commencing the setting out of the Works, the Contractor and the Engineer shall make an inspection of the Site.

Where appropriate, the Engineer shall require the Contractor to arrange for surveys to be undertaken, in conjunction with the owners or occupiers, of the condition of roads, properties, lands and crops which may be affected by the Works. Before any work affecting such roads, properties, lands or crops is commenced, the Contractor shall confirm in writing to the Engineer that the relevant survey is a true and accurate record of their condition.

#### **Levels and reference grid**

The Contractor shall establish accurate temporary bench marks on permanent blocks from which the levels to which the Works are to be constructed may be transferred. The location of temporary bench marks shall be agreed with the Engineer. The level of temporary bench marks shall be related to the Serbian National Height Datum. An existing bench mark or control station related to the Serbian National Height Datum will be indicated by the Engineer for this purpose.

The Contractor shall prepare a plan detailing the location of the bench marks and temporary bench marks and keep it up to date for the duration of the Contract.

The Contractor shall protect and maintain the temporary bench marks until the Works are complete. Upon completion of the Works the Contractor shall clear away the temporary bench marks to the satisfaction of the Engineer.

The Contractor is responsible for checking the accuracy of temporary bench mark. Any rework resulting from incorrect or inaccurate temporary bench marks shall be undertaken at the Contractor's cost.

When it is a requirement of the Project Documentation, or unless otherwise notified by the Engineer, the Contractor shall establish a Site Grid. The orientation, spacing and notation of the Site Grid shall be determined by the layout of the proposed works and as agreed with by the Engineer.

## **Surveying**

Before the Works of any part thereof are commenced, the Contractor and the Engineer shall together make a complete survey and take levels of the Site and agree all particulars upon which setting out of the Works shall be based, including existing plant, buildings and services.

The Contractor shall prepare drawings detailing all survey information and levels. Such levels shall be related to the temporary bench marks as aforesaid. The Plans shall also show the Site Grid. After agreement of the drawings they shall be signed by the Engineer and Contractor and shall form basis of setting out of the Works.

The Contractor shall submit the original signed Drawings with three copies to the Engineer.

Failing such surveys and agreements being prepared and/or signed by the Contractor, the surveys of the Engineer shall be final and binding upon both parties.

## **Setting out**

The Contractor shall carry out at his own cost the setting out of the Works.

A setting-out study of a construction work shall be prepared by a person authorized for activities of state surveying and real estate cadastre pursuant to a special regulation in line with the main design (i.e. 'Glavni Projekat'), which is an integral part of the Building Permit.

The setting-out of construction work shall be conducted by a person authorized for the performance of activities related to state surveying and real estate cadastre in conformity with a special regulation.

The correctness of the setting-out of the construction work shall be confirmed by Engineer by making an entry in the site diary before beginning with excavation works.

The Contractor shall be responsible for true and proper setting out of the Works in relation to reference data given in the Project Documentation and for accurately setting out the positions, levels and dimensions of all parts of the Works.

Any delay or loss resulting from errors in the setting out of the Works shall be the responsibility of the Contractor. Setting out shall be reviewed by the Engineer before commencing the Works, but such approval shall in no way relieve the Contractor of his responsibility for the correct execution of the Work.

## **Clearing of ground**

The clearing of a ground shall consist of removal of all obstacles above ground, from all the surfaces to be occupied with permanent or temporary structures, access roads and the like, including the disposal of materials. The clearing and field limits shall be the least possible required (a working corridor width 15 m) and approved by the Engineer. The method of the ground clearing work shall be chosen by the Contractor itself, whereby all safety at work regulations shall be observed.

The clearing shall include:

- manual collecting and burning of bushes and brush wood (dia < 10 cm)
- manual and mechanical cutting of vegetation and trees (dia > 10 cm)
- clearing of other obstacles (materials and waste)
- pulling out vegetation and tree roots.

All unsuitable materials shall become property of the Beneficiary and shall be disposed of satisfactorily as approved by the Engineer.

All the material obtained from a ground clearing operation that cannot be used shall be hauled to a spoil (depressions and holes along a route), without regard to a transportation length and it will have no impact on payment. The tree trunks (dia > 10 cm) shall be trimmed



by cutting branches off and sawn to the 1.0 m lengths and stacked away along a working corridor.

## **Site facilities**

### **General**

This section specifies the requirements for the Engineer's temporary site facilities and includes site offices, utility connections, provision of equipment and supplies and attendance.

Also this section specifies the requirements for the Contractor's offices, sheds, materials storage areas and other buildings as well as for utility connections, obligations and activities associated with the construction of the Works.

### **Engineer's site facilities and vehicles**

The Contractor shall provide, heat, cool, clean and maintain, until the completion of the Works or as long thereafter as the Engineer may require, but not beyond the Defects Notification Period, Engineer's temporary site facilities including site office and meeting room, utility connections, provision of equipment and supplies and attendance.

Facilities shall be mounted on adequate concrete foundations and shall be provided with concrete access steps where necessary.

Facilities shall be finished internally and externally with low maintenance materials.

Both site office and meeting room shall have a minimum area of 20 m<sup>2</sup> each and shall comply with the following:

- the structure shall be resistant to water and wind
- the office shall be air-conditioned to maintain a maximum temperature of 25°C at a relative humidity of 50% under the expected climatic conditions expected at the Site
- the office shall be efficiently heated and insulated to maintain a temperature of 20°C during winter months
- supply of technical and potable water
- adequate effective lighting, power outlets
- telephone and internet connections

The offices and meeting room shall be provided with the furniture (described in section 2) to the approval of the Engineer:

Sanitary and washing facilities shall be provided for the exclusive use of the Engineer and shall include a WC and a wash-hand basin. An adequate supply of hot and cold water shall be provided at all times.

The Contractor shall provide two suitable parking places adjacent to the office of the Engineer.

The Contractor shall make all arrangements and pay all charges in connection with the installation, maintenance, operation and removal of the service utilities described in this section.

The Contractor shall insure the site offices against fire, burglary and other risks.

The Contractor shall maintain the Offices in a clean and sanitary condition.

The position of the site facilities shall be to the approved by the Engineer.

Upon removal of the site offices, the area occupied or otherwise affected by them shall be reinstated to its original condition.

The Contractor shall provide the Engineer with one new personal vehicle and one new 4x4 vehicle (pick-up truck) for the period of the construction and Defect Notification Period. The Contractor shall bear the costs for registration, casco and regular insurance and servicing for both vehicles. The Engineer shall bear all other expenses, including servicing and repairs caused by misuse.

Minimum requirements for the personal vehicle are:

- engine type: turbo diesel
- engine power: 75 kW
- number of doors: 5
- number of seats: 5
- air conditioning: automatic
- trunk capacity: 500/1300 litres
- emissions: Euro 5
- other: ABS + MBA + MSR, ESP  
front and side airbags for driver and passenger

Minimum requirements for the 4 x 4 vehicle (pick-up truck) are:

- engine type: turbo diesel
- engine power: 90 kW
- cabin: double cab
- number of doors: 4
- number of seats: 5
- air conditioning: manual
- load compartment area: 2 m<sup>2</sup>
- payload: 900 kg
- emissions: Euro 5
- other: ABS + MBA + MSR, ESP  
front and side airbags for driver and passenger  
selectable 4WD with low range gears

All of the equipment shall be property of the Beneficiary after the end of the Defect Notification Period. The Contractor shall bear all costs related to the transfer of ownership.

### ***Contractor's site facilities***

The Contractor shall provide all offices, sheds, stores and other buildings necessary for him to undertake all duties, obligations and activities associated with the construction of the Works.

All buildings shall be supplied and maintained in good condition and shall be of neat appearance.

The position of all the Contractor's temporary site buildings shall be to the approval of the Engineer.

The Contractor shall maintain an office at the Site for the duration of the Contract. This office shall be open at all times during Site working hours.

Upon completion of the Contract, all temporary site buildings shall be removed and the area occupied or otherwise affected by them reinstated to its original condition.

The Contractor shall provide sufficient and appropriate materials storage areas. The storage areas shall be suitable for the materials to be stored in them and shall offer necessary protection where required.

The Contractor shall provide, maintain and subsequently remove temporary services for power supply, water supply, lighting and heating.

The Contractor shall provide, maintain and subsequently remove temporary roads, paths and parking areas and refuse disposal areas. The area occupied by temporary roads, paths, parking areas and refuse disposal areas or otherwise affected by them shall be restored to their original condition on completion of the Contract.

### **Project Sign Board**

The Contractor shall erect a Project Sign Boards in a position to be agreed with the Engineer and EUD according to visibility requirements and Construction and Planning law..

## **3.10. Earthworks**

### **3.10.1 General**

This section covers requirements for materials, products and works related to earthworks. Materials, products, equipment and works shall be made in compliance with Serbian standards and technical regulations.

If no standards are specified, corresponding EN (Euro Norms) shall be applied. If any standards or regulations cease being in effect in the meanwhile, the standards or regulations that replace them shall be applicable.

The contractor can propose that the recognized technical regulations (standards) of a foreign standardization institution (ISO, EN, DIN, ASTM, ...) be applied, provided this is justified in writing and the Engineer has approved it. The Engineer shall approve this change with the approval of the design engineer. The Contractor shall enter the change into the construction documentation.

The Contractor shall be responsible for all excavations and for the disposal of excavated materials as required for the construction of the Works and referred to herein as earthworks.

No earthworks shall commence until the Contractor has affected all safety measures, including the provision of barriers and traffic management measures.

### **Definition**

**"Compact soil"** is that part of the lithosphere on which the construction of a road or any other roadway object is planned.

**"Base soil"** (prepared compact soil) is compact soil on which any embankment is built, and it is prepared in a manner that will satisfy the stipulated geo-mechanical conditions.

**"Poor base soil"** is the layer that cannot be prepared with usual methods in such a way as to satisfy the stipulated geo-mechanical conditions. As a result, because of its adverse properties or state it needs to be removed or prepared for the intended function through special methods.

**"Humus"** is a surface layer of soil which contains organic matter in such quantities that it has adverse properties for the purpose of construction.

**"Bed"** is the prepared final layer of the embankment, compact soil prepared in the dyke or replaced compact soil, to a specific level and slope, which satisfies the required conditions with its physical or chemical conditions so that it can hold the load of any roadway construction and the traffic load.

"**Embankment**" is the part of the road built of land, stone or mixed materials on the base soil (prepared compact soil).

"**Step**" is step-shaped excavation in inclined compact soil.

"**Construction pit**" is excavation in compact soil in the shape of a pit for the purpose of building the foundations of a building or structure.

"**Trench**" is shallow or deep excavation in compact soil for laying out the installations.

"**Karst sinkhole**" is a type of a naturally-occurring pit in karst terrain.

"**Geotextiles**" are waterproof, non-woven, woven and composite materials which do not decompose.

"**Non-woven geotextiles**" are made by fixing filaments or fibres of a limited length (short fibres) which are placed straight one on top of another. They can be fixed mechanically (needle punching or sewing) and/or adhesively (using adhesives) or cohesively (by thermal action).

"**Woven geotextiles**" are made of fibre systems placed vertically to each other (nets). They vary according to the fibre type and the way they are connected, as well as the fibre count in a unit of length.

"**Sewn geotextile**" is a common term for flat products made by tying together one or more groups of fibres, threads or other elements.

"**Geocomposites**" are combinations of two or more of the previously mentioned individual components.

"**Geonets**" are polymer, flat structures which are used in geotechnical and construction works, with openings that are significantly larger than the structural elements which are tied together.

"**Drainage**" is used for collecting surface and ground water and/or other liquids and transferring them to other sewage systems.

### **3.10.2 Excavation**

#### **3.10.2.1 Excavation of humus**

##### ***Description of works***

This works encompass surface excavation of humus of different thickness and its transportation onto permanent or temporary landfills.

Works shall be performed in compliance with design and regulations and in accordance with requirements of these Beneficiary's Requirements and to the approval of the Engineer.

##### ***Performance of works***

Because of its properties, humus significantly changes its volume under a load, and changes of its water content significantly decrease its load-bearing capacity. As a result, it is not appropriate as a construction material and must be removed, unless it is being used as a surface layer. Humus soil is excavated from the surfaces of the site as well as from the surfaces of the borrow-pit.

Generally humus shall be excavated with machines. Hand excavations shall be used only when works done by machines are not satisfactory. Branches can in part be removed together with the humus, but it must be separated from it before humus is used for the humidification of embankment slopes or dykes.

During the repelling of humus no mixing of humus and non-humus material shall be allowed. In case of surplus of humus, it is necessary to foresee the location and shape of landfill in order to determine the amount of humus to be disposed of.

Water should not be allowed to remain on the ground for a long time during the excavation of humus. Therefore permanent transverse and longitudinal drainage must be provided. Water must be removed from the body of the site using connections to a drainage ditch, creek or a natural depression.

Areas meant for embankments as well as the first layer of embankment shall be settled and compressed immediately.

The thickness of humus shall be identified by the Engineer in the presence of the Contractor's representative, for every section of the site, particularly on the basis of a geotechnical report and control during the performance of works.

Identification of humus layer shall be done on the basis of odour, colour, content of agricultural and animal residual and the total amount of organic matter. If it is not possible to separate the humus layer and soil visually, the thickness of humus layer shall be determined according to testing of organic matter. If not otherwise defined, humus layer is considered to be a surface layer of spliced ground with the amount of organic matter more than 10 mass %.

### **3.10.2.2 Open-cut excavation**

#### ***Description of works***

The Works encompass open-cut excavations which are foreseen by the design or according to the requirements of the Engineer. These open-cut excavations can be: excavation of cutting, notch, borrow pit, excavation for corrections of rivers and regulations of rivers, excavations for deviation of roads and access roads as well as open-cut excavations during construction. The works include loading the excavated materials into transport vehicles. All excavations shall be carried out according to elevations specified in design and prescribed slopes and having in mind required properties for the intended purpose of excavated material, in accordance with these Beneficiary's Requirements.

Works shall be performed in compliance with design and regulations and in accordance with requirements of these Beneficiary's Requirements and the Engineer.

#### ***Performance of works***

The choice of work technology in wide excavations depends on the following:

- Planned artificial objects (support and retaining walls, drainage, road canalisation and similar),
- Type of soil,
- Possibility of using a certain type of machinery for excavation and transport,
- Height and length of the desired excavation,
- The quantity of soil that needs to be excavated,
- Transport lengths,
- Deadlines for the completion of the excavation and/or deadlines for the completion of the landfill.

Using the aforementioned elements, as well as other circumstances which can affect the choice of the technology used, the Contractor shall, respecting the appropriate valid regulations and standards and in accordance with these Beneficiary's Requirements select the optimal technology for excavation.

The excavation can be performed in one of these ways or a combination thereof:

- Full profile excavation from the front,
- Excavation of the dyke (ditch) from the side,
- Excavation in horizontal layers,

- Excavation with a transverse ditch.

All excavation must be carried out according to the planned levels and stipulated slopes, according to the project and/or the requirements of the Engineer. During the excavation works, all occupational health measures must be implemented and all existing objects and communication networks shall be ensured.

All materials from excavation remain the property of the Beneficiary. The Contractor shall remove it from the Site and dispose of it in a manner and at a location to the approval of the Engineer.

During the excavation special care has to be taken in order not to undermine or damage slopes which can lead to scrolling and sliding. In case of undermining or damaging of slopes, the Contractor shall immediately repair damages according to instructions given by the Engineer. The Contractor has no right to ask for additional money for repairing those damages. Open-cut excavation shall be carried out according to chosen technology and using the appropriate machinery. Manual excavation shall be limited to the minimum necessary. Depending on soil type, technology and chosen machinery, there are several types of open-cut excavations:

#### ***Excavation in "A" category material***

"A" category materials include all hard materials which require blasting over the entire excavation.

This group includes all types of hard and very hard stone soils of compact rock (eruptive, metamorphic and sedimentary) in a healthy state, including also possible thinner layers of loose materials on the surface or such boulders with occasional loam deposits and local friable or pulverized zones.

This category also includes soils which contain over 50% of isolated rocks larger than 0.5 m<sup>3</sup>, which also require blasting to facilitate excavation.

#### ***Excavation in "B" category material***

"B" category material includes semi-solid rock soil, which requires partial blasting, and the remaining part of the excavation is executed with direct machine work.

This group of materials includes the following: flysch materials, including loose materials, homogenous marlstone, friable sandstone and mixtures of marlstone and sandstone, most dolomites (except the very compact ones), disintegrated boulders on the surface in thicker layers with mixed disintegrated zones, very pulverized limestone, all types of slate, some conglomerates and similar materials.

#### ***Excavation in "C" category material***

"C" category materials include all materials that need not to be mined, but can be dug up right away by means of appropriate machines – bulldozers, excavators or scrapers. This category would comprise:

- Fine-grained connected (coherent) soils such as clay, dusts, pulverized clay (loam), sandy dust and loess,
- Coarse-grained unconnected (incoherent) soils such as sand, gravel i.e. their mixtures, natural crushed stones or similar material,
- Mixed soils that are a mixture of coarse-grained unconnected and fine-grained connected materials.

#### ***Wide excavation in "A" category material***

During the blasting works in this category of materials, the Contractor must have at his disposal an experienced and qualified work force for these types of works. The blasting plan must be prepared by the Contractor and it must be approved by the Engineer before the

beginning of the works. All amendments during the works must be approved by the Engineer.

During the use of explosive it is necessary to proceed in compliance with the chosen technology, legislation in force and related regulations in order to assure the safety of site, equipment, structures, people and environment. When blasting, as well as during excavation works, possible disturbances to traffic, people and the environment must be minimized. Where approval for blasting is required the Contractor shall obtain same at his own cost.

Also all necessary traffic and safety signalling shall be provided, as appropriate.

Blast holes as a rule are executed using deep drills equipped and adapted to this type of work. Prior geotechnical tests shall be used to determine the physical and the mechanical properties of the stone masses and the direction the layers spread and fall in relation to the site. This will serve as the basis for the selection of the technology and determining the excavation manner, the drilling manner, the distance between the holes and the explosive charges. The layout of the holes and the explosive charges per hole must be such that they will ensure the creation of the most favourable granulation of the blasted material, minimizing the need to subsequently pulverize stone pieces.

In order to create the slopes in the best manner possible, "smooth blasting" must be carried out prior to blasting in the excavation profile. This will make it easier to prepare the slopes in the end, the surfaces will be more regular and the quantity of loose materials which needs to be cleaned from the slope is minimized. This prevents the stone mass from scattering on the slopes, rendering them more stable and easier to maintain. If the stone mass is separated from the remaining mass in the excavation core according to the projected surface of the slope embankments to the finished level, profile digging of the excavation is reduced to a minimum. This effect depends on the hardness of the stone mass, and the direction and slope of the layers, as well as the number of layers and the cracks within the stone mass.

Materials are excavated to the projected slope incline. Loose parts of the stone must be removed to the height of the bed, so that construction site traffic can pass over it. Temporary lateral and the longitudinal drainage must be prepared immediately. If necessary, the slope of the ditches should be executed at a steeper angle than projected (for the protection of objects and similar). In some cases, this can be achieved using the correct drilling and blasting technique. This way the slope pitch can be increased by approximately 25%, especially when the layers in the slope have a favourable position. The Engineer must approve such solutions.

If the material from the excavation is to be used for the production of granular stone material for construction, aggregates for concrete and asphalt layers, proof of usability based on the results of laboratory tests must be obtained from the authority in charge.

If, based on prior testing by the authority in charge, proof is obtained that the stone material may be used, the appropriate work technology must be planned and attention paid to avoid mixing loam mixtures with the stone material which has been tested. The Engineer must approve the use of such materials.

#### **Wide excavation in "B" category material**

In addition to machine work, this category of material requires a certain degree of blasting or ripping. However, despite the fact that when excavating such material the scope of blasting is small, the Contractor must apply the same technology and safety measures as when blasting pure stone material ("A" category material). When excavating material sensitive to atmospheric conditions, at the same time the following need to be ensured: loading the material, transport to the permanent deposit site or its construction in the embankment, unloading and construction.

The excavation to the planned bed formation height may be done only if the material is not sensitive to atmospheric conditions and if the soil in the bed zone is capable of handling the construction site traffic. If this is not the case, the excavation must be done to a height of 0.2-

0.3 m above the planned bed formation height, while the final excavation shall be carried out immediately before making the bed construction. The materials from the wide excavation may be of various components, so that the lateral and longitudinal drainage must be executed properly in all phases of the work. All water must be taken away from the body of the landfill into appropriate receptacles..

During work on the excavation until the completion of all works on the site, the Contractor is obliged to pay attention that due to possible improper drainage the executed slopes are not damaged, nor their stability before landscaping and releasing the object for use.

The slope inclines in the ditches and the dykes must be executed in accordance with the project. Inclines may be very different, because this group of materials encompasses a wide range of stone masses according to their physical and mechanical properties. The slope pitch will depend on the following:

- In sandstone and conglomerates on the type of adhesion and the degree of adhesion,
- In layered rocks on the slope of the layers, and
- How cracked the soil is and its properties.

During the work, at the request of the Contractor, possible changes to the slope incline shall be determined by the Engineer with the previous opinion of the design engineer and in accordance with the properties of the mixed material, the geological findings, the increased need for the appropriate material and occurrences in the excavations, etc.

Such materials are intended mainly for the making of embankments and berms. Sometimes the materials from this group can be used for making the load-bearing layers of the access and other local roads. This needs to be proved with appropriate testing on test sections.

#### ***Wide excavation in "C" category material***

The excavation is done directly with machines in materials of this category. Scarifying in these materials is applied sometimes only in order to increase the efficiency of the machines. The selection of the type of machines and their number is determined by the selected excavation technology.

The excavation is allowed to a height of 0.2-0.3 m above the planned bed formation height, while the final excavation shall be carried out immediately before making the base of the landfill and any road construction, except for materials which are not sensitive to the effects of water.

If the excavated material is sensitive to atmospheric conditions, it may not be deposited in the body of the landfill or any road. As a result, such materials must be immediately loaded, transported and built into the embankments or unloaded at the place of the permanent deposit. All excavations shall be carried out according to the project profiles, heights and inclines, bearing in mind the properties of the excavated materials and their possible usage for building embankments, berms or as construction material for other useful purposes.

Everything that has been said about the drainage and slopes of the inclines in excavations in "B" material categories is applicable in particular to the earthen materials of this category, because they are exceptionally sensitive to the effects of water and the stability of the incline, so that even the smallest mistake can reduce the speed of the work and significant material damages. The incline of the working slopes in excavation is within the limits of 1:1 for loose large-grained soil and 1:3 for fine-grained coherent soil. Material of this category is most frequently used for making embankments and berms. Since they are frequently obtained through excavation in shallow dirt dykes and/or ditches, they usually contain a high quantity of humidity, and they can also contain a high quantity of organic substances.

Considering this, during the work, the quality of the material is verified through laboratory testing, while how appropriate they are is determined based on the criteria specified in that



subsection. During excavation, for every change of soil, appropriate samples must be taken for testing whether the soil is appropriate for its intended use.

If the testing does not confirm that the material may be used for building embankments, the Engineer shall determine the place this material will be deposited and approve it be replaced by a more appropriate material. Unless specified otherwise, such material is mainly used for expanding the embankments, making berms and creating plateaus for parking lots and lookout points.

If the excavation technology is not specified by the project or cannot be applied due to changes which arose during the works, the Contractor shall propose appropriate technology.

The Engineer shall consider and approve the proposed technology.

The schedule of the masses and the transport distances shall be determined by the Contractor.

The mass schedule shall be used for determining the most appropriate location of the permanent material deposits if there is excess material from the excavation or if the material is not appropriate for building embankments or berms, etc.

If there is a lack of material for building embankments and berms, it can be made up from the borrow-pit(s) proposed by the Contractor which has been approved by the Engineer.

If the Contractor proposes one or more borrow-pit, he shall prove the quality and the quantity of the material at his own expense and based on this request the Engineer shall, if appropriate, approve the use of this borrow-pit. The costs of expropriation, preparation of the access, preparation of the borrow-pit after completing the excavation in it, as well as the appropriate fees shall be paid by the Contractor.

Before starting to use the borrow pit, the Contractor shall survey the terrain in agreement with the Engineer and create a proposal for the excavation technology. The technology proposal must contain the following: The situation with the longitudinal profiles of the planned excavation, the excavation manner-both vertically and horizontally, the type of machines and vehicles, the places humus and other useless material will be disposed of and a proposal for reinstating the borrow-pit after the end of its use.

Before starting to use the borrow-pit, the Contractor shall request the approval of the Engineer for the proposed technology.

The capacity of the excavation in the borrow-pit must be in accordance with the transport and integration possibilities, especially if the material is sensitive to atmospheric conditions.

The borrow-pit drainage, as well as the inclines of the slopes being used, must be in accordance with the given conditions for earth materials.

The Contractor must request approval from the Engineer for all subsequent expansion and deepening of the borrow-pit. The Contractor shall be responsible for all of the expenses and damages that are caused by the works. The Contractor shall be responsible for all damages for destroyed cultures and land.

### **3.10.2.3 Excavation of trenches for pipelines**

#### ***Description of works***

This work on excavations for trenches for pipelines and drainages includes excavations of materials according to the design with all necessary braces, drainage and temporary disposal of excavated material and spreading or carriage of surplus material after the completion of backfilling. Trenches can be executed in all types of material.

#### ***Performance of works***

Excavations must be carried out in accordance with the chosen technology, by machines, while manual labour should be minimized and used only where working with machines is not possible.

The excavated material should be deposited temporarily at a safe distance, and at least one meter from both sides of the upper edge of the excavation, provided this is possible considering the terrain and other circumstances.

Humus should be separated from other materials if the excess material is used for building embankments or berms.

If the project does not foresee the use of excavated materials for specific purposes (embankments or berms), at the end of the works it needs to be spread out and planned or transported to a depot specified by the project or determined by the Engineer and organized in accordance with these requirements.

The excavated material shall be sorted (evaluated) according to categories ("A", "B", or "C").

The grade level of the regulation canals must correspond to the project so that water cannot remain in the canal. This will be verified by geodetic control after completing the excavation on every project profile or more frequently if needed.

If more material is excavated during construction than anticipated by the project and without the approval of the Engineer, the Contractor shall not be compensated for this excavation and the possible reparations of such work shall be done at the Contractor's expense.

The work must be organized in such a way that in case of adverse weather conditions there is no damage to the performed works or the open surfaces due to material being washed away.

Roots and similar obstacles in the trench must be removed. This work is deemed to be included in Contract Price.

After completing the excavation, the height of the bottom and the slope of the trench shall be verified on every project profile and more frequently if needed.

### **3.10.2.4      Transportation of materials**

#### ***Description of works***

This work covers transport of excavated material from the location of excavation to the location of unloading.

#### ***Performance of works***

The types of transport vehicles and the transport manners can vary according to the following: The category and quantity of the material, excavation and loading method, as well as the length of the transport. The transport capacity must be in accordance with the excavation capacity and the capacity of the compaction machines for making the embankment.

Because of the limited size of the transport vehicle box, the mass of the material in loose state must be kept in mind, and the number of transport vehicles must be planned accordingly.

The transport must be quick and economical. To this end, the following must be done:

- Use greater capacity transport vehicles respecting the bearing of the existing roads,
- Use multi-functional transport vehicles.

Bulldozers, scrapers, dump trucks, vehicles for transporting materials which operate off public roads and vehicles for transporting materials greater distances on public roads may be used for pushing and transporting excavated material.

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Transport distances, over a previously made path or public transport roads according to these technical terms and conditions are divided into the following groups:

- Pushing or disposal up to a length of 10 m (calculated in the excavation)
- Pushing to a distance of 10-60 m
- Pushing to a distance of 60-100 m
- Transport to a distance of 100-300 m
- Transport to a distance of 300-600 m
- Transport to a distance of 600-1,500 m
- Transport to a distance of 1,500-5,000 m
- Transport to a distance greater than 5,000 m.

The Contractor is responsible for fully ensuring the transport, both at the construction site itself, as well as on the public traffic areas.

The Contractor shall do this:

- a. At the construction site
  - By setting up and maintaining properly the construction site roads,
  - By building and maintaining temporary facilities,
  - By equipping the excavation across a road with appropriate signage, which must be lit up at night;
- b. On the public roads
  - By setting up appropriate traffic and light signalization,
  - By using vehicles of the appropriate parameters and permitted load-bearing capacity (axle weight),
  - By preventing mud from being brought onto the roadway and if it is, cleaning the roadway.

The Contractor shall be solely held responsible for all consequences resulting from not acting in accordance with the valid legislation and regulations as well as the specified requirements.

### **3.11. Settlement of foundation ground**

#### **3.11.1 Settlement of foundation ground with mechanical equipment**

##### **3.11.1.1 Description of works**

This work refers to enabling spliced soil to take the load of any from embankment, pavement structure and traffic load for roads on the embankment or to take the load from any pavement structure and traffic load on roads in cuttings.

The depth of foundation ground depends on the type of soil. It is defined with project and it shall be greater than 30 cm.

##### **3.11.1.2 Performance of works**

In case of bound soil, foundation soil shall be settled after the removing of all humus according to design or instructions received by Engineer. Such soil shall achieve optimum moisture before compaction.

Special care shall be dedicated to keeping foundations from significant wetting in case of materials which are sensitive to water. Technology and planning of work shall be in such manner that soil shall be compacted immediately after the removing of humus in case of

favourable moisture content. Drainage of foundation soil shall be ensured during the construction.

The soil surface shall be settled before compaction. Compaction of foundation soil shall be according to chosen technology and appropriate compaction equipment which depends on type of bound soil.

Settlement of the foundation layer for unbounded materials shall be done mostly with compaction equipment.

In solid materials it is not necessary to compact the soil. It is important to clean the surface and ensure good placing of embankment, especially in case of inclined terrain and if case of execution of steps.

Solid materials on cuttings shall be levelled with crushed stone material and compacted.

### **3.12. Execution of embankment**

#### **3.12.1 Description of works**

This section includes filling, spreading, forming and, if necessary, wetting or drying of materials for embankments.

#### **3.12.2 Performance of works**

Every layer of filling material shall be placed horizontally in longitudinal direction or according to a slope close to the designed longitudinal slope. Deviation from this is possible only when building access ramps for deeper recesses, when the embankment layers can be at a greater slope. Embankments shall have minimum cross slope at all stages of execution.

Each additional layer must be compacted in its entire width using appropriate compaction devices. Compacting must be done from the lower edge towards the higher one.

The material must be transported on an already partially compacted embankment, if possible always on new tracks, so that the transport also enables certain uniform compaction of embankment layers. Adding a new layer of the embankment can be started only after the previous level has been compacted enough and when the required compaction has been proven through testing.

The height of each individual spread layer of the embankment material must be in accordance with the type of embankment material and the depth effect of the compaction machinery.

If there is no verified experience about the possibility of compacting with specific embankment material and machinery, the depth of the embankment layer is determined on an experimental segment.

Test shall be performed on trial section of 50 m:

- A layer of embankment material of the appropriate moistness and thickness is spread, for which it is assumed that it can entirely be compacted using the planned compaction machinery.
- The layer is then compacted as the compaction machinery passes over it a number of times. After a certain number of times, the compaction is tested.
- Compaction is tested in at least four places, at least two of which are on the bottom half of the layer.
- Based on the given results, the Engineer approves the appropriate methodology by recording it in the construction log. The Contractor shall bear all costs connected to the experimental segment, and the segment built in such a way, if it is located on the

route and if the compaction is satisfactory, shall be recognized as constructed embankment.

- The embankment material is placed on prepared base soil or an already created embankment layer only after the Engineer approves the base soil or the layer of the already created embankment. Upon completing the embankment, its slopes are organized and planned.

### 3.12.3 Quality control

The embankment dimensions must be controlled during the work by comparing them to the project dimensions. Detailed control is performed upon the final approval of the final layer of the embankment (bed) by measuring from the fixed staked out points on the site on the horizontal and vertical projection.

If it is determined that the embankment slope pitch exceeds the projected pitch, the Engineer may demand correction according to the projected slope. The slope pitch must be corrected using steps, by applying the same quality material and the same compaction machinery until reaching the required level of compaction. Decreasing the embankment slope pitch by "sticking" a layer of material without compaction and without prior building of steps is not allowed.

### 3.12.4 Execution of embankment of earth materials

Earth materials are clays of low to high plasticity, dust, clay dust and similar materials, which are sensitive to the presence of water (part of the materials included in the excavation category "C").

These materials are compacted using tampers, smooth rollers on rubber wheels and vibroplates.

Embankments and berms of earth materials shall be executed in layers from 30 to 50 cm, and the actual maximum thickness of the spread embankment layer shall be determined on an experimental segment, if there is no verified experience regarding the thickness of the layers in which this material can be properly compacted using specific compaction machinery. In determining the appropriateness of earth materials for building embankments, all materials from the dykes and the borrow-pit must be previously tested, if this has not been done in the geotechnical report. All material changes must be determined as well. At least two samples must be tested for each type of material.

Non-uniformity coefficient ( $U = d_{60}/d_{10}$ ) of the material for embankment building must be greater than 9.

The use of materials where  $U \leq 9$  (for instance, uniformly granulated sand) is also possible, but with the application of special integration technology.

Embankment material must not contain more than 6 % of organic components. If it contains between 6 % and 10 % of organic matter, it must be proven through detailed laboratory tests that it is appropriate for being used.

This condition applies to uniformly spread out and dissolved organic matter. Organic matter in pieces or deposits (wood and similar) must be removed from the embankment material.

- The optimal quantity of water must be below  $W_{opt} \leq 25\%$ .
- The material must not have a dry surface mass (according to the standard Proctor) under  $\gamma_d = 1.50 \text{ g/cm}^3$  for embankments up to 3.0 m in height, and for embankments over 3.0 m  $\gamma_d = 1.55 \text{ g/cm}^3$ .
- The material must not have a liquid limit in excess of  $W_L \leq 65\%$ .
- The material must not have a plasticity index in excess of  $I_p \leq 30$ .

- The swelling of the material under water after four days must not be greater than 4 %.
- Proctor's number must equal  $P_b = 0$  to 0.20.

The material must not be built into the embankment even if it meets all the aforementioned conditions if its humidity is over the limits which ensure the stipulated quality of the construction. The humidity of the material must not vary more than  $\pm 2\%$  from the optimal wetness determined by the standard Proctor procedure. This means that material which is too humid must be dried before being used (by being spread out, broken down, turned over, exposed to the sun and wind) and material which is too dry moistened (by spraying and splashing) until the desired humidity is achieved. Before compacting earth material which was too dry and was then sprayed, some time should pass so that the humidity in the material may be uniformly distributed.

When building embankments from compacted earth material, all of the material brought to the construction site must be used and compacted on the same day.

If after a certain layer of the embankment has been compacted and tested the next layer is not immediately placed over the top, but only after a longer period of time in various weather conditions, before continuing, the compaction of that layer must be tested again.

Adding a new layer of the embankment can be started only after the previous level has been compacted enough and when the required quality (compaction) of the previous layer has been proven.

Work on the embankment and compaction must be stopped any time when the desired results cannot be obtained (due to rain, high ground waters or other adverse atmospheric conditions).

Materials for embankment shall be not placed on frozen ground. Snow, ice or frozen earth materials shall be not incorporated into the embankment. Earth materials used for the embankment shall satisfy following requirements:

Position of embankment layers	Sz (%)	Ms (MN/m <sup>2</sup> )
a) layers of embankment with more than 2 m height from the base of embankment to 2 m below formation level	95	20
b) layers of embankment with less than 1 m height and layers of embankment with more than 2 m height below formation level	100	25

### 3.12.5 Execution of embankment of mixed materials

Mixed materials are mixed stone and earth materials, clay gravel, crushed stone covered in clay, friable stones - slate, marlstone, flysch materials and so on, in other words, materials which are less sensitive to water action (most materials of the "B" excavation material category and part of the "C" excavation material category).

These materials are compacted using rollers.

Embankments and berms of mixed materials shall be executed in layers from 30 to 60 cm and the actual maximum thickness of the spread embankment layer shall be determined on an experimental segment, if there is no verified experience regarding the thickness of the layers in which this material can be properly compacted using specific compaction machinery.

Non-uniformity coefficient ( $U = d_{60}/d_{10}$ ) of the material for embankment building must be greater than 9.

If these are materials with a tendency to over-granulation during compaction, such as, for instance, some types of friable rocks, and their non-uniformity coefficient cannot be determined or is not realistic, it must be determined in a practical manner on the experimental segment whether they are appropriate for use.

The material must not be built into the embankment when the moisture exceeds the limits which enable the stipulated quality of construction to be achieved.

Materials for embankment shall be not placed on frozen ground. Snow, ice or frozen earth materials shall be not incorporated into the embankment. Mixed materials used for the embankment shall satisfy following requirements:

Position of embankment layers	Sz (%)	Ms (MN/m2)
a) layers of embankment with more than 2 m height from the base of embankment to the 2 m below formation level	95	35
b) layers of embankment with less than 1 m height and layers of embankment with more than 2 m height in the area below formation level	100	40

### 3.12.6 Execution of embankment of stone materials

Stone materials are the materials obtained through mining, ground stone and gravel; in other words, and materials which are practically not sensitive to the presence of water (materials of the "A" excavation material category and part of the "C" excavation material category).

These materials are compacted through vibro-rollers (self-propelling and trailer-type), vibro-compactors and compactors, depending on the type of material used.

Embankment of stone materials shall be executed in layers from 50 to 100 cm, and the actual maximum thickness of the spread embankment layer shall be determined on an experimental segment, if there is no verified experience regarding the thickness of the layers in which this material can be properly compacted using specific compaction machinery.

The material for building the embankment must satisfy the following criterion:

- non-uniformity coefficient ( $U = d_{60}/d_{10}$ ) must be greater than 4.
- maximum grain size may be equal to at most half the thickness of the layer, but not over 40 cm (allowing that 15 % of the grains are up to 50 cm in size).

Near to structures, the Contractor usually has to change the methodology of building and compacting the embankment since large vibrating machines can cause damage on newly built and old structures. For the proposed machines, the Engineer must approve the manner and the start of compaction near structures.

Works on the execution of embankments shall not be performed when the material is frozen or when there is snow or ice on site. Stone materials used for the embankment shall satisfy following requirements:

Position of embankment layers	Sz (%)	Ms (MN/m2)
a) layers of embankment with more than 2 m height from the base of embankment to 2 m below formation level	-	40
b) layers of embankment with less than 1 m height and layers of embankment with more than 2 m height in the	-	40

### 3.13. Execution of formation level

#### 3.13.1 Description of works

This section includes setting of the formation level in cuttings, embankments and trenches, in other words, the rough and fine planing of the material and compaction to the required level of compaction. The bed must be built according to the heights from the design.

The formation level is the final layer of embankment or cutting with an appropriate bearing capacity and a thickness of up to 50 cm depending on the type of material.

#### 3.13.2 Execution of formation level of earth materials

Earth materials are clays of low to high plasticity, dust, clay dust and similar materials, which are sensitive to the presence of water (part of the materials included in the excavation category "C").

The material spread on the base must be compacted immediately. If the already compacted bed has been exposed to adverse weather conditions or damage for some time, before continuing the works the Contractor must put it in the state required by this project and these General Technical Terms and Conditions. Works on preparing earth material beds include planing, possible repairs of smaller areas of poor quality with better material, possible necessary moistening or drying of the material and compaction to the required level of compaction.

If compaction is not possible because of high natural humidity or adverse weather conditions, one of the methods of repairing this must be used as specified in the section of preparing the base soil. The Contractor shall propose the repair method and the Engineer approve it.

The material for the construction of earth material beds must satisfy the following criteria:

- The non-uniformity coefficient ( $U = d_{60}/d_{10}$ ) must be greater than 9,
- The maximum dry surface mass according to the standard Proctor procedure must be greater than  $1.65 \text{ t/m}^3$ ,
- The liquid limit  $W_L$  must be less than 40 %,
- The plasticity index  $I_p$  less than 20 %,
- The swelling of the material after four days of immersion in water must not be greater than 3 %,
- The California Bearing Ratio must be greater than 3 %.

The humidity of the material must not vary more than  $\pm 2$  % from the optimal wetness (determined by the standard Proctor procedure).

If in the cuttings with earth materials the material does not satisfy the required criteria of appropriateness, the poor material in the bed needs to be replaced in the manner specified for replacing poor base soil, most frequently in combination with the application of geotextiles.

Works on the execution of formation level shall not be performed when the ground is frozen or when there is snow or ice on site. Earth materials used for the formation level shall satisfy following requirements:

- compaction degree according to standard Proctor procedure ( $S_z$ )  $\geq 100$  %,
- compressible module measured with circular plate  $\varnothing 30 \text{ Ms} \geq 30 \text{ MN/m}^2$ .



### 3.13.3 Execution of formation level of mixed materials

Mixed materials are mixed stone and earth materials, clay gravel, crushed stone covered in clay, friable stones - slate, marlstone, flysch materials and so on, in other words, materials which are less sensitive to water action (most materials of the "C" excavation material category and part of the "B" excavation material category).

Works on preparing mixed material beds include planing, possible repairs of smaller areas of poor quality with better material, possible necessary moistening or drying of the material and compaction to the required level of compactness.

When the bed material in the dyke is very non-homogenized (rock mixed with clay), the excavation needs to be 30-50 cm deeper and a layer built of homogenized mixed or stone material.

The material for the construction of mixed material beds must satisfy the following criteria:

- The non-uniformity coefficient ( $U = d_{60}/d_{10}$ ) must be greater than 9,
- The maximum grain size is 60 mm (10 % of the grains may be up to 70 mm).

The humidity of the material must not vary more than  $\pm 2$  % from the optimal wetness (determined by the standard Proctor procedure).

Works on the execution of formation level shall not be performed when the ground is frozen or when there is snow or ice on site. Earth materials used for the formation level shall satisfy following requirements:

- compaction degree according to standard Proctor procedure ( $S_z$ )  $\geq 100$  %,
- compressible module measured with circular plate  $\varnothing 30$  Ms  $\geq 35$  MN/m<sup>2</sup>.

### 3.13.4 Execution of formation level of stone materials

Stone materials are the materials obtained through blasting, ground stone and gravel (materials of the "A" excavation material category and part of the "C" excavation material category).

Works on the preparation of the bed in stone materials in the cuttings includes levelling of the remaining rock tips, adding and spreading a levelling layer made of pure finer stone material, it's planing, moistening and compacting to the required level of compactness.

For stone material embankments, the finishing layer must be levelled using finer stone material.

The quality of the material for the levelling layer must be verified before it is used for construction.

The material for the construction of stone material beds must satisfy the following criteria:

- The non-uniformity coefficient ( $U = d_{60}/d_{10}$ ) must be greater than 9,
- The maximum grain size is 60 mm (10 % of the grains up to 70 mm).

Works on the execution of formation level shall not be performed when the ground is frozen or when there is snow or ice on site. Stone materials used for the formation level shall satisfy following requirements:

- compaction degree according to standard Proctor procedure ( $S_z$ )  $\geq 100$  %,
- compressible module measured with circular plate  $\varnothing 30$  Ms  $\geq 40$  MN/m<sup>2</sup>.

### 3.14. Road Works

#### 3.14.1 General

All items must be executed in compliance with "GENERAL TECHNICAL CONDITIONS FOR ROADWORKS" issued by "Putevi Srbije" (ROADS OF SERBIA) and current regulations and standards.

#### 3.14.2 Materials

##### 3.14.2.1 Crushed Aggregate

The Base Course Material Grading Requirements for Crushed Aggregate shall be formed of mixed aggregates as following:

Sieve Size	Percentage by Weight Passing
50 mm (2")	100
25 mm (1")	35 - 60
12 mm (½")	20 - 40
4.76 mm (No. 4)	10 - 30
420 micron (No 40)	5-15

The aggregate material shall consist exclusively of fragments of rock. It shall be free from clay, organic matter and other deleterious materials. It shall be hard and sound and shall not contain more than 20% of flat or elongated pieces. A flat piece is one where the breadth is three times greater than the thickness and an elongated piece is one where the length is three times the thickness.

##### 3.14.2.2 Filling material

Selected fill whether selected from locally excavated material or imported, shall consist of uniform readily compactable material, free from roots, vegetable matter, building rubbish and frozen material, or materials susceptible to spontaneous combustion, and excluding clay of liquid limit greater than 80 and /or plastic limit greater than 55 and materials of excessively high moisture content. Clay lumps greater than 75 mm and stones greater than 25 mm shall be excluded from the material. Filling material is to be approved by Engineer.

##### 3.14.2.3 Wet-mix macadam

Wet-mix macadam shall consist of crushed rock or crushed slag, graded in accordance with the following table:

BS 410 test sieve	Percentage by mass passing
50 mm	100
37.5 mm	95 - 100
20 mm	60 - 80
10 mm	40 - 60
5 mm	25 - 40
2.36 mm	15 - 30
600 µm	8 - 22
75 µm	0 - 8

The particle size shall be determined by the washing and sieving method of BS 812 Part 103.

Aggregate quality and cleanliness shall comply with the relevant requirements of Clause A13.3. The flakiness index shall be less than 35 when determined in accordance with BS 812: Part 105, Section 105.1.

The moisture content of the wet-mix macadam shall be the optimum + 0.5% as determined in accordance with BS 5835: Part 1.

#### **3.14.2.4 Coated macadam**

Coated macadam for roads and other paved surfaces shall comply with the relevant provisions of BS 4987: Part 1.

#### **3.14.2.5 Rolled asphalt**

Hot rolled asphalt shall comply with the relevant provisions of BS 594: Part 1.

#### **3.14.2.6 Bitumen road emulsions**

Bitumen road emulsions shall comply with the relevant provisions of BS 434: Part 1.

#### **3.14.2.7 Dowel bars**

Dowel bars for expansion joints in concrete shall consist of mild steel complying with the provisions of BS 4449, Grade 250.

Dowel bars shall be straight, free from burrs or other irregularities and shall have their sliding ends sawn. The sliding half of each dowel bar shall be painted with a thin coat of bond-breaking compound, and the end of this half shall be provided with a close fitting plastic or waterproof cardboard cap at least 100 mm long, the end 20 mm of which shall be fitted with a disc of joint filler or a pad of cotton waste.

Bond-breaking compound for dowel bars shall consist of a bitumen paint containing 66% of 200 pen bitumen, blended hot with 14% light creosote oil with the addition, when cold, of 20% solvent naphtha. It shall in no way retard or otherwise affect the setting of concrete.

#### **3.14.2.8 Joint filler board**

Filler board for joints in concrete (other than softwood) shall comply with the tests in Clause 1015.1 of the British Department of Transport's "Specification for Highway Works". Knot-free softwood, preserved as those General Structural Grade timbers of strength class SC3 or Table 3 of BS 5268: Part 2.

Holes in performed joint filler to accommodate dowel bars shall be accurately bored or punched out to produce a sliding fit on the dowel bars.

The material comprising the joint filler shall be of such quality that it can be satisfactorily installed in position at the joint. Adhesives used to retain performed joint fillers in place during construction shall have no harmful effects on concrete and, except for those used in connection with softwood fillers, shall be obtained from the same manufacturer as the joint filler.

Performed filler for joints in structures to retain aqueous liquids shall have a maximum water absorption of 0.3% by volume and a non-recovered compression set at 20% of the original thickness, both when tested in accordance with ASTM D3595.

### **3.14.3 Road Layers**

The road layers shall be the surface obtained after completion of any earthworks.

The preparation and surface treatment of layers shall be carried out after the reinstatement of any excavations for services.

Layers, immediately before being covered with sub-base or road base material, shall be clean, free from mud and slurry and properly shaped and compacted to an even and uniform surface.

### 3.14.3.1 Construction of Sub-base

The Contractor shall include adequate excavation to the levels detailed to provide a smooth, gentle gradient to meet the adjacent ground surface.

For the sub-grade preparation he shall scarify a layer of an adequate area and suitable depth not less than 300mm, and the soil shall be pulverised, mixed, shaped well watered and compacted, and finished. All materials within the top 450 mm below sub-grade level shall be an approved material.

Unless otherwise specified, and approved by the Engineer, the excavated materials shall be used as fill material. Unsuitable material shall be removed and the surface of the cut section shall be compacted to a depth of 150 mm below the surface of the cut before placement of approved fill material.

Borrow materials shall be placed in horizontal layers of uniform thickness and the work shall be carried out to adhere to the lines, levels and slopes. Moisture Content shall be adjusted in order to attain maximum density; the loose materials compacted to obtain the required density. Prior to placement of any borrow materials; the Contractor shall carry out trial tests as directed by, and for the approval of, the Engineer. After primary levelling, compaction operations shall be carried out by in order to obtain the 95% of maximum dry density - to a minimum depth of 300mm when tested in place.

Once prepared the sub-grade shall be maintained in the finished, completely satisfactory condition until the next course has been placed, and the Contractor shall take all precautions to protect same from damage from any cause - both from his own and from general public traffic.

Within 48 hours of completion of a road layer, granular sub-base material shall be spread and compacted to the required thickness. The sub-base shall be protected from deterioration due to ingress of water, the adverse effects of weather and the use of Contractors' Equipment. Compaction shall be carried out in accordance with the following table:

Type of compaction Plant	Category	Number of passes for layers not greater than:		
		110 mm	150 mm	225 mm
Smooth-wheeled roller	Mass per metre width of roll: over 2700 kg up to 5400 kg	16	unsuitable	unsuitable
	over 5400 kg	8	16	unsuitable
Pneumatic-tired roller	Mass per wheel: over 4000 kg up to 6000 kg	12	unsuitable	unsuitable
	over 6000 kg up to 8000 kg	12	unsuitable	unsuitable
	over 8000 kg up to 12000 kg	10	16	unsuitable
	over 12000 kg	8	12	unsuitable
Vibrating roller	Mass per metre width of vibrating roll: over 700 kg up to 1300 kg	16	unsuitable	unsuitable
	over 1300 kg up to 1800 kg	6	16	unsuitable
	over 1800 kg up to 2300 kg	4	6	10
	over 2300 kg up to 2900 kg	3	5	9
	over 2900 kg up to 3600 kg	3	5	8
	over 3600 kg up to 4300 kg	2	4	7
	over 4300 kg up to 5000 kg	2	4	6
	over 5000 kg	2	3	5
Vibrating plate compactor	Mass per unit area of base plate: over 1400 kg/m <sup>2</sup> up to	8	unsuitable	unsuitable
		5	8	unsuitable

	1800 kg/m <sup>2</sup> over 1800 kg/m <sup>2</sup> up to 2100 kg/m <sup>2</sup> over 2100 kg/m <sup>2</sup>	3	6	10
Vibro-tamper	Mass: over 50 kg up to 65 kg over 65 kg up to 75 kg over 75 kg	4 3 2	8 6 4	unsuitable 10 8
Power rammer	Mass: 100 kg – 500 kg over 500 kg	5 5	8 8	unsuitable 12

The sub-base course shall consist of an aggregate material, placed and compacted on the previously prepared sub-grade.

The specific gravity of aggregates shall not be less than 2.4.

### **3.14.3.2 Wet-Mix Macadam Construction**

Wet-mix macadam shall be spread evenly on the sub-base and compacted in layers of not more than 200 mm thickness at the optimum moisture content + 0.5%. Spreading shall be undertaken concurrently with placing.

### **3.14.3.3 Lean Concrete Construction**

Lean concrete construction for roads shall be Grade C7.5 and shall be spread evenly on the sub-base and laid and compacted in layers of not more than 200 mm thickness. Spreading shall be undertaken concurrently with placing. The maximum period of time between mixing of the materials and final compacting of any given material shall be 2 hours.

Where practicable, joints against hardened material shall be avoided. Where such joints are unavoidable, the hardened material shall be cut back vertically for the full depth of the layer before placing any further adjacent material.

Lean concrete shall be cured for a period of not less than 7 days. No vehicular traffic shall be allowed to run on the base during this time.

### **3.14.3.4 Laying Coated Macadam**

Transportation, laying and compaction of all coated macadam shall be carried out in accordance with the relevant provisions of BS 4987: Part 2.

### **3.14.3.5 Laying Hot Rolled Asphalt**

Transportation, laying and compaction of hot rolled asphalt shall be carried out in accordance with the relevant provisions of BS 594: Part 2

### **3.14.3.6 Waterproof Underlay for Concrete Carriageways**

Waterproof underlay shall consist of waterproof paper or impermeable plastic sheeting, laid to provide a membrane immediately below the concrete. Overlaps shall be not less than 300 mm and precautions shall be taken to prevent ponding on the membrane.

Waterproof paper shall be Grade 'BIF' complying with the relevant provisions of BS 1521.

Plastic sheeting for waterproof underlay shall be free from tears and voids and be substantially free from pinholes and other discontinuities. It shall have a composition in accordance with Clause 3 of BS 6076 and a nominal film thickness of 125 µm.

### **3.14.3.7 Reinforcement of Concrete Carriageways**

Reinforcement in concrete carriageways shall be so placed that, after compaction of the concrete, its cover below the finished surface of the slab is 60 mm (+ 10 mm) and it terminates 125 mm (+ 25 mm) from the edges of the slab and all pre-formed joints in the concrete.

At transverse joints between mats of steel fabric reinforcement, the longitudinal bars shall overlap by at least 35 times the bar diameter, provided that such overlap shall not in any case be less than 450 mm. Mats shall be placed so as to maintain the same spacing between edge longitudinal bars as in the body of the mat.

Reinforcement shall be positioned above dowel bars and tie bars irrespective of the tolerances on position.

#### **3.14.3.8 Laying Concrete Carriageways**

Placing, compacting and finishing concrete in carriageways shall be carried out in one layer as rapidly as possible and shall be so arranged that, in any transverse section, the time for completion of mixing the first batch of concrete to completion of compaction of that section shall not exceed 2 hours.

Carriageway surfaces shall have a Screeded Finish, which shall be brushed transversely to produce a lightly brush marked finish, with a 100 mm arris Steel Trowel Finish to sides and at joints.

Surface irregularities shall not exceed 3 mm when checked with a 3 m straight edge.

#### **3.14.3.9 Laying Kerbs and Channels**

Kerbs, edgings, channels and quadrants shall be laid and bedded on a layer of Class M1 mortar, either on the concrete carriageway or on a Grade C20 concrete foundation. They shall be butt-jointed except where otherwise described in the Contract, save that, where laid on concrete carriageways, they shall be provided with joints coincident with the carriageway movement joints, of width and with filler identical to that used in the carriageway joints. All kerbs shall be backed with Grade C20 concrete.

For radii of 12 m or less, kerbs and channels of the appropriate radius shall be used.

#### **3.14.3.10 Foundations for Footways**

Foundations for footways shall consist of Type 1 granular sub-base material spread evenly and compacted in layers of not more than 100 mm thickness.

Compaction to the correct levels shall be carried out using a vibratory roller having a static load of at least 100 kg/m width of roll.

#### **3.14.3.11 Laying Concrete Paving Flags**

Precast concrete flags shall be laid to the required falls on sub-base material bonded with joints at right angles to the kerb, and spot bedded with Class M4 mortar with no lipping of top surfaces.

Flags shall be cut to fit around surface boxes and other furniture and on circular work where the radius is 12 m or less, shall be radially cut on both edges to the required lines.

#### **3.14.3.12 Tolerances for finished Carriageway Surfaces**

Finished surfaces at each stage of road construction shall not vary from the levels described in the Contract by more than the following permissible deviations:

Surface	Permissible deviation (mm)
Formation and sub-base	+10 – 30
Base	± 15
Wearing surface or slab surface	±6

The combination of permitted tolerances in the levels of different pavement courses shall not result in a reduction in thickness of the pavement, excluding the sub-base, by more than 15 mm from the specified thickness, nor a reduction in the thickness of the bituminous wearing course by more than 5 mm from that specified, and the maximum allowable irregularity of the wearing surface below a 3 m straight edge shall be 3 mm.

#### 3.14.3.13 Fixing of Gullies

Gullies shall be bedded and surrounded with Grade C20 concrete to the thickness according to Serbian standards.

Frames shall be bedded in Class M1 mortar on two courses of Class B engineering brickwork or precast concrete gully cover slabs.

#### 3.14.3.14 Pavement Thickness

Four classes of pavements have been considered as follows:

- Class 1 - Pavement exposed to continuous excessive heavy loads capable of withstanding passage of 2 million 18 ton axles or 50 million 10 ton axles and virtually any number of passenger cars
- Class 2 - Pavement exposed to continuous heavy loads capable of withstanding passage of 3 million 10 ton axles and virtually any number of passenger cars
- Class 3- Pavement exposed to moderate heavy loads capable of withstanding 1 million 10 ton trucks and virtually any number of passenger cars
- Class 4 - Pavement exposed to occasional heavy loads capable of withstanding 150,000 10 ton trucks and virtually any number of passenger cars

#### List of Pavement Thickness

Description of Layer	Layer Thickness, mm			
	Class 1	Class 2	Class 3	Class 4
Wearing Course	35	25	35	35
Binder Course	45	40	-	-
Asphalt Concrete	70	50	70	50
Cement Stabilised Gravel	200	150	-	-
Base Gravel	250	250	250	159

*Note: In Classes 3 and 4, the base gravel shall be protected with a penetration course of hot applied cut-back medium curing asphalt at the rate of 2 to 3 litres per square metre.*

#### 3.14.3.15 Drainage

Surface water drainage to Site roads, hard-standings and access roads consists of a cross fall on the surface of the roads or paved areas draining to the adjoining ground.

#### 3.14.3.16 Testing

The Contractor shall carry out tests at such intervals as the Engineer may direct to demonstrate that the materials for the granular sub-base and road-base comply with the Specification and that the specified densities for the sub-grade, sub-base and road base are being achieved.

The Contractor shall inspect and test each area of layer for compliance with surface level accuracy.

### **3.15. Concrete**

#### **3.15.1 General requirements**

The quality of materials, batching and mixing, workability and the standard of workmanship for reinforced concrete shall at the minimum comply with the relevant following clauses:

#### **3.15.2 Cement**

All cement used in structural work shall, unless otherwise specified, comply with EN 197-1. Manufacturers' or suppliers' certificates of compliance with the Standard shall be provided when requested by the Engineer.

For all cement used in structural concrete, certificates of the relevant proportions in accordance with EN 450 of any ggbs (ground granulated blast furnace slag) or pfa (pulverized fly ash) shall be provided to the Engineer.

Cement delivered to the Site should be in properly and permanently marked, sound and sealed paper bags or other approved containers, unless written approval from the Engineer is obtained for the handling of cement in bulk.

Cement shall be delivered in quantities sufficient to ensure the proper progress of the Works and the quantities held in stock on Site shall be to the approval of the Engineer. Such approval shall not in any way relieve the Contractor of his responsibilities for providing cement. Cement from abroad, shall be packed in sealed plastic bags and placed inside paper bags.

All cement shall be stored in a weather proof, water proof and reasonably airtight structures provided solely to that purpose. The floors of the building shall be raised at least 300 mm above the ground level to prevent the absorption of moisture.

When white or coloured Portland cement is required, added pigments shall comply with EN 12878 and shall be mixed with the cement in accordance with the manufacturer's instructions. The amount of pigments shall not exceed 10% of cement by mass, except for carbon black where the limit shall be 2%.

#### **3.15.3 Tests of Cement**

The Contractor shall submit to the Engineer, free of charge, test certificates relating to each consignment of cement. Each certificate shall show that a sample of the consignment has been tested by the manufacturer or by an approved laboratory and that it complies in all respects with the Requirements and the applicable standards, and that the cement is certified in accordance with the Serbian "Decree for compulsory cement certification" or EN 196, whichever is more strict.

The Contractor shall maintain a record of the locations of the concrete made from each consignment which record shall be available for inspection by the Engineer.

If for any reason the Contractor wishes to vary the source of supply, country or manufacture in respect of any type of cement already approved by the Engineer at any time during the Contract, he shall give adequate notice of every such variation to the Engineer and shall carry out all the tests called for by the Engineer's written approval of such variation before ordering any material from the new source or supplier.

#### **3.15.4 Aggregates**

Fine and coarse Aggregates for concrete shall comply with the relevant provisions of the appropriate Standards.

Aggregates complying with EN12620 and PD6682-1 or EN 13055 & PD6682-4 shall not have values of the Los Angeles Coefficient greater than 40.



The water absorption of aggregates for concretes designed to retain and aqueous liquid shall not exceed 3% when measured in accordance with EN 1097-5.

The proportion of coarse recycled aggregate or coarse recycled concrete aggregate shall not exceed 20% by mass of the total coarse aggregate in concrete. Fine recycled aggregate or fine recycled concrete aggregate shall not be used.

Recycled aggregates or recycled concrete aggregates shall not be used in contact with raw water or potable water.

The Contractor shall notify the Engineer of his proposals for complying with this requirement at the time of commencement of the Works.

### **3.15.5 Storage of Aggregates**

Each size of fine and coarse aggregate shall be stored in separate bins or on areas covered with steel plate, concrete, or other hard and clean surface, which shall be self-draining and protected from contamination by earth or other deleterious matter.

Fine and coarse aggregates shall be stored in such a way so as to avoid the two materials from becoming intermixed.

### **3.15.6 Grading of Aggregates**

The grading of aggregates shall conform with EN 12620 and Fuller optimization. The Contractor shall, if required by the Engineer, obtain the specified grading by combining single sized aggregates in proportions to give the specified grading.

The maximum size of aggregates required will not normally exceed 40 mm. At least four separate size ranges of aggregate are required as follows:

- Fine aggregate: 8 mm
- Coarse aggregate, nominal size: 16 mm
- Coarse aggregate, nominal size: 32 mm
- Coarse aggregate, nominal size: 40 mm (i.e. for use in Mass Concrete)

### **3.15.7 Testing of Aggregates**

The Contractor shall submit to the Engineer test certificates of the fine and coarse aggregates proposed for use in the Works. Sampling and testing shall be carried out in accordance with appropriate Testing Norms.

The aggregate shall be tested for

- Mineralogical/petrographic composition
- Physical-mechanical characteristics for stone aggregate
- Grain size and grain shape

Aggregates shall be hard, durable and clean and shall not contain materials that may adversely affect the strength and durability of mass or reinforced concrete. At each point where concrete is batched, aggregates shall be stored on Site in separate stockpiles, so arranged as to prevent intermingling of their various sizes. Stockpiles shall be suitably protected to prevent contamination of the aggregates from soil, rubbish, leaves, dust or other extraneous materials. Any aggregate so contaminated shall not be used in the Works, and the bottom 300 mm layer of any stockpile shall be used only if approved by the Engineer. Storage heaps shall be capable of draining freely.

Aggregates for high strength concrete topping (granolithic finish) shall comply with BS 882 and be 10 mm nominal size, graded in accordance with Table 6 of that Standard.

### **3.15.8 Sands**

Sands for mortar and grout shall comply with EN13139.

### **3.15.9 Water**

The water used in concrete shall comply with the appropriate Serbian Standards.

### **3.15.10 Admixtures**

Admixture shall mean material added to the concrete materials during mixing for the purpose of altering the properties of the concrete mix.

Admixtures containing calcium chloride shall not be used.

Admixtures shall be used only if the Engineer has given his prior approval in writing, and with due regard to the manufacturer's instructions. Both the amount added and the method of use shall be to the approval of the Engineer who shall also be provided with the following information:

The typical amount added and the detrimental effects, if any, of an increase or decrease in this amount.

The chemical name(s) of the main active ingredient(s) in the admixture.

Whether or not the admixture leads to the entrainment of air when used at the amount the manufacturer recommends.

Any approved admixture shall conform to whichever of the following standards is appropriate:

Water reducing admixtures and retarding admixtures according EN480-12:1998. Fly ash and raw or calcined natural pozzolans for use as mineral admixture according EN 206

All other use of admixtures shall be used strictly in under the supervision of the Engineer, following the detailed instructions issued by the manufacturers. Calcium chloride shall not be used in concrete which is to be reinforced, contain embedded metal, or has been design to retain an aqueous liquid. Where used with sulphate resisting cement or in concrete which is to be reinforced or contain embedded metal, the chloride ion content of admixtures shall not exceed 2% by mass of the admixture or 0,03% by mass of the cement. Admixtures containing chlorides shall not be used in reinforced concrete designed to retain an aqueous liquid.

### **3.15.11 Mortar**

Sand-cement mortar shall be composed of Portland Cement, Sulphate Resisting if necessary, hydrated lime and sand.

All mortar shall be conveyed fresh to the Works as required for use. Mortar which has begun to set or which has been Site-mixed for a period of more than one hour in the case of classes M1, M2, M5 and M6, and two hours in the case of Classes M3, M4, M7 and M8 shall not be used. Plasticizing and set retarding mortar admixtures shall comply with BS4887: Parts 1 and 2 respectively and shall be supplied with instructions for use.

Where re-design of any mortar mix becomes necessary the making and testing of the trial mixes shall be repeated until the trial mix satisfies the following requirements. The proportions of these materials determined by the Contractor in his mix design shall be used in preliminary mixes of mortar made and tested for strength and workability under laboratory conditions.

### 3.15.12 Concrete

Concrete shall, except where otherwise described in the Contract, be produced, transported and assessed for compliance with the Specification in accordance with the relevant Serbian provisions and BS 8500.

The maximal size of aggregate in any structural member shall not exceed 25% of the minimal thickness of the member.

Conformity control and criteria shall be undertaken in accordance with relevant EU provisions.

Where identity testing is specified as described in BS 8500: Part1:2000, Clause 5.1.b and Annex A for strength, it shall be undertaken in accordance with EN 206-1:2000, Annex B as follows:

Type of structure	Sample to represent a Volume (m <sup>3</sup> )
Critical structures	10
Intermediate structures	50
Heavy concrete structures	100

### 3.15.13 Organisation of Concrete Production at the Site

At the commencement of the Contract the Contractor shall submit for the approval of the Engineer a Method Statement and Concrete Design detailing his proposals for organisation of concreting activities at the Site.

The Method Statement shall include the following items:

- Plant proposed
- Location and layout of concrete production facility
- Proposed method of organisation of the concrete production facility if applicable
- Quality control procedures for concrete and concrete materials
- Transport and placing of concrete
- Details of formwork including striking times and procedure for temporary support of beams and slabs
- Protection and curing

### 3.15.14 Ready-mixed Concrete

Where the Contractor wishes to obtain the concrete from a ready-mix supplier, he shall obtain the approval of the Engineer before using any concrete in the Works. The Contractor shall submit the documentation and confirmation that the concrete supplying plant is approved by a Third Party Certification body. The Contractor shall advise the Engineer of alternative sources and suppliers available.

Each load of ready mixed concrete shall be accompanied by a delivery ticket in accordance with EN 206-1. Clause 7.3 and in addition the following information shall be provided:

- a) type of aggregate
- b) the actual cementitious content and the percentage of any pfa or ggbs included; and
- c) the position of the concrete in the Works (details to be inserted at the point of discharge).

All delivery tickets shall be kept on Site and be available for inspection.

#### **3.15.15 Concrete Class**

The concrete class for each application is to be defined in accordance with RS standards. Based on the Main Design and additional information from climate, process etc. the Contractor shall define the concrete class to be used. He shall provide this information as part of the design for the approval by the Engineer.

#### **3.15.16 Concrete Mixes**

Prescribed, Standardised prescribed, Designated, Designed and Proprietary concrete shall be in accordance with BAB and RS standards.

#### **3.15.17 Concrete Mix Design**

The various classes of concrete which are resulting from the application of BS EN 8500 shall be designed by the Contractor with particular attention to durability, strength, workability and surface finish, and to satisfy the Engineer on these qualities. The water content of all concrete shall be rigidly controlled and kept to the minimum required to obtain a workable concrete suitable for the nature of the work to be executed.

The addition of proprietary admixtures intended to change the flow characteristics cohesion or rate of setting of the concrete shall not be made without the approval of the Engineer. No admixture shall contain more than trace levels of chloride ion.

The Contractor shall indicate in his design for each structure the type and grade of concrete to be used.

No concrete shall be placed in the Works until the relevant mix has been approved by the Engineer. Approval will not be given to any concrete mix until it has been successfully subjected to Preliminary Mix and Trial Mix Tests.

#### **3.15.18 Initial testing**

The Contractor shall carry out initial testing for each classification of structural concrete.

Such testing shall be in accordance with RS standards and norms.

#### **3.15.19 Identity testing**

The Contractor shall make all necessary arrangements for the sampling and testing of fresh and hardened concrete in accordance with the provisions of relevant RS standard, and shall supply all necessary apparatus labour materials and transport.

Slump tests shall be carried out at such times and places as the Engineer may direct and shall be used as a guide to the consistency of each class of mix.

Prior to the commencement of construction of the Works concrete test cubes shall be taken and tested in accordance with the requirements of the Clauses herein entitled "Preliminary Mix Tests" and "Trial Mixes of Concrete".

#### **3.15.20 Compliance Requirements for Concrete**

During the course of the Works and after satisfactory completion of Preliminary and Trial Mix tests the compliance of concrete mixes with the requirements specified in the Table of Designed Concrete Mixes shall be determined as detailed below.

The Contractor shall carry out required tests in accordance with EN 8500 on each concrete mix of each different concrete class mixture or grade. The Contractor shall provide all data as required by the Engineer.

Compliance with the maximum values of free water/cement ratio for each class of concrete mix shall be assessed by means of slump tests. Following the approval by the Engineer of slump values for each class of concrete mix the tolerance which shall subsequently apply to test results shall be  $\pm \frac{1}{3}$  of the approved slump.

Should cube test results fail to satisfy either or both of requirements the Contractor shall remove the concrete represented by the non-complying cubes or execute such other measures as the Engineer may direct.

The Engineer may require that additional testing be carried out by the Contractor upon concrete represented by non-complying cubes. The results of any such additional tests shall not nullify the previous establishment of non-compliance with this Clause.

If the requirement for the strength test above is not satisfied the Contractor shall unless otherwise directed by the Engineer immediately cease production of the particular class or grade of concrete mix represented by non-complying cube test results. He shall submit to the Engineer in writing a detailed assessment of the situation and works affected, propose the measures for remediation and propose measures to supply concrete of the right quality for the approval by the Engineer.

All costs consequent upon non-compliance with the specified requirements for concrete shall be borne by the Contractor.

#### **3.15.21 Mixes Not Approved**

Approval of a mix may be withheld or withdrawn under the following circumstances:

- The grading of the aggregate changes such that the fraction of aggregate retained on any sieve differs from the corresponding fraction of aggregate in the approved mix by more than 2% of the total quantity of fine and coarse aggregates.
- The source of supply of aggregate or cement is changed.
- In the event that approval of a mix for any class or grade of concrete is withdrawn for any reason the Contractor shall carry out such further trials and tests in order to achieve a satisfactory mix for that particular class or grade of concrete.

#### **3.15.22 Testing of Concrete Cores**

If the results for the compressive strength of the concrete used in the Works do not fulfil the requirements or if defects of workmanship during construction give rise to doubt as to the strength, durability and/or safety of the structure or of part thereof, supplementary testing may be required to be performed.

At least six concrete cores shall, where ordered by the Engineer, be drilled or cut perpendicular to the face of the hardened concrete and tested in accordance with RS standards..

If the compressive strength of the cores, adjusted for height/diameter ratio and age fails to attain the specified characteristic strength at 28 days, the suspected part of the concrete shall be cut out, removed and replaced at no extra cost.

#### **3.15.23 Water Content and Slump Tests**

A check on the moisture content of the aggregate shall be made before concreting is commenced. The amount of water introduced into the mix shall be strictly controlled.

The slumps of the trial mixes shall be recorded for identification purposes and for subsequent use as a rough routine check on quality. However, slump test shall not be used as an officially acceptable measure of the workability of any concrete.

### **3.15.24 Batching and Mixing**

All cement and aggregates in any concrete mix shall be proportioned by mass by automatic plant (except as may otherwise be approved by the Engineer for minor parts of the Works), set to provide the proportions of the approved mix in use. Provision shall be made for locking and sealing of the proportioning device. Any adjustment after such sealing shall be made only with the specific permission of the Engineer. The accuracy of the weighing plant shall be regularly checked and re-calibrated as necessary and reported to the Engineer. Accuracy shall not be less than  $\pm 5\%$  when measured against standard weights over the full range of the plant.

The mixing plant shall have more than adequate capacity and efficiency to provide thoroughly mixed concrete at a rate in excess of the maximum rate of placing required in any part of the Works. The water content of each batch of concrete shall be strictly controlled by a measurement device which can be adjusted and locked in position. Mixing time after adding aggregates and cement as well as water shall be sufficient to ensure uniform distribution of the cement, but not so long as to cause deterioration to the quality of the batch.

Should any mixer at any time produce unsatisfactory results it shall be promptly stopped until it has been repaired or replaced. Mixers shall be completely emptied before receiving materials for the succeeding batch; they shall also be kept clean and washed out after stopping work and at the end of each shift.

### **3.15.25 Transporting, placing and compacting Concrete**

#### **3.15.25.1 Preparatory works**

The Contractor shall give 24 hours' notice to the Engineer that he is prepared to place concrete and that all constructional plant and materials required, or which may be required during the concreting work and for curing is on Site and the Contractor shall be fully prepared for the work.

If necessary and/or directed by the Engineer, the Contractor shall cool any shuttering that has become overheated or exceptionally dry through prolonged exposure to the sun. The Contractor shall ensure that all shuttering retains a sufficient amount of humidity and has not become shrunk or warped. All soaking or spraying of shuttering shall be done with potable water.

The Engineer may forbid altogether the placing of concrete in any shuttering which he believes has become too hot and/or dry and the condition of which could harm the quality and strength of concrete. No extra payment for cooling or soaking of shuttering shall be claimed and costs incurred by the Contractor, due to shuttering becoming too hot or dry, shall be deemed to be included in the prices.

All shuttering, area of deposition, reinforcement and exposed surfaces of adjoining concrete surface shall be thoroughly cleaned and free from dust, debris, oil or any other substance that may be harmful to fresh concrete.

#### **3.15.25.2 Transport**

Concrete shall be transported from the mixer and placed in the works as rapidly as practicable by methods which will prevent the segregation or loss of any of the ingredients and will maintain the required consistency. It shall be deposited as nearly as practicable in its final position and all equipment for transporting concrete shall be kept clean.

Concrete shall be delivered to site to allow concrete to be placed directly in the Works as soon as possible without the need for re-handling and not more than 20 minutes after mixing and in any case, before the initial set has taken place. If any delay has occurred after mixing and the concrete has begun to set, it shall not be used in the Works and shall be removed from the Site.

### **3.15.25.3 Placing**

Concreting of any section or unit shall be carried out in one continuous operation to avoid construction joints and no interruption of the concreting will be allowed without the approval of the Engineer. Where deposition of concrete has to be interrupted, precautions shall be taken to ensure satisfactory adhesion of later batches of concrete to that previously placed.

Where delays of more than one hour have occurred between successive concreting operations in one section or unit of work, concreting shall only be resumed when, in the opinion of the Engineer, the previously placed concrete has had ample time to harden and the resulting joint shall be treated as a Construction Joint.

Transportation of concrete directly over fixed reinforcement steel during concreting shall not be allowed unless proper provisions are made to avoid displacing or damage to the reinforcement.

### **3.15.25.4 Compaction of Concrete**

Concrete shall be thoroughly compacted in its final position within 30 minutes of commencing discharge. The plant used for compaction shall be operated continuously during the placing of each batch of concrete until the expulsion of air has virtually ceased and in a manner which does not promote segregation of the ingredients.

Mechanical vibrators shall be of the immersion type with a frequency of not less than 6000 vibrations per minute. A sufficient number of vibrators shall be used to handle the maximum rate of concrete production with a 50% allowance for stand-by units during any period of concreting. All operators handling vibrators shall be trained in their operation.

Vibrators shall be inserted into the un-compacted concrete vertically and at regular intervals. Where the un-compacted concrete is in a layer above freshly compacted concrete the vibrator shall be allowed to penetrate vertically for about 100 mm into the previous layer. Vibrators shall be withdrawn slowly from the mass of concrete so as to leave no voids. Internal type vibrators shall not be placed in the concrete in a random or haphazard manner nor shall concrete be moved from one part of the work to another by means of the vibrators.

Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the formwork over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the formwork or shuttering.

Every care shall be taken to see that reinforcement and fittings attached to the shuttering are not disturbed, and that no damage is caused to concrete that has already set or to the internal face of the shuttering by using immersion type vibrators. In areas of congested reinforcement, it may be necessary to use small diameter pokers and the Contractor shall supply suitable sizes of pokers for each part of the work. Vibration of concrete by hammering the shuttering with hand tools shall not be permitted.

When placing concrete against horizontal or inclined elements of waterstops they shall be lifted and the concrete placed and compacted to a level slightly higher than the underside of the waterstops before releasing the waterstop to ensure complete compaction of the concrete around the waterstop.

The duration of vibration shall be limited to that required to produce satisfactory compaction without causing segregation. Vibration shall not be continued after water or excess grout has appeared on the surface.

Concrete shall not be disturbed after compaction and placing in its final position. Concrete that has partially set before final placing shall not be used and shall be removed from the Site.

### **3.15.25.5      Depositing in Layers**

Concrete shall be deposited in approved quantities and in horizontal layers of such depth as to permit thorough incorporation with the layers below by vibration, spading, ramming and working. If, for unforeseen reasons, it is necessary to stop concreting before completion of a lift, then construction joints as specified shall be formed.

### **3.15.25.6      Loading of Concrete Structures**

No external load of any kind shall be applied to any part of a concrete structure until the concrete has matured for at least 7 days and then only after confirmation that 7 day cube strengths have been met.

The full design load shall not be applied until confirmation that the specified 28 day strength has been reached.

The Contractor shall not fill around any structure incorporating a ground or floor slab before confirmation that the slab and the wall has reached its specified 28 day strength.

### **3.15.25.7      Concrete in large pours**

A large pour is defined as a pour where the least dimension is greater than 1,5 m.

Subject to the requirements for construction and movement joint locations and the requirements for the test blocks detailed in the following clause, the Contractor will not be limited as to the size of a large pour, provided that adequate measures are taken to control temperature differentials. Such measures will be evaluated with reference to the following:

#### ***Temperatures:***

The temperature of the concrete at the time of placing shall not exceed 15 °C and peak hydration temperature shall not exceed 60°C, except under hot conditions, when the requirement of paragraph 3.15.25.8 shall apply.

The difference in temperature between thermometers in the concrete near any concrete face and the interior of the concrete at a distance of 1 metre from that face shall not exceed 20°C at any stage after placing.

#### ***Monitoring of temperature changes:***

Sets of thermometers for recording concrete temperatures shall be placed at positions in the concrete near to each exposed face at spacing not exceeding 5 m. Further sets shall be placed at corresponding positions within the concrete at a distance of 1 m from each face. The concrete temperatures shall be recorded at intervals not exceeding 6 hours, or such other intervals as may be required by the Engineer, for a period of at least 7 days.

Where the minimum dimension of a pour is between 1.5 m and 2.0 m the internal temperatures shall be recorded by thermometers placed at mid depth of the least thickness.

#### ***Insulation and protection of concrete surfaces:***

Formwork shall be plywood 19 mm thick, or such other combination of materials having an equivalent insulation value. The formwork shall remain in position for a sufficient time to ensure that the temperature control requirement in a) ii) above can be maintained after its removal.

Unformed surfaces shall be protected, as soon as practicable after the initial set has taken place, by either of the following means:

by pounding the surface with at least 100 mm depth of water,

by covering the surface with a layer of polythene sheet upon which shall be placed a layer of sand of at least 50 mm thickness.

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When the latter method of protection is adopted, the Contractor shall take appropriate steps to ensure that no loss of sand is suffered through the action of wind; the thickness of the sand layers shall be maintained at the specified minimum of 50 mm at all times.

Whichever method of protection is adopted, the protection itself shall be kept shaded from direct sunlight.

The Contractor shall provide the Engineer with details of the precautions he proposes to take to protect the concrete from the effects of temperature build-up and with details of the methods he proposes to use to assess the correct timing at which the protection may be removed. No concreting in large pours shall be put in hand until the proposed measures have been approved by the Engineer.

#### **3.15.25.8 Concreting in Hot and Cold Weather**

In situations of Hot weather and Cold weather, as defined in RS standards and ACI 305 ("Recommended Practice for Hot Weather Concreting") and ACI 306 ("Recommended practice for Cold Weather Concreting").

The Contractor shall take great care during hot weather to prevent the cracking or crazing of concrete. The Contractor shall arrange for concrete to be placed in the early morning or late evening as directed by the Engineer. Formwork shall be shaded from direct exposure to the sun both prior to placing of the concrete and during its setting. The Contractor shall take appropriate measures to ensure that reinforcement in and projecting from the section to be concreted is maintained at the lowest temperature practicable. Concrete at placing shall have a temperature of not more than 32° C. If necessary the Contractor shall cool the aggregates and mixing water by methods approved by the Engineer.

Cold weather is defined as the situation existing at the Works, where either the air temperature at the time considered is below 2°C; or the mean daily air temperature over three or more successive days has dropped below 5°C. On no account may concrete be placed in contact with frozen ground or formwork, or in contact with ice, snow or frost on the ground or on formwork or reinforcement. Concrete shall not be made with frozen materials. Concreting may proceed in cold weather provided special precautions are taken to ensure that the surface temperature of the concrete at the time of placing is not less than 5°C. The Contractor shall provide the Engineer with details of the precautions he proposes to take to protect the concrete from the effects of low temperatures and with details of the methods he proposes to use to assess the correct timing at which such protection may be removed. No concreting in cold weather shall be put in hand until the proposed measures have been approved by the Engineer.

#### **3.15.25.9 Concreting in Unfavourable Weather**

Concreting will not be permitted during heavy rain, or when the air temperature falls below 2°C, or when the concrete temperature rises above 32°C. When the air temperature exceeds 25°C, concreting will only be permitted after special precautions, approved by the Engineer, have been taken to prevent early setting of the concrete, such as lowering the temperature of the water to be used in the mix or by means of a cooling-system, keeping the aggregates and shutters continuously sprayed with water and erection of temporary sun shades over the working area. During concreting operations the temperature of the placed concrete shall be recorded.

#### **3.15.25.10 Curing of Concrete**

All concrete shall be moist-cured commencing immediately after removal of forms. Immediately concrete shall be cured for a period not less than that given in the following table by methods that shall ensure that cracking distortion and efflorescence are minimized.

Type of cement	Ambient temperatures after casting	Minimal period of curing and protection
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		5 - 10°C 4 days	Above 10°C 3 days
BS 4027	Average Poor	4 days 6 days	3 days 4 days
all except BS 4027 and all combinations at the mixer with ggbs and pfa	Average Poor	6 days 10 days	4 days 7 days
All	Good	no special requirements	

Curing shall be by an approved method or combination of methods applicable to local conditions. The Contractor shall have on hand, and ready to operate, all equipment needed for adequate curing and protection of the concrete before placing begins. Concrete shall be kept wet by covering with an approved water saturated material, plastic sheets, or by a system of perforated pipes or mechanical sprinklers or by another approved method which will maintain all surfaces continuously (not periodically) wet. Water for curing shall be clean and free from any elements which might cause staining or discoloration of the concrete.

In cold weather, when the temperature of the freshly placed concrete may approach 0°C, water curing may not be employed.

During hot weather the Contractor shall make arrangements for windbreaks, shading, fog spraying, sprinkling, sheeting etc.. before start of placement of the concrete and shall start operating such protective measures as soon as concrete hardening will allow. The Contractor may propose any other protective measure for approval by the Engineer.

All exposed surfaces shall, as finishing proceeds, be covered with a wet hessian sheet followed by a reflective polythene sheet or other methods aiming at the same result. The sheets shall be securely fastened around the edges and supported in order not to damage the finished concrete surface. As soon as practicable the hessian and polythene shall be lowered into close contact with the concrete and securely weighted or fastened down to prevent wind blowing underneath. The hessian sheet shall be maintained in a moist condition at all times and shall be inspected at intervals not exceeding 6 hours.

During very hot weather conditions, the Contractor may be required to cool formwork containing concrete by spraying with water and this shall be carried out where directed notwithstanding and whatever other measures the Contractor may have employed for the curing of the concrete.

Components which are intended to have a similar exposed surface finish shall be cured in the same manner.

### **3.15.26 Formwork and concrete finishes**

#### **3.15.26.1 General**

Formwork shall include all temporary moulds for forming the concrete together with all temporary constructions required to support such moulds.

#### **Design and construction**

Formwork shall be sufficiently rigid and tight to prevent loss of mortar from the concrete and to maintain the correct position, shape and dimensions of the finished works. It shall be constructed as to be removable from the cast concrete without shock or damage. Reference is made to BS 5975 as to standards of good practice in formwork construction.

The forms shall be capable of producing a consistent quality of surface.

Where holes are required to be made to accommodate projecting reinforcement, fixing devices or other built in items precautions shall be taken to avoid loss of mortar matrix.

### 3.15.26.2 Back Shuttering

Back shuttering shall be used to form concrete surfaces which are designed to be concealed by earth backfill or further construction, and shall comply with the specified requirements of shuttering except in so far as the board faces are not required to be planed.

### 3.15.26.3 Release agent

All formwork in contact with concrete shall be treated with an approved release agent or to prevent the adhesion of the concrete.

Where a concrete surface is to be permanently exposed only one release agent shall be used throughout the whole area.

The release agent shall be carefully applied in such a manner that there is no contamination of the reinforcement or previously placed concrete by the release agent.

### 3.15.26.4 Cleaning and Re-use of Shuttering

Before any concrete is placed, the forms shall be properly cleaned to remove sawdust, shavings and all other foreign matter. All water shall then be drained and mopped out from the shutter.

In no case shall concrete be placed in shuttering until the shuttering has been approved by the Engineer. If shutters or moulds are to be re-used, all surfaces shall be cleaned and shall be completely free from remnants of concrete or mortar. If, in the opinion of the Engineer, shutters or moulds are not acceptable for reuse, they shall be either properly repaired or substituted with new shutters or moulds.

### 3.15.26.5 Removal of Formwork

Formwork shall be removed without shock to or damage to the concrete.

Formwork to vertical surfaces or sloping formwork not supporting concrete in flexure shall not be removed until the concrete strength shall be sufficient to meet any wind loading upon the concrete likely to arise at the time when the formwork is removed and

- a) the concrete strength (as confirmed by the tests in cubes cured under representative conditions) has reached 5 N/mm<sup>2</sup> or
- b) for concrete containing cement, in the absence of cube tests results a minimal period shall have elapsed since the concrete was placed equivalent to 11 hours at 15°C for unsealed plywood or 8 hours at 15°C for impermeable forms.

Formwork supporting concrete in flexure shall not be removed until:

- a) the concrete strength (as confirmed by the tests in cubes cured under representative conditions) has reached 10 N/mm<sup>2</sup> or twice the strength as the concrete will then be subjected whichever is greater; or
- b) for concretes containing cement, in the absence of cube tests results or any formal procedure agreed in writing the period before striking calculated from the relevant formula given in the following table shall be used:

Type of formwork	period calculated for the mean ambient temperature (t) between 0°C and 25°C using the formulae below
Soffit forms to slabs and beams	100 / (t+10) days
props to slabs and beams	250 / (1+10) days

### 3.15.26.6 Sloping formwork

Top formwork shall be provided to slopes 30° or more from the horizontal

### 3.15.27 Finish to Concrete Surfaces

#### 3.15.27.1 General

The following requirements for the finish to concrete surfaces shall apply:

- A. Exposed surfaces (other than exposed upper surfaces), surfaces in contact with liquid including sewer inverts and outside vertical surfaces of in-situ caissons:  
The surface texture required shall unless otherwise specified be that obtained precise and high quality formwork resulting in a fair finish with the occurrence of very minor blemishes. The blemishes concurrently shall be filled with fresh specially prepared cement and aggregate paste, and rubbed down to produce a smooth and even finish.
- B. Concealed surfaces:  
The surface texture required shall be that obtained from the use of sawn close-jointed timber or the like.
- C. Exposed upper surfaces:  
Exposed upper surfaces of floor slabs and upper surfaces in contact with water shall be floated with a steel trowel to a dense smooth uniform finish free from trowel marks. Other exposed upper surfaces shall have a smooth finish obtained with a wood float.
- D. Concrete road and hard standing surfaces:  
Concrete road and hard standing surfaces shall have the surface finish obtained by the conventional use of a hand tamper or vibrating beam.
- E. Rendered or surfaced areas:  
Areas to be subsequently rendered or to receive a surfacing shall be adequately scored to provide an effective key.
- F. All surfaces:  
All surfaces shall be free from cracks, sand runs, honeycombing, porosity and grout/matrix loss.

For partly buried surfaces the exposed surface quality shall extend to 500 mm below final ground level.

#### 3.15.27.2 Dimensions and Surfaces of In-Situ Concrete

Workmanship in formwork and concreting shall be such that concrete shall not normally require making good, surfaces being perfectly compacted, smooth and with no irregularities. Concrete surfaces for the various finishes shall in any event never exceed the maximum permitted tolerances stated in the table below.

In the table "line and level" and "dimension" shall mean the lines, levels and cross-section dimensions shown on the Drawings.

Surface irregularities shall be classified as 'abrupt' or 'gradual'. Abrupt irregularities include, but shall not be limited to, offsets and fins caused by displaced or misplaced formwork, loose knots or other defects in formwork materials, and shall be tested by direct measurement. Gradual irregularities shall be tested by means of a straight template for plane surfaces or its suitable equivalent for curved surfaces, the template being 3.0 m long for unformed surfaces and 1.5 m long for formed surfaces.

	Maximum Tolerances [mm] for In-Situ Concrete
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Finish	Line & Level (except tunnels)	Abrupt Irregularity	Gradual Irregularity	Dimension
Exposed or PVC/GRP lined formed surfaces and surfaces in contact with liquid	$\pm 3$	0	$\pm 3$	$\pm 6$
Rendered form surfaces	$\pm 6$	$\pm 3$	$\pm 6$	$\pm 6$
Other concealed surfaces	$\pm 12$	$\pm 6$	$\pm 6$	+12/-6
Exposed unformed surfaces	$\pm 6$	$\pm 3$	$\pm 3$	$\pm 6$
Concealed unformed surfaces	$\pm 12$	$\pm 6$	$\pm 6$	+12/-6

### 3.15.27.3 Remedial Treatment of Concrete Surfaces

Any remedial treatment to concrete surfaces shall be agreed with the Engineer following inspection immediately after the stripping of formwork and shall be carried out without delay.

Any concrete the surface of which is found to have been treated before inspection by the Engineer shall be rejected.

Any minor surface blemishes shall be repaired to the satisfaction of the Engineer immediately after completion of curing. Remedial measures may include, but shall not be limited to, the following:

- Holes left for formwork supports shall be thoroughly cleaned out to remove all loose material and the sides shall be roughened, if necessary, to ensure a satisfactory bond. They shall then be filled with dry-pack mortar.
- Fins, pinhole bubbles, surface discoloration and minor defects may be rubbed down with sacking and cement immediately the formwork is removed.
- Abrupt and gradual irregularities may be rubbed down with carborundum and water after the concrete has been fully cured.
- Small defects and minor honeycombing shall be chipped out perpendicular to the face of the concrete to a depth of at least 25 mm and filled with dry-pack mortars.

All other defects will be regarded as too extensive to permit satisfactory repair and the concrete containing the defect shall be broken out and replaced.

### 3.15.27.4 Dry-pack Mortar

Dry-pack mortar for filling holes and repairing surface blemishes shall be made from one part by weight of cement and three parts fine aggregate passing a 1 mm sieve and an expanding agent approved by the Engineer. Additives to improve workability may be added to the approval of the Engineer. The colour of the mortar shall match that of the surrounding concrete. The mortar shall be mixed with only sufficient water to make the materials stick together when being moulded in the hands.

The dry-pack material shall be placed and packed in layers having a thickness not greater than 15 mm. The companion shall be carried out by use of hardwood stick and hammer and shall extend over the full area of the layer, particular care being taken to compact the dry-pack against the sides of the hole. After companion the surface of each layer shall be scratched before further loose material is added. Holes shall not be over filled and the surface shall be finished by laying a hardwood block against the dry-pack fill and striking the

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block several times. Steel finishing tools shall not be used and water shall not be added to facilitate finishing.

Instead of dry pack mortar the Contractor may propose commercially available alternatives, having the same or better specifications.

### **3.15.28 Construction Joints and connection to old concrete work**

#### **3.15.28.1 Construction Joints**

Except where construction joints in concrete are described in the tender documents, the Contractor shall obtain the Engineer's approval of the positions and details of such joints before any work is commenced.

Joint lines shall be arranged to coincide whenever possible with features of the finished work.

Concreting shall be carried out continuously up to construction joints.

Concrete shall not be allowed to taper off to a thickness of less than 50 mm. Vertical joints shall be formed against a stop board suitably notched to accommodate the reinforcement. The top surface of each lift of concrete shall be straight and level unless described otherwise in the Tender Documents.

Shuttering for construction joints shall be square to the work and shall incorporate continuous shear keys of substantial proportions so as to produce a watertight joint. For the same purpose, the Contractor may propose the use of water stops as appropriate.

Where a kicker is used, it shall be at least 70 mm high and shall be incorporated with the previous concrete.

The surface of new concrete against which new concrete is to be cast shall be free from laitance and shall be roughened to the extent that the large aggregate is exposed but not disturbed. The joint surface shall be cleaned immediately before the fresh concrete is placed against it.

Where practicable, such preparation of joints shall be carried out when the concrete has set but not hardened.

#### **3.15.28.2 Placing Concrete on Previously Executed Work**

Where concrete is to be deposited against or on top of previously executed work, the surface of the old concrete shall be thoroughly wire brushed and hacked and cleaned with water and air under pressure to expose the surface of the aggregate and to remove all laitance and cement slurry to be applied on the clean surface.

Special care shall be taken to ensure that the new concrete is thoroughly compacted and rammed against the old. In certain cases, depending on the class of concrete in use, the elapsed time between successive concreting operations and the weather conditions at the time of recommencing concreting, the Engineer may require the old concrete to be treated differently, including the use of "wash-off" and "dry-bond" techniques, wire brushing, etc..

#### **3.15.28.3 Blinding Concrete (Sub-base)**

A blinding layer of minimum 75 mm concrete Class D shall be placed under foundations where shown on the Drawings or ordered by the Engineer. The blinding layer shall be allowed to harden before the structural concrete for the foundation is placed.

### **3.15.29 Contraction and Expansion Joints in Structures**

#### **3.15.29.1 Design**

The Contractor shall be responsible for the design and location of movement joints which shall be of the contraction or expansion type as appropriate. All movement joints shall be

provided with a waterstop and sealant. Expansion joints shall be provided with a joint filler whereas discontinuity at contraction joints shall be provided by painting one face of the concrete with two coats of bituminous paint. At contraction joints, the sealant shall be set in a caulking groove formed in the concrete.

#### **3.15.29.2 Waterstops**

Waterstops shall be made in accordance with BS 6093.

Waterstops of the integral type shall have a minimum width of 230 mm. Waterstops without provision for wiring to reinforcement shall have a minimum web thickness of 10 mm. Waterstops with such provisions shall have a minimum web thickness of 4 mm.

Surface type waterstops shall have a minimum width of 230 mm and a minimum of two flanged integral ribs to the approval of the Engineer.

Site jointing of waterstops shall be by heat welding only.

The Contractor shall submit details of the procedure for joining of horizontal and vertical waterstops.

#### **3.15.29.3 Joint Filler**

Joint Filler shall be pre-formed compressible cellular and resilient and shall not become brittle in cold weather. It shall be granulated cork bound with bitumen.

Where low compression filler is required this shall be low density closed cell polythene.

#### **3.15.29.4 Joint Sealer**

Joint Sealer shall be non-degradable and shall be suitable for use in hot climates. Joint sealer shall be elastoplastic and shall possess a movement accommodation factor of at least  $\pm 12,5\%$ .

For movement joints in water retaining structures the physical properties of the sealer shall not be inferior to those of poly-sulphide based sealers complying with BS 4254 and the sealer shall have a minimum life expectancy of 15 years.

For horizontal joints in non-water retaining structures or pavements unless otherwise shown on the Drawings the sealer shall be a type A1 rubberized bituminous compound to BS 2499 and shall have a minimum life expectancy of 10 years.

In other situations the sealer shall be synthetic rubber based on poly-sulphide to BS 4254 or BS 5215 or based on polyurethane or silicone to the approval of the Engineer and shall have a minimum life expectancy of 15 years.

Where the joint sealer is to be in contact with a protective coating the Contractor shall satisfy the Engineer that the sealer and the protective coating are compatible.

The sealer shall be stored in accordance with the manufacturer's instructions and no sealer shall be used after its shelf life has elapsed.

To ensure non-adhesion to the back of the joint cavity a bond breaker is to be fixed where this is specified by the manufacturer of the sealer. Primer shall be obtained from the same manufacturer as the sealer.

#### **3.15.29.5 Dowel bars**

Dowel bars for expansion joints in concrete shall consist of mild steel complying with the provisions of BS 4449, Grade 250.

Dowel bars shall be straight, free from burns or other irregularities and shall have their sliding ends down. The sliding half of each dowel bar shall be painted with a thin coat of bond breaking compound and the end of this half shall be provided with a close fitting plastic or waterproof cardboard cap at least 100 mm long, the end 20 mm of which shall be fitted with a disc of joint filler or a pad of cotton waste.

### 3.15.30 Quality Controls

Before their use in the Works, the Contractor shall demonstrate to the satisfaction of the Engineer that all materials and methods of storage and mixing to be employed in the production of concrete conform in every way with the requirements of this Specification. Such deliveries of materials to Site as the Engineer may designate shall be carried out sufficiently in advance of their intended use in the Works.

If the Engineer shall decide that any concrete has commenced to set before being placed, then such concrete shall be rejected. The Contractor shall remove all rejected concrete materials from Site without delay and at his own cost. Permission to use any material shall not be construed as an approval of its source, nor any acceptance as continued acceptance.

The Contractor shall maintain a thermometer at the concrete batching plant for checking concrete temperatures, which shall normally not fall below 10°C or exceed 30°C on mixing. All surfaces with which the fresh concrete will come into contact with shall be free of snow, ice and frost. Water for curing concrete shall not be applied in cold weather until the concrete has attained strength of 5 N/mm<sup>2</sup>

### 3.15.31 Testing

This paragraph must be read in conjunction with the other relevant paragraphs. The sampling and testing of concrete for strength, workability, analysis of freshly mixed concrete and unit weight shall be carried out in accordance with the relevant Serbian norms mentioned.

The Contractor shall take samples of concrete and shall make cubes for testing as specified hereafter and when directed by the Engineer. The Engineer may, however, require that slump and cube tests be made at a greater frequency in structures of particular static or hydraulic importance. Samples shall be taken, at the Engineer's discretion, at the point of discharge from the mixer or at the site where concreting operations are in progress.

Each type of concrete sampled for compression testing shall consist of 3 pairs of cubes; each pair shall be tested at 3, 7 and 28 days, after having been cured by submersion in a tank filled with water (total of 6 cubes per sample).

A continuous ink written record of all concrete testing shall be kept by the Contractor and countersigned by the Engineer, providing but not limited to the following data: type of concrete; grade of approved mix; location of concrete sample; date of sampling; slump; density of fresh compacted test cube; density of test cube at 28 days; compressive strength at 3, 7 and 28 days. All cubes shall be marked with the date of casting and a reference number.

Except as may be otherwise reduced in the course of the Works, at the sole discretion of the Engineer based on the quality and variability of results obtained, the frequency of cube tests to be performed on concrete shall be as follows :

Type of concrete	Frequency of cube test (whichever is the more frequent)
No fines	according RS standards and BAB
Blinding	according RS standards and BAB
Walls	according RS standards and BAB
Water retaining structures	according RS standards and BAB
Floor Slabs	according RS standards and BAB



Roof Slabs	according RS standards and BAB
Thrust Blocks	according RS standards and BAB
Lightweight	according RS standards and BAB

For each type of concrete of up to 20 m<sup>3</sup> pour, at least two slump tests shall also be carried out if not defined different in RS standards and BAB.

The standard of acceptance for slump tests shall be the design slump.

Concrete cubes tested at 28 days shall be taken to represent the concrete placed in the Works. The standard of acceptance for cube strength tests shall be as follows.

Cube strength shall be calculated from the maximum load sustained by the cube at failure. The appropriate strength requirement shall be considered to be satisfied if:

- a) none of the cube strengths is below the specified minimum, or
- b) the average strengths of four consecutive cubes sampled from any one pour is not less than the specified average strength

All compressive strength tests shall be performed on 150mm cube specimens accurately moulded in appropriate steel forms (fabricated by a reputable specialist manufacturer, to the Engineer's written approval).

Concrete quality conditions regard to the following:

toughness to the pressure of concrete cubes 15 x 15 x 15 cm

- tensile strength
- water permeability
- wearing
- resistance to frost impact

### **3.15.32 Steel Reinforcement**

#### **3.15.32.1 General**

Steel for reinforcement shall comply with the appropriate standards.

All bars shall be delivered to Site firmly tied together in bundles, with length, diameter and number clearly indicated. Where bars are cut and bent prior to delivery to site, bundles of similar bars shall be tied together and tagged with a tag stating the bar mark and quantity. The Engineer shall select samples of steel reinforcement for testing if no test data is supplied by the Contractor, and the costs arising out of the tests shall be borne by the Contractor. The results of such tests shall be considered representative of the entire consignment. Reinforcement shall be stored on Site in racks off the ground, and shall be protected from excessive rusting, damage, oil or other deleterious matter.

All reinforcement bars shall be carefully bent with an even and gradual motion to the correct dimensions by experienced steel benders and in a manner which will not damage the material. In particular, no reinforcement shall be heated before bending. Unless stated to be otherwise, all bends and bending shall be in accordance with BS 4466/89. No bar, except links and stirrups, shall be bent to a smaller radius than twice its diameter. All bars lapped to secure continuity shall, unless otherwise stated, overlap not less than 40 times the diameter of the larger bar to be lapped. Before being fixed in position, all reinforcing bars shall be cleaned of mill scale, loose rust, dried grout, paint, oil, grease, soil, grit or any other substance which may impair the bond between reinforcement and concrete. Reinforcement steel for reinforced concrete shall be fixed in accordance with the detailed working drawings

and the instructions of the Engineer. The Contractor shall be responsible for all bar bending schedules, ensuring their accuracy and obtaining the Engineer's consent before cutting and bending reinforcement steel. The cover of concrete over reinforcement bars and fabric shall in no case be less than their diameter, and, unless shown otherwise on the drawings, a minimum of 30 mm in parts of structures not in contact with water and 40 mm for all water-retaining concrete and for concrete in contact with soil.

#### **3.15.32.2 Types, Quality and Storage**

Steel reinforcement for concrete shall consist of steel bars or steel wire fabric, except where otherwise shown. Steel wire fabric reinforcement shall be delivered in flat sheets.

The Contractor shall prepare test specimens of steel reinforcement to be used in the Works. Test specimens shall be taken in the presence of the Engineer and shall be of a size sufficient to carry out the tests as described below. They shall be tested in an approved laboratory and the certified copies of the results of the tests shall be submitted to the Engineer. The specimens shall be tested for bending and tensile properties and the wire fabric also for weld shear strength. The methods and requirements for testing shall be carried out in accordance with the applicable provisions of RS standards. No steel reinforcement shall be used in the Works until the testing results have been approved by the Engineer. If ordered by the Engineer, test procedures shall be repeated at the Contractor's expense for any new supply of reinforcement during the course of the Works.

Storage of reinforcement shall be on racks or supports clear of the ground. Different types and sizes of reinforcement shall be kept separate.

#### **3.15.32.3 Bending and Cutting Schedules**

Cutting and bending of reinforcement shall be in accordance with BS 8666.

The Contractor shall prepare for his own use bar bending schedules and bar lists, cutting schedules and sheet lists for wire fabrics for each individual structure, and shall be responsible for ensuring that correct information is given when ordering reinforcement.

#### **3.15.32.4 Protection and Cleaning**

Reinforcement shall be protected at all times from damage, and when placed in the structure shall be free from dirt, loose mill scale, rust scale, paint, oil, or other foreign substance. All reinforcing steel shall be carefully cleaned of all set or partially set concrete, shutter oil or paint which may have been deposited during the construction of adjacent Works.

#### **3.15.32.5 Bending of Bars**

Steel reinforcement shall be cut from straight bars free from kinks and bends or other damage and shall be bent cold by experienced competent workmen. Bars of diameter greater than 12 mm shall be bent in a bending machine designed for the purpose and approved by the Engineer. Any reinforcing bar that has already been bent shall not be re-bent at the place of the previous bend.

#### **3.15.32.6 Cutting of Wire Fabrics**

Wire fabric reinforcement shall be cut straight from the sheets. Cutting of sheets shall be done in such a way as to limit the loss of material. The use of off-cuts in the Permanent Works will not be permitted.

#### **3.15.32.7 Lapping of Bars and Wire Fabrics**

Lapping bars and wire fabrics is permitted when necessary and approved by the Engineer. No welding of reinforcement shall be carried out unless authorised by the Engineer. If approved by the Engineer, welding and testing for reinforcement shall comply with the requirements specified in BS4483.

Unless otherwise specified, lap length of bars shall be at least forty (40) times the diameter of the larger bar, and laps shall be positioned in a staggered pattern.

Laps on adjacent sections of wire fabric shall generally be carried out as follows:

- End-to-End by lapping the two pieces one full mesh (measured from the ends of the longitudinal wires in the other piece) and securing the two pieces together with wire ties placed at intervals of about 450 mm.
- Side by Side by placing the two wires (the longitudinal wires at the edges of the fabric) one alongside and lapping the other, and by securing the two pieces together with wire ties placed at intervals of about 900 mm.

### **3.15.32.8 Fixing of Reinforcement**

All reinforcing steel shall be accurately placed and fixed in position and retained in that position during the placing of the concrete.

Correct positioning will be achieved with the use of steel bar supports, blocks, ties, hangers or other approved supports. Spacer blocks for holding the reinforcement from contact with the forms, or adjacent reinforcement, shall be of dense precast concrete blocks of approved shapes and dimensions. The blocks shall be fitted with a semi-circular hollowing and double bent poured-in binding wires. The water-tightness of these blocks must be at least similar to the concrete into which they are concreted. The use of pebbles, pieces of broken stone or brick or other materials will not be permitted. Steel shall be bound and tied in its correct position using steel wire. Apart from any other requirement, the reinforcing steel shall be fixed in such a manner that it will support its own weight and any loads which may be imposed upon it during construction without displacement, deflection, or movement of any kind.

In slabs provided with two or more layers of reinforcement the parallel layers of steel bars shall be supported in position by the use of steel chairs. Spacer blocks shall be placed at each chair to support the layers of reinforcement from the blinding concrete or shuttering.

The concrete cover shall not be less than the minimal cover as specified in BS 8500: Part 1 Clause 3.1.8 and, where reinforcement is located in relation to only one face of a member, not more than the minimal cover plus:

- 5 mm for bars up to and including 12 mm size
- 10 mm for bars over 12 mm up to and including 25 mm size
- 15 mm for bars over 25 mm size

In addition, the minimum concrete cover to the nearest reinforcement exclusive of plaster or other decorative finish and concrete blinding, shall be as follows:

- For external work and for work against earth faces and in liquid retaining structures - 60 mm
- For external work in tidal environment and for concrete placed in or under water - 60 mm
- For internal work in non-liquid retaining structures

For beams and columns - 50 mm to the main steel and in no place less than 40 mm to the bar nearest the outside wall.

- For slab reinforcement - 40 mm to all bars or the diameter of the largest bar whichever is the greater.

The distance between any two parallel bars except at laps shall not be less than 5 mm greater than the nominal aggregate size.

All reinforcement projecting from construction joints or likely to be exposed to the weather for long periods before concreting is commenced, shall be covered with polythene, blinding

tape, cement grout or other materials to the satisfaction of the Engineer in order to prevent excessive rusting or staining of the surrounding concrete.

Should rust staining occur on any permanently visible surfaces, in spite of these precautions, it shall be removed at once to the satisfaction of the Engineer.

### **3.15.32.9 Approval before Concreting**

All reinforcement, after having been fixed in position, shall be inspected and approved by the Engineer before any concrete is placed. Any concrete placed contrary to this requirement shall, if ordered by the Engineer, be removed together with the reinforcement and replaced by the Contractor at his own expense.

## **3.16. Precast Concrete Units**

### **3.16.1 General**

All precast concrete units, both reinforced and not reinforced, shall be manufactured to comply with EN 13369:2004 and shall be casted in strong, rigid moulds, clean, wetted before concreting and with fillets fixed to the angles to give chamfered arises as necessary.

Where the installation of precast concrete units in any particular structure is such that the faces of the units are to be left exposed either internally or externally, the exposed surfaces of the units as finished shall be uniform in colour and in texture. All cement, aggregates and other materials used in the manufacture of the units shall be obtained from the same approved sources throughout the period of manufacture.

### **3.16.2 Concrete Quality and Tests on Concrete**

The concrete used in the manufacture of pre-cast concrete units shall comply in every respect with sub clauses relating to concrete fabricated on site and-or concrete from a ready-mixed plant.

### **3.16.3 Cast-in Parts**

The cast-in parts, such as lifting lugs, fasteners, jointing materials supporting structures, etc., shall be fixed in the positions as shown on the working drawings. Cast-in parts shall be free from rust, dirt or grease and shall be properly stored before use.

### **3.16.4 Transport, Storage and Erection**

At all stages and until completion of the Works, precast units shall be adequately protected to preserve all permanently exposed surfaces and arises. The protection shall not mark or otherwise disfigure the concrete.

Transportation, storage and erection of the precast concrete units shall be done carefully and in such way as to avoid any damage and to keep the surfaces of the units free from dirt or other unwanted marks. Loading and unloading, storage and erection of the precast concrete units at the Site shall be carried out by skilled labour and under supervision of a competent supervisor.

Any precast concrete unit which is found to be cracked, damaged or otherwise inferior in quality either before or after erection shall be rejected and shall be replaced by the Contractor.

### **3.16.5 Installation of Precast Concrete**

All precast concrete units shall be laid, bedded, jointed and fixed in accordance with the lines, levels and other details shown on the approved working drawings.

Dry-pack mortar where necessary shall be used for jointing or packing. The mortar shall be placed and packed in stages where possible from both sides of the space being filled using a hardwood stick hammered until the mortar is thoroughly compacted.

### **3.16.6 Manufacturing in a Factory**

Precast concrete units may be manufactured in a factory approved by the Engineer and which is off the Site. If the units are to be made in a concrete factory, then the Contractor shall give the Engineer full information, in advance concerning the name and address of the factory, details of the probable date of commencement of manufacture. The Contractor shall make the necessary arrangements for the Engineer to inspect the factory during working hours.

### **3.16.7 Work Programme and Method Statement**

The Contractor shall submit to the Engineer for his approval, the Work Programme and Method Statement giving full details of his proposed method of carrying out all operations connected with the manufacture and erection of precast concrete units, which shall include the following:

- period required to produce the drawings and detailed calculations
- dates of commencement of manufacturing of the concrete units
- dates of delivery to Site with the Specification for erection
- sequence of erection and the period required for Site erection works
- a description of the types of casting bed, mould and shuttering for the various types of members
- procedure for reinforcing, concrete casting and method of curing the concrete
- procedure for transporting, handling, hoisting and placing of each type of precast concrete unit
- the necessary strength of in situ cast concrete before starting site erection works
- the design manufacturing and mounting details to adapt the in situ cast concrete to the assembly
- particulars of temporary supports as deemed necessary to ensure adequate stability during erection and to sustain the effects of construction loads, wind loads or other transient loads

No works should be commenced until the programme and method statement have been approved by the Engineer.

### **3.16.8 Precast Concrete Kerbs, Channels, Edgings and Quadrants**

Precast concrete kerbs, channels and edgings shall be hydraulically pressed. Where kerbs or channels are required to be laid to a radius of 12 m or less, components of the appropriate radius shall be used.

### **3.16.9 Precast concrete flags and paving blocks**

Precast concrete flags shall be hydraulically pressed and, unless otherwise described in the Contract, flags shall be 50 mm thick.

### **3.16.10 Bituminous Jointing Strip**

Jointing strip for precast concrete segments shall be bitumen based, 3 mm minimum thickness and be suitable for the size and type of segments which it is to be used.

### **3.17. Connections to Concrete Structures, Temporary Holes & Openings**

#### **3.17.1 General**

All connections to concrete structures, temporary holes and openings in structures shall be made in accordance with the Drawings and/or to the directions of the Engineer.

All steel constructions and other items to be cast in, such as anchor bolts, steel frames, sockets, pipes, strips, waterstops of rubber, etc.. shall be fixed and cast in by the Contractor in accordance with the approved working drawings.

The Contractor shall also provide templates and other supplementary means for the correct positioning of the constructions and items as mentioned above.

The Contractor is to ensure that all of the constructions and items as mentioned above are on Site in time in order to avoid interruptions during the execution of concrete works. If recesses are provided, these shall be sufficiently larger in size than the dimensions of the construction or items to be cast in.

#### **3.17.2 Building-in Pipes and other Items**

Pipes and other items passing through concrete structures shall wherever practicable be built into the structure as work proceeds, having been installed and connected to the remainder of the system to ensure a proper fit, prior to the start of any concreting.

Before placing concrete all bolts, pipes or conduits or any other fixtures which are to be built in shall be fixed in their correct positions, and cores and other devices for forming the holes shall be held fast by fixing to the formwork or otherwise. Holes shall not be cut in any concrete without the prior approval of the Engineer in writing.

When that procedure cannot be adopted, holes or openings of suitable dimensions shall be formed for such items to allow them to be built in later along with or after installation of the remainder of the system. Such holes or openings shall be of a size and shape sufficient to permit proper placing and compaction of concrete or grout. The surfaces of the holes or openings shall be treated as construction joints.

All items to be built-in shall be securely supported in their correct position to prevent movement or damage during building in. In particular, any pipe with flanged joints shall not be concreted in until its accurate fit with other pipework has been checked and it has been secured in position.

Concrete used for building-in shall be of the same Class as the surrounding concrete, except that the mix shall also incorporate an approved expanding additive used with due regard to the manufacturer's instructions.

Cement sand mortar or cement grout used for this purpose shall also incorporate an expanding additive. Concrete, mortar and grout shall be placed and compacted by methods which will avoid moving or damaging built-in items.

#### **3.17.3 Cutting or Displacement of Reinforcement**

Reinforcement shall not be cut bent or displaced to facilitate building in without the Engineer's approval.

Where reinforcement is cut or displaced to facilitate the formation of holes or openings, the Contractor shall provide and fix additional reinforcement steel as required and approved by the Engineer to transfer the stresses from one side of the hole, opening or recess to the other.

Cutting or displacement of reinforcement shall only be permitted after the approval and inspection by the Engineer.

#### **3.17.4 Cleaning**

Before filling or grouting, the holes and openings shall be roughed and cleaned to remove dust or other impurities. The openings and holes shall be moistened with clean water before filling or grouting. The threads of anchor bolts and other items shall be cleaned and greased immediately after filling or grouting.

#### **3.17.5 Grouting in Narrow Spaces**

In the event of the space between the fixture or unit to be cast in and the adjacent concrete being less than or equal to 25 mm, the grouting shall compose of one part cement and two parts of sand with an approved expanding additive.

#### **3.17.6 Joint between Old and New Concrete**

Where new concrete is joined with old or existing concrete, the Contractor shall cut the old concrete to form a straight surface. The joint shall be considered as a construction joint and treated with an approved epoxy resin compound, prior to placing the new concrete. The exposed surface of the joint between old and new concrete shall be formed with a timber insert 20 mm x 25 mm. After the concrete has fully hardened, the timber insert shall be removed and the space filled with an approved epoxy sealer.

### **3.18. Coatings on Concrete Surfaces**

#### **3.18.1 General**

Bituminous Coatings shall be applied to concrete structures in order to protect the concrete against effects of groundwater and surface water or other unwanted matters.

The Contractor shall supply, deliver and apply all paints and protective coatings. The type of coating to be used shall be a bituminous (asphalt emulsion) approved by the Engineer.

All priming-coats and undercoats shall be obtained from the same manufacturer and shall be the type of primer and undercoat recommended by the manufacturer for that particular paint or bitumen.

All paints and bituminous coatings shall be applied strictly according to the instructions of the manufacturer. All the paints shall be delivered to the Site(s) in sealed containers with the manufacturer's name clearly shown. All coatings shall be applied by skilled labour under the supervision of a competent foreman and to the satisfaction of the Engineer. No bituminous coatings shall be applied until the concrete is properly cured and the prior approval of the Engineer has been obtained.

#### **3.18.2 Preparation of Surface**

Before the application of any coating or primer, the surface of the concrete shall be thoroughly cleaned of all dirt, curing compound, dust and loose material and, where necessary, the surface shall be made good so that it is smooth and free from air or water holes. The surfaces of the concrete shall be dry before application of the first priming coat. No bituminous coating shall be applied until the Engineer has approved the preparatory work. The Contractor shall ensure that the required quantity of paints and coatings are on Site prior to commencing work so as to avoid interruptions during the execution of the work.

#### **3.18.3 Application**

No paint, bituminous coating or primer shall be applied until the surface to be treated has been approved by the Engineer. After the application of a particular coat, the surface shall be approved by the Engineer before the next coat is applied.

#### **3.18.4 Priming Coat**

The priming coat shall be applied and well brushed into the concrete and allowed to dry.

#### **3.18.5 First Coat**

A heavy brush coat shall be applied in one direction and allowed to dry.

#### **3.18.6 Second and Subsequent Coats**

A heavy brush coat shall be applied at right angle to the previous coat and allowed to dry.

#### **3.18.7 Number of coats**

A minimum of two coats of bitumen excluding the priming coat shall be applied to concrete and other surfaces unless otherwise ordered by the Engineer.

#### **3.18.8 Holidays or Skips**

The applying of any layer or coating shall be done in such a manner that no holidays or skips shall occur on any treated surface.

#### **3.18.9 Quantity and Curing**

The application rate for the primer shall be  $0.05 \text{ kg/m}^2$  and subsequent coats shall be not less than  $0.5 \text{ kg/m}^2$  of surface. Each coat shall be thoroughly dry before applying a subsequent coat and shall be considered as dry when no staining occurs on a wet finger which is rubbed vigorously over the coating. No coating shall be immersed in water for at least seven days after it has been applied on the surface.

#### **3.18.10 Coating underside of Structures**

The underside of concrete structures in water logged ground shall be protected by the application of bituminous coating to a layer of cement sand mortar of minimum thickness 25 millimetres. The blinding layer will be lowered in order to accommodate this protection

The cement sand mortar shall be constructed on top of the blinding concrete and when it has been properly cured and hardened, the bituminous coating shall be applied prior to laying the structural concrete.

### **3.19. Steel Pipes, Pipe Laying and Testing**

#### **3.19.1 General**

Steel pipes, fittings and joints shall be factory made and shall comply with the relevant provisions of RS standards. Factory welding of longitudinal and spiral seams shall be made by Electric Resistance for outside diameters up to 508 mm. Submerged arc welding may be used for diameters larger than 508 mm. The ends of pipes, fittings and specials shall be fully prepared for jointing by the specified method, prior to delivery to site.

Internal and external corrosion protection systems shall normally be applied at the factory, and pipes and fittings shall be supplied to the site with adequate quantities of materials to permit the completion of the protection systems at welded joints on site.

#### **3.19.2 Materials**

Steel pipes, fittings and joints shall comply with the relevant provisions of RS standards and/or relevant EN.

Required steel grade: 360

The mechanical properties shall be as follows:



Minimum Yield Strength : 235 MPa  
Minimum Tensile Strength : 360 MPa  
Minimum wall thickness as in BS 534.

### **3.19.3 Manufacture**

Pipes shall be manufactured from hot-formed steel strip or plate, which is subsequently cold-formed longitudinally through a series of rolls into a pipe form and electric resistance welded (ERW).

Pipes with diameter larger than DN 150 may be produced by spiral fusion welding, in which coiled strip is formed helically into a pipe and the spiral seam is continuously welded by submerged arc.

The Contractor shall provide a manufacturer's certificate which shall state that the pipes, joints and specials, as appropriate, comply in all respects with the requirements of BS 534 : 1990.

### **3.19.4 Dimensions**

Outside diameters and thicknesses shall be selected from table 1 of BS 534 : 1990. The thicknesses selected shall not be less than the minimum nominal thicknesses.

Mass per metre length shall be in accordance with table 1, BS 534 : 1990

Pipes for cutting into closing lengths at site shall be supplied sized throughout their lengths to the same dimensions as the spigot ends.

### **3.19.5 Pipe Lengths**

Steel pipes shall be supplied in cut lengths of 6 m.

### **3.19.6 Joints**

Pipe ends shall be prepared, as appropriate, for the following types of joints:

- a) Slip-on type couplings
- b) Flange joints.

Slip-on type couplings for use with plain end pipes shall be of the general type given in BS 534. Lengths of coupling sleeves and tolerances shall be as given in table 3 and table 4, BS 534. Surface irregularities such as peaks, flats or depressions shall blend smoothly into the surface of the pipe and their depth or height shall not exceed 0.25 mm.

Flange joints shall have flanges in accordance with BS 10, BS 4504 : Section 3.1 or BS 1560 : Section 3.1. Where pipes are supplied with flanges welded on, the welding shall be carried out in accordance with BS 2633 or BS 2971.

Gaskets for flange joints shall be of the inside-bolt-circle type. The dimensions of gaskets shall comply with BS 4865:Part 1. Gaskets shall be manufactured from material complying with the provisions of BS 2494 for type W rings.

### **3.19.7 Fittings**

Where fittings are fabricated by welding, the preparation and welding shall be carried out in accordance with BS 2633 or BS 2971. The ends of specials shall be prepared to match those of the pipes to which they are to be joined.

Bends and tees shall be in accordance with the provisions of BS 534 : 1990, Section 4.

### **3.19.8 Protection Against Corrosion**

The surfaces to be protected shall be clean and free from scale, loose rust, oil, grease, or other foreign matter. Surface preparations for other than cement mortar or concrete linings shall be effected by one of the following methods, in accordance with BS 534 : 1990:

- b) acid pickling
- c) abrasive descaling

Coatings and linings shall be applied in accordance with the provisions of BS 534: 1990: Section 5.

### **3.19.9 External protection**

Pipes and fittings with nominal diameter greater than 150 mm shall be protected externally by bitumen sheathing in accordance with the relevant standards.

### **3.19.10 Internal protection**

Pipes and fittings with nominal diameter greater than 150 mm shall be protected internally by a cement mortar lining made from Portland cement .

Pipes and fittings up to and including 150 mm nominal diameter shall be hot dip galvanised. Prior to galvanising, units shall be thoroughly descaled and cleaned.

### **3.19.11 Working Pressure**

Maximum working pressure for pipes and fittings shall be 10 bar.

### **3.19.12 Transport, Storage and Stringing of Pipes**

All equipment necessary for the loading, transport to construction sites or storage sites and unloading shall be supplied by the Contractor.

Pipes shall be handled in such a way that damage is avoided as far as possible. They shall only be lifted with straps of a material and a form which protects the pipes and their coating from damage. The Contractor shall check the pipes for any visible defect or damage and notify the Engineer in case of any damage or defect found. The Contractor shall be responsible for making good any damage or defect to the approval of the Engineer.

All pipes shall be protected against weather attack, including sunlight, and fouling during transport storage and stringing. If any pipe gets fouled, it shall be cleaned before installation.

When pipes are collected from a storage site, the Contractor shall secure the remaining pipes against slippage. When a storage site is emptied of materials the Contractor shall clean the site and any access road and reinstate both to their original condition.

The pipes shall be strung consecutively along the working width on timbers or similar. with at least two per pipe, to avoid damaging or fouling the pipes. The pipes shall be strung in such a way that the normal use of the surrounding areas is disturbed as little as possible. Pipes shall be secured against rolling. When stringing pipes with diameter tolerance marks (+, 0, -), ends with the mark + shall never abut on ends with the mark (-).

### **3.19.13 Pipe Laying**

Pipes shall be laid to the alignments and grades shown on the drawings and in the pipe trench and subsequently jointed. Jointing at the trench side and snaking the jointed pipeline into the trench is not allowed due to the risk of overstressing the joints and damage to the linings occurring unless so designed.

Care should be paid during backfilling to ensure that pipe diametrical deflections are minimal and do not exceed the following limits:

Lining	Coating	Maximum diametrical deflection (%)
Cement mortar	Cement mortar	2
Cement mortar	Flexible	3
Flexible	Flexible	5

Joint type	Maximum diametrical deflection (%)
Mechanical/flexible with elastomeric gasket	2
Welded	4 - 5

### 3.19.14 Testing and Commissioning of Steel Pipes

The requirements for pressure testing and commissioning of steel pipelines are summarised in the following table:

Site pressure test	In accordance with BS CP 2010 Part 2
System Test Pressure	10 bar
Leakage allowance:	
Butt welded/internally and externally welded sleeve jointed pipelines	No observable drop other than that due to temperature changes.
All other steel pipelines	37 litres/metre nominal bore/length/ 24 h/bar pressure head applied maximum.
Test duration	Minimum 24 hours.

Pipeline trenches should be backfilled prior to pressure testing. Previously inspected butt welded joints may also be backfilled. Where practicable, other types of joint should be left uncovered to permit ready identification of any joint leakage. Permanent anchors should be permitted to develop adequate strength to resist the test pressure loads before pressure testing commences.

Hydrostatic pressure testing shall be commenced in comparatively short lengths, as instructed by the Engineer, and the test section length shall be increased as experience is gained, until lengths of about 1.5 km are tested in one section.

Should leakage of water occur at the joints, the joint shall be reassembled to eliminate such leakage or, should this not prove possible, the Contractor shall supply and assemble new joints at his own expense. Should any pipe or joint burst or should water leak through the body of a pipe or joint the Contractor shall forthwith remove the faulty pipe or joint and replace them with new at his own expense. In all the above cases the length under test shall be re-tested as above described and the process repeated, if necessary, until the pipeline satisfactorily withstands the prescribed test.

A test report shall be prepared in respect of each and every test performed. The test report shall contain as a minimum the following data:

- Number and date of the test
- Description of the stretch tested with unambiguous indication of the extremities of the stretch
- Sketch showing, in the order of laying, the number and the characteristics of the pipes, the fittings, the specials and other apparatus incorporated in the stretch

- Duration of the test, test pressure, results obtained
- Decisions relative to possible repair works and conclusions

The test report shall be signed by the Contractor and the Engineer's Representative.

The Contractor shall provide labour, install and work the test pump, pressure gauges and all other equipment required for the test and he shall fill the pipes with water and subsequently empty them after the test, all to the approval of the Engineer. Water drained from the pipes shall be discharged in a way that does not affect the stability of the Works or adjacent structures.

### **3.20. Galvanised Steel Pipes**

#### **3.20.1 Standards**

Except where otherwise stated, steel pipes and fittings shall be in accordance with relevant standards: Specification for Steel Pipes and Specials for Water and Sewage, Carbon Steel Pipes and Tubes with specified Room Temperature Properties for Pressure Purposes and Screwed and Socketed Steel Tubes and Tubulars and for Plain End Steel Tubes suitable for Welding or for Screwing Pipe Threads.

#### **3.20.2 Joints**

Flange joints shall have flanges in accordance with standards. Where pipes are supplied with flanges welded on, the welding shall be carried out in accordance with applicable standards too.

Where screwed ends are specified each pipe shall be supplied complete with one screwed socket to complete the joint.

Gaskets for flange joints shall be of the inside-bolt-circle type. Gaskets shall be manufactured from material complying with the RS standards of relevant EN.

#### **3.20.3 Tests and Disinfection**

Before dispatch all mild steel straight pipes shall be hydraulically tested by the manufacturer.

Hydraulic testing of mild steel fittings and specials shall be carried out in accordance with the relevant standards.

Disinfection shall be as specified in other paragraphs

#### **3.20.4 Galvanising**

After being tested the mild steel pipes and fittings shall be galvanised in accordance with BS 729.

### **3.21. Un-plasticized Polyvinyl Chloride (uPVC) Pipes**

#### **3.21.1 General**

Unplasticized PVC pressure pipes, joints and fittings shall comply with the relevant provisions of WIS 4-31-06 (pipes) and WIS 4-31-07 (joints and fittings)

All buried uPVC pressure pipes shall, unless otherwise indicated, be of the socket and spigot type made water tight in the joints by the compression of rubber gaskets with two thick lips.

uPVC pipes, joints and fittings for gravity sewers and drains shall comply with the relevant provisions of EN 1401, ISO 4435 or equivalent. Solid wall concentric external rib-reinforced PVC sewer pipes shall comply with the relevant provisions of WIS 4-31-05.

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uPVC pipes shall be capable of withstanding ultraviolet degradation. A rodent inhibitor shall be incorporated in the material of the pipe.

The Contractor shall advise the manufacturer of the climatic and conditions at the site of the Works and shall seek his advice on the storage of uPVC materials on site. Subject to the Engineer's approval this advice shall be followed at all times.

### **3.21.2 Dimensions**

Normal outside diameters and normal pressures shall be in accordance with the requirements of ISO 161 – 1:1996, Part 1, Metric series.

### **3.21.3 Pipe lengths**

Unplasticized PVC pipes shall be supplied in lengths of 6 m.

### **3.21.4 Pipe Jointing**

Pipe jointing may take place under one of the methods and in accordance with the procedures recommended by the manufacturer:

1. Solvent Cement
2. Ring Seal
3. Threaded Fittings
4. Saddle joints
5. Flange jointing

Solvent cements for jointing uPVC pipes shall comply with BS 4346 : Part 3. For pipes and fittings complying with BS 4660, solvent cement may alternatively comply with BS 6209.

Except in the case of flanged joints and where otherwise specified or approved by the Engineer, pipe joints shall be flexible and sealed with a rubber gasket to the approval of the Engineer and shall withstand the various tests specified in the applicable standards. For pipes with a nominal bore of 100 to 230 mm the joints shall be capable of withstanding a deflection of not less than 3.0 degrees in any direction and for pipes with a nominal bore of 250 to 330 mm a deflection of 2.0 degrees and from 350 to 600 mm 0.5 degrees in any direction. All pipes shall be capable of withstanding a "draw" of 13 mm over and above the initial jointing allowance. The initial jointing allowance is the gap measured parallel to the centre line of the pipeline and shall not be less than 6 mm or more than 13 mm or as otherwise recommended by the pipe manufacturer and approved by the Engineer. Pipes and fittings shall be indelibly marked prior to laying to indicate the correct initial jointing allowance.

### **3.21.5 Gaskets**

The gasket shall consist of a substantial body, which is extended into two thick lips directed towards the bottom of the socket. The outer edge of the body shall be formed into an annular shoulder, which fits into the recess in the socket of the pipe. The side of the shoulder facing the entry to the socket shall be given a chamfer to centre the gasket in its recess.

The standard gaskets shall be moulded components with a generous cross section providing large seating surfaces to ensure fluid tightness and a substantial reserve of elasticity. The maximum continuous working temperature for these gaskets is 70°C. In natural rubber or an equivalent elastomer, the gaskets shall be for ND 60 to 600 shall be homogenous. The gaskets shall be factory fitted and factory lubricated with a long lasting silicone lubricant. The pipes must be supplied with end caps protecting the pipes effectively against fouling etc..

The storage conditions for the gaskets shall be in accordance with the manufacturer's recommendations.

### **3.21.6 Handling, Storage and Transport**

During transport, handling and storage, each item (pipe and fitting) shall be free from damage prior to installation. Damaged pipes and fittings shall be discarded.

### **3.21.7 Handling**

The protection of the pipe ends is particularly important. Pipes and fittings shall never be dropped to the ground. They shall be unloaded from the transport either by hand or using appropriate slings and lifting equipment.

Pipes shall be cut by a method which provides a clean square cut of the pipe and lining (if applicable) without damage. All cut or trimmed ends shall be cleaned and in the case of metal pipes coated with phenol-free bitumen before the pipes are laid. The external surfaces of cut spigot ends of ductile-iron pipes shall be ground for at least 125 mm from the joint.

### **3.21.8 Storage**

Pipes shall be protected from ultraviolet light from the sun, from direct sunlight or other heat sources.

Racks for long term storage shall provide continuous support along the pipe's length, or if this is not possible then supports of 75 mm (minimum) bearing widths at 1 metre (maximum) centres shall be placed beneath the pipes. If side restraints are required these can be at up to 2-metre spacing. Racks should not exceed 1 metre in height.

Where racks are not available pipes can be stored on a temporary basis on the ground, providing the surface is level and free from loose stones or other sharp projections.

Where different sizes and classes of pipe are stored in the same rack, the heaviest pipes must be at the bottom and where pipes are nested inside one another the stack height must be reduced in relation to the added weight.

Packs of pipes shall remain in their packing until ready for use. The complete packs can be stored directly onto level ground that is free from loose stones and other sharp projections. Packs of pipes can be stacked, however the total stack height should not exceed 3 metres.

### **3.21.9 Transport**

PVC pipes shall only be transported on vehicles with a flatbed that provides adequate support along the full length of the pipe. The bed of the vehicle must be thoroughly checked before loading to ensure that it is free from imperfections that may damage the pipes. Any unsupported overhang at the rear of the vehicle should not exceed 1 m. As with storage the packs of pipe shall be loaded with the heaviest at the bottom. Pipe that arrives on site damaged shall be discarded.

### **3.21.10 Installation of PVC Pipes**

The Contractor shall submit for the Engineer's approval the pipe manufacturer's complete and detailed recommendations for the handling and installation of pipes and fittings in open trench.

Particular care shall be exercised by the Contractor when installing pipes at temperatures below 10°C. Pipe laying shall not be carried out when the temperature is below 0°C.

During excavation and laying of pipelines, the trench walls should be supported with an appropriate system to safeguard the installation personnel against collapse of the trench. The excavated soil shall be kept well back from the edge of the trench and loose stones removed and discarded.

At the crown of the pipe, the trench width should be 200 mm wider than the diameter of the pipe on both sides. The trench should be over-excavated to a depth of 100 mm. The bedding and surround material shall be filled and thoroughly compacted with sandy material which conforms to WIS 4-08-01. Care must be taken to ensure continuous support is given along the entire pipe length and not just on the joints. The bedding shall be scooped out to accommodate joints and fittings. In all cases the bedding shall be laid to the correct fall and gradient.

After laying the pipe on the prepared bed, the sand side fill should be placed around the pipe and compacted to 80% of optimum density, in 75 mm layers, to a thickness of the pipe diameter or a maximum of 200 mm above the pipe crown. Care must be taken to avoid displacing or damaging the pipe and to ensure that the cavities under the two lower quadrants of the pipe are eliminated. For the protection of the pipe initial backfilling of the trench shall be carried out as soon as possible after laying. The remaining backfilling can be completed with suitable excavated material "on site" spoil in well rammed layers not exceeding 300 mm. Heavy mechanical rammers shall not be used until the pipe is covered by more than 300 mm.

### **3.22. High Density Polyethylene Pipes (HDPE)**

#### **3.22.1 General**

Polyethylene pipes and fittings for water supply services shall comply with the provisions of EN 12201, ISO 4427:1996 or equivalent.

All HDPE pipes and fittings shall be manufactured by a brand known manufacturer which will comply with Certified QA procedures in accordance with EN ISO 9001.

HDPE pipes shall be manufactured from PE100 /SDR 17 and shall comply with ISO 4427, DIN 8074, colour RAL 9011 with blue kite mark according to WIS 4-32-17.

Pipes up to DN 100 shall be delivered in coils. The length of the coiled pipes shall be 50m to 100 m. If the pipes are to be coiled, this must be done at a temperature less than 30°C. The ends of the pipe shall be plugged or covered.

The minimum diameter of the rollers for coiled pipe should be such that kinking of the pipe is prevented. The minimum internal diameter of the rollers shall not be less than 24 times the nominal outside diameter of the pipe with a minimum of 60 cm. The end of the pipe shall be plugged or covered.

The pipes shall be manufactured from high density polyethylene containing only those antioxidants, UV stabilizers and pigments necessary for the manufacture of potable water black pipes and comply with ISO/DP 4427/ clause 4.1. The Contractor shall provide an approved third party certificate to verify the above. Rework material generated from a manufacturer's own production of pipes, shall not be used.

Materials in contact with or likely to come into contact with potable water shall not constitute a toxic hazard, shall not support microbial growth and shall not give rise to unpleasant taste or odour and cloudiness or discoloration of the water. Concentration of substances, chemicals and biological agents leached from materials in contact with potable water, and measurements of the relevant organoleptic / physical parameters shall not exceed the maximum values recommended by the World Health Organization (WHO, 1984) or as required by the EEC, Council Directive 1980, whichever is in each case is the more stringent.

The pipe manufacturer shall provide evidence of the nominal values of the density and melt flow rate (index) of the raw material. The density of the raw material (compound) shall not be less than 0.945 g/cm<sup>3</sup>.

### **3.22.2 Distribution Network**

The HDPE distribution pipes shall be of PE 100 SDR 17 and be provided with metallized indicator band in order to be subsequently detected from the ground surface by specific equipment.

The pipes shall have a MRS of 10 MPa (designated as PE100) and a MOP of 16 bar.

### **3.22.3 Building Connection**

The PE pipes for building connection shall be of PE 100 SDR 11 and shall be designed for a nominal working pressure Class of PN 16.

### **3.22.4 Dimensions**

Normal outside diameters and normal pressures shall be in accordance with the requirements of ISO 161 – 1:1996, Part 1, Metric series.

### **3.22.5 Pipe Joining**

HDPE pipes shall be joined by butt fusion welding, electro-fusion welding compression fittings, flanges or mechanical couplings, as appropriate to the pipe, fittings and location.

Polyethylene butt fusion joints and fittings for use with cold potable water shall comply with the relevant provisions of ISO 12176-1:1998.

Mechanical joint compression fittings for use with cold potable water shall comply with the relevant provisions of ISO 14236-1:2000.

Electro-fusion fittings shall comply for use with cold potable water shall comply with the relevant provisions of ISO 12176-2:2000.

### **3.22.6 Transport and Storage**

During transportation, the Contractor shall ensure that any precautions specified by the manufacturer of materials, plant and equipment for handling of their products are strictly adhered to.

The vehicles on which pipes are to be transported shall have a body of such length that the pipes do not overhang. This is particularly applicable to HDPE pipes in 6m or 12 m lengths.

During handling, the pipes shall not be dropped or allowed to strike one another or be rolled freely down inclines and they shall not be dragged on the ground.

All materials, including couplings and joints which are likely to deteriorate or be damaged by exposure of the elements, shall be stored in weatherproof building.

Pipes shall be stacked lengthways, clear of the ground and to a height of 2.0m or less having regard to the recommendation of the Manufacturer and the adequacy of the Contractor's stacking arrangement. The first layer shall be placed on a firm foundation of timber set level and the pipes firmly anchored to prevent spreading. Subsequent layers shall be placed using timber spacers. Timber spacings and nests shall be such that pipe flanges or sockets do not take any load.

All pipes and fittings supplied as spares shall have end covers which are proof against the entry of sand and vermin.

End covers and protection shall not be removed until incorporation of the pipes and fittings into the works.

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Sufficient space shall be left between stacks to enable plant to pass between without causing damage to the pipes.

Each consignment of each material shall be stored separately so as to provide easy access for inspection. After they have been approved by the Engineer, consignment shall be used in the order in which they were delivered on Site.

### **3.22.7 Installation of PE pipes**

Installation shall be in accordance with the recommendations of CP 312: Parts 1 and 3 and of the manufacturers of pipes, fittings, tooling and equipment. Should any of these requirements conflict, the Contractor shall inform the Engineer of the conflict and propose the procedure to be adopted in sufficient time to allow the Engineer to review the Contractor's proposals.

Thermal fusion jointing, whether by socket fusion, butt fusion or the use of electro fusion couplings, shall be carried out only by workmen who have been trained in such work by a manufacturer of HDPE pipes meeting this specification. The Contractor shall submit the names of thermal fusion jointers to the Engineer for his consent together with full details and evidence of the relevant training and experience each has received. Only approved jointers shall be allowed to make each type of joint.

Where not otherwise specified, pipes shall be jointed using electro-fusion couplings or socket or butt thermal fusion. However, socket or butt thermal fusion shall be used only where the Contractor has made proposals for its use and for routine testing of a proportion of joints which are acceptable to the Engineer. Should the Engineer become dissatisfied with the standard of socket or butt thermal fusion jointing he may withdraw approval for its use, in which case electro-fusion couplings shall be used.

Gradual changes in direction or grade of the pipeline may be made by bending the pipe provided that the pipe centre-line radius shall not be less than 40 times the pipe nominal diameter, and provided that no tension is transferred to socket/spigot joints or other vulnerable joints.

HDPE pipe or fittings to be built into concrete shall first be wrapped in not less than 3 layers of heavy gauge polyethylene sheet. Additionally each pipe or component shall be visually inspected to ensure that it has not sustained any visually determinable damage.

Where a change in direction cannot be made by the inherent flexibility in HDPE pipes, prefabricated bends shall be used. The approximate locations of such bends and other specials shall finally be indicated upon the Contractor's Drawings, and their exact positions will be determined together with the Engineer on the Site.

The Contractor shall provide all necessary personnel, equipment and materials for welding. The Contractor shall supervise the site, the welders and their work during the entire working period. For this purpose the Contractor shall use a qualified and certified welding specialist. Welding certificates shall be submitted to the Engineer. Only skilled welders and welding operators who can document qualifications relevant for pipeline welding will be accepted by the Engineer. Prior to the performance of any production welding operators shall qualify for the relevant welding procedures according to DVGW Arbeitsblatt GW 330.

Surfaces to be welded have to be sufficiently clean, to avoid deterioration of weld quality by any dirt, oil, grease or other contamination. Welding shall be suspended by the Contractor when prevailing weather conditions will impair the quality of the work, e.g. rain or thunderstorms. Vibration inducing operations carried out in the vicinity of welding machine are prohibited during welding operations.

After welding, the joint shall be checked visually. In case of any of the following imperfections, the pipe ends shall be cut and welded again:

- different high welding beads on pipe end
- welding beads too narrow and too tall
- welding beads too small
- crack on the centre of welding beads
- offset too high (10% of pipe wall thickness is tolerated)

After the compaction of the first layer of base course backfilling, a plastic strip with tracking tape should be laid along the trench for subsequent location of the pipe route. The tape shall be blue in colour and of 200 mm overall width and contain an aluminium strip throughout its length of minimum width 50 mm. The words "Caution water main below" along the top section of the tape and "Water Authority" along the bottom section of tape shall be written in Serbian. Samples of tape shall be submitted to the Engineer for his approval.

Thrust blocks shall be installed whenever the pipeline changes direction or size, stops or has an inline tee piece or valve. The thrust blocks shall prevent deflection or extension of the pipeline under the action of internal fluid pressure and to transfer the resultant forces to the surrounding ground of load bearing capacity.

When placing concrete on a HDPE pipeline care should be taken to avoid encasing the pipe completely. This is because the slight flexibility of PE may cause pulsing under pressure variations which may cause the pipe to shear at the interface between the concrete anchor and the backfill. It is recommended that a thin membrane, such as bituminised paper, thin roofing felt or polythene film to a thickness of about 250  $\mu$  is applied between the concrete and the PE pipe.

Except where self-anchoring joints are used, thrusts from bends and branches in pressure pipelines shall be resisted by concrete thrust blocks cast in contact with undisturbed ground.

Any additional excavation required to accommodate thrust blocks shall be carried out after the bend or branch is in position and the thrust face shall be trimmed back to remove all loose or weathered material immediately prior to concreting.

Thrust blocks shall be allowed to develop adequate strength before any internal pressure is applied to the pipeline.

Rapid hardening cement shall not be used in concrete for thrust blocks to plastic pipes.

Pipes shall be wrapped with a layer of plastic sheeting before being surrounded by concrete.

### **3.22.8 HDPE Pipelines for Sewers**

HDPE non pressure pipelines shall be in accordance with DIN 19537.

### **3.23. Other Pipes and Fittings**

#### **3.23.1 Ductile Iron Pipes and Fittings**

Ductile iron pipes and fittings shall comply with EN 545 or ISO 2531: 1998 for potable water pipelines and EN 598 for sewerage applications.

Polyethylene sleeving shall be in accordance with ISO 8180 – ductile iron pipes – polyethylene sleeving. Tubular polyethylene film for use as a loose protective sleeving for buried iron pipes and fittings shall have a nominal width of 280 mm for use with 80 mm and 100 mm nominal internal diameter pipelines. Sleeving for pipes for below ground use for potable water shall be coloured blue and all other sleeving black.

Cement mortar linings shall comply with EN 545 or ISO 4179 "Ductile iron pipes for pressure and non-pressure pipelines - Centrifugal cement mortar lining - General requirements",. Where there may be problems of lime leaching due to high pH water, a seal coating may be required (generally less than 50 mg/l of calcium alkalinity). This will be detailed in the Contract. The maximum thickness of lining shall be limited to give a clear bore to the pipe as follows:

DN	Minimum clear bore (mm)
80	67
100	87
150	137
200	187
250	237
300	287

Pipes with cement mortar lining shall comply with National Regulations for drinking water or health regulations where appropriate.

Pipes with a wall thickness of less than that specified for Class K9 shall not be used unless specified elsewhere in the Contract.

Pipe ovality shall not exceed the values given in EN 545.

All gaskets and adequate lubricants required in flexible joints and flanged joints shall be supplied with pipes and fittings.

Flanges, including rotatable flanges, shall be PN16 unless otherwise specified and comply with ISO 2531 or EN 545 (for potable and raw water) and EN 598 (for sewerage applications).

All bolts, nuts and washers required for flange joints and anchored flexible pipe joints shall be supplied with pipes and fittings. Bolts for anchored pushfit flexible pipe shall be of high tensile steel.

Flanged pipes and fittings shall be in accordance with EN545 for potable water and shall be drilled to NP10 unless otherwise stated.

For potable water applications external coating of DI pipes DN ≤300 shall comply with EN 545:2002 and of DN > 300 shall comply with ISO 8179

### **3.23.2 Accessories**

**3.24. Dismantling joints shall be provided for the installation and later removal of flanged equipment in larger sizes e.g. valves, flow meters. The dismantling joints must allow longitudinal adjustment by a telescopic action between the flanged spigot and the flange adaptor. Pipeline Testing**

#### **3.24.1 General**

On completion of construction, internal surfaces of pipelines shall be cleaned thoroughly.

Before testing any pipeline the Contractor shall ensure that it is anchored adequately and that thrusts from bends, branch outlets or from the pipeline ends are transmitted to solid ground or to a suitable temporary anchorage.

Open ends shall be stopped with plugs, caps or blank flanges properly jointed. Testing against a closed valve is not permitted.

Before any testing of a pipeline the Contractor shall submit to the Engineer his proposed programme of testing. The Contractor shall notify the Engineer at least 3 working days beforehand of his intention to test a section of pipeline.

Pipes shall be tested in reasonable lengths which are appropriate to diameter and site conditions. The Contractor shall propose the lengths of such sections for the approval of the Engineer.

### **3.24.2 Testing non-pressure pipelines**

Non-pressure pipelines laid in open cut shall be tested after they are jointed and before any concreting or backfilling is commenced, other than such as may be necessary for structural stability whilst under test.

The pipelines shall be tested by means of an air or water test or by a visual or closed circuit television (CCTV) examination, in lengths determined by the course of construction, in accordance with the programme.

A further test shall be carried out after the backfilling is complete.

### **3.24.3 Water test for non-pressure pipelines**

Water testing for non-pressure pipelines shall comply with the provisions of RS standards.

The test pressure for non-pressure pipelines up to and including 750 mm nominal bore shall be not less than 1.3 m head of water above the pipe soffit or ground water level, whichever is the higher at the highest point, and not greater than 6 m head at the lowest point of the section. Steeply graded pipelines shall be tested in stages in cases where the maximum head, as stated above, would be exceeded if the whole section were tested in one length.

The pipeline shall be filled with water and a minimum period of 2 hours shall be allowed for absorption, following which the original water level shall be restored. Water shall then be added from a measuring vessel at intervals of 5 minutes over a 30 minute period and the quantity required to maintain the original water level noted. Unless otherwise specified, the length of pipeline shall be accepted if the quantity for the water added over a 30 minute period is less than 0.5 litre per lineal metre per metre of nominal bore.

### **3.24.4 Air test for non-pressure pipelines**

Air testing for non-pressure pipelines shall comply with the provisions of BS 8005:Part 1

### **3.24.5 Infiltration**

Non-pressure pipelines and manholes shall be tested for infiltration after backfilling. All inlets to the system shall be effectively closed and any residual flow shall be deemed to be infiltration. The permissible infiltration is the same as the permissible loss in the water test in Clause 23.3.

The pipeline, including manholes, shall be accepted as satisfactory if the infiltration. Including infiltration into manholes, in 30 minutes does not exceed 0.5 litre per lineal metre per metre of nominal bore. Infiltration rate calculation shall be made in accordance with the provisions of EN 1610.

Notwithstanding the satisfactory completion of the above test, if there is any discernible flow of water entering the pipeline at a point which can be located either by visual or CCTV inspection, the Contractor shall take such measures as are necessary to stop such infiltration.

### 3.24.6 Testing of pressure pipelines

Steel pipes must be tested in accordance with the paragraph 3.19.14-"Testing and Commissioning of Steel Pipes".

The entire pipeline shall be tested in accordance with the provisions of relevant RS standard.

Gauges used for testing pressure pipelines shall either be of the conventional circular type, not less than 200 mm diameter, calibrated in metres head water, or shall have a digital indicator capable of reading increments of 0.1 m head. Before any gauge is used, the Contractor shall arrange for it to be checked independently and a dated certificate of its accuracy shall be provided.

Before testing, valves shall be checked and sealed, the sections of main filled with water and the air released. Pressure testing against closed valves is not accepted. After having been filled, pipelines shall be left under normal operating pressure for 24 hours, so as to achieve conditions as stable as possible for testing. For thermoplastic pressure pipelines particularly for the first 6 hours, the pressure shall be maintained at 1.3 x nominal pipe pressure.

The pressure in the pipeline shall then be raised steadily until the pressure of 1.5 x maximum operating pressure is reached in the lowest part of the section and the pressure shall be maintained at this level, by pumping if necessary, for a period of one hour. The pump shall then be disconnected and no further water shall be permitted to enter the pipeline for a further period of one hour. At the end of this period the original pressure shall be restored by pumping and the loss measured by drawing off water from the pipeline until the pressure as at the end of the test is again reached. The permissible loss shall not exceed 2 litres per metre nominal bore per kilometre length per metre head (calculated as the average head applied to the section) per 24 hours. For thermoplastic pressure pipelines particularly, the pipe is exposed to a pressure of 1.3 x nominal pressure rate for a period of 2 hours during which water may be added to maintain the pressure. For the next 1 hour no water shall be added. At the end of this period the original pressure shall be restored by pumping and the loss measured by drawing off water from the pipeline until the pressure as at the end of the test is again reached. The permissible loss shall not be higher than the limits defined as:  $0.02 \times d_i - 0.001 + \Delta V$ ,

where  $d_i$  is the internal diameter and  $\Delta V$  is equal to  $0.05 \times d^2$  for PVC pipes and  $0.08 \times d^2$  for PE pipes.

Where a new pipeline is to connect to an operational pipeline the final connection shall be inspected visually under normal operating pressure and there shall be no visible leakage.

### 3.24.7 "Short tests" for HDPE

The so-called "Short Test" may be used for pipelines up to 30 metres long and nominal diameter up to and including DN 50 and can be applied for service connections. The Short Test can be used for pressure testing the house connections when approved by the Engineer. The test pressure for the Short Test is 1.5 times the nominal pressure.

The test pressure is applied to the pipe and the first reading taken after 30 minutes. This pressure will usually be slightly less than the initial pressure due to the normal expansion of the pipeline under pressure, but no additional "top-up" pressure should be applied.

For the short test the results are deemed to be satisfactory when the pressure loss from the HDPE pressure pipeline is  $< 0.1$  bar per 5 minute.

### 3.24.8 Isolation test of zoned areas

After all lengths in a sub-zone that are to be connected, have been jointed together on completion of preliminary testing, an isolation test shall be carried out on the complete sub-zone as a step test.

The isolation test shall be carried out in the night and in such a way that after closing of all valves at the boundary the outside pressure shall be  $> 0$  bar whereas the inlet pressure along the boundary shall be 0 bar. The isolation passes until at all sites along the boundary the test pressure is within the time frame of the test always 0 bar.

### **3.25. Cleaning of Sewers and Water Mains**

#### **3.25.1 Cleaning of sewers**

##### **3.25.1.1 New Works**

All debris shall be cleared from the inside of the pipe before a joint is completed. Before testing is undertaken on a pipeline section, the pipeline shall be cleared internally to ensure that no foreign matter remains inside the pipes. Pigs or polyurethane swabs may be used for cleaning of pressure pipes provided that the Contractor takes all necessary precautions using this equipment.

#### **3.25.2 Cleaning and disinfection of water mains**

The cleaning and disinfection of water supply pipes shall take place in four stages complying with Serbian standards.

##### **3.25.2.1 Preliminary Flushing**

All pipes shall be preliminarily flushed at least once at high rates of flow (velocity shall exceed 1.5 m/sec). The Contractor shall prepare a flushing plan and submit it to the Engineer for approval.

##### **3.25.2.2 Cleansing**

All pipes shall be cleaned with clean water for a duration of at least five minutes at a rate of flow sufficient to obtain a velocity exceeding 1 m/sec. This cleansing procedure shall be repeated until any trace of taste or smell has disappeared from the water.

##### **3.25.2.3 Disinfection**

Following the satisfactory cleansing the Contractor shall with the use of a portable dosing system or by some other approved method introduce a solution of a sterilising chemical containing chlorine into the pipeline. The solution shall be introduced at a very slow rate and shall be of such strength as to give a free available chlorine concentration of not less than 20 mg/l throughout the pipelines.

All fire hydrants (or tees where appropriate) on the distribution system shall be opened successively, working progressively away from the place where the solution is introduced. Each hydrant shall be closed when the water discharged begins to smell of chlorine. The whole system shall then remain charged for 24 hours, after which the water shall show a residual chlorine concentration of not less than 1 mg/l. If no residual chlorine is found or if the residual chlorine is less than 1 mg/l, the sterilisation process shall be repeated until a satisfactory result is obtained.

##### **3.25.2.4 Bacteriological Testing**

After the disinfection period of 24 hours the water shall be evacuated from the pipes and the pipe system shall then be refilled with potable water having a concentration of residual chlorine of about 0.1 ppm.

A number of water samples to be determined by the Engineer shall then be taken and subjected to laboratory tests for coliform bacteria. If the tests show the presence of coliform bacteria, the whole cleaning and disinfection process from preliminary flushing shall be redone until the result is negative.

### **3.26. Chambers and Manholes**

#### **3.26.1 General**

Manholes and chambers shall be constructed on sewer and water supply pipelines in the positions as detailed on the Drawings.

For sewer pipelines revision manholes and/or drop manholes shall be made at every horizontal and vertical route change as well as at the places conditioned by channel or object connection.

Manholes and chambers for the housing of valves and flow meters shall be constructed in accordance with Volume V and Volume III-1. Generally all manholes and chambers shall be constructed in either precast or in-situ concrete to the standard details shown on the Drawings in Volume V and in accordance with the provisions of the present Specifications.

Manholes and chambers shall be constructed as detailed on the drawings. On completion of construction, all manholes and chambers shall undergo a water retaining test. The test shall consist of filling the structure with water, to within 200 mm of the underside of the roof slab, and maintaining it filled for a period of 2 days. At that stage, the water shall be replenished to the original level and left for a period of 1 day. The drop in level, if any, during that 24 hours shall not exceed 50mm.

#### **3.26.2 Construction details**

Pre-cast concrete chamber and manholes sections shall be constructed with steps and step rungs, irons, ladders or slabs aligned correctly. Joints shall be made so that the required jointing material fills the joint cavity. Any surplus jointing material extruded inside the chamber shall be trimmed off and joints shall be pointed on completion.

Incorporation of special connectors of adequate profile into the chamber walls shall be foreseen for connection to the pipelines.

Where manholes are to have a concrete surround, the concrete shall be of quality C-20 and the height of each concrete pour shall not exceed 2 m.

Bases for chambers shall be constructed to the standard details shown on the Drawings.

All the manholes for sewerage shall be made of water impermeable concrete C-30 with a wall thickness of 20 cm and a thickness of the bottom slab of 20 cm. Cover board shall be reinforced-concrete one, 20 cm thick. The free bottom slab and the cascade of all the manholes shall be plastered by cement mortar.

Manholes covers and frames shall comply with the relevant Serbian provisions. All manholes shall have closed keyways. Covers shall be light duty on structures not subject to vehicular loads, medium duty in footpaths and heavy duty in footpaths alongside roads and roadways.

Step irons shall be provided at 300 mm horizontal spacing and 300 mm vertical (staggered) intervals.

For valves of diameter above DN 200 mm and for mechanical flow meter chambers, chamber covers and frames shall be of ductile iron and comply with the relevant provisions of EN 124 and have a minimum clear opening of 600 mm. For valves with DN up to 200 mm surfaces boxes will be provided and shall be ductile iron Class A in accordance with BS 5834 and shall have a minimum clear opening of 380 x 230 mm. Surface boxes for other purposes shall be cast iron and shall comply with the relevant provisions of BS 5834 and be heavy duty grade A.

Covers and frames with minimum clear openings outside the ranges in EN 124 shall comply with the relevant provisions of that standard where applicable. All manhole covers shall have at least two closed keyways per complete cover. Keyways shall be at symmetrical points to enable lifting without tilting or jamming.

Chamber covers and frames shall in general be constructed flush with the final ground level. In exceptional cases where it is not possible or necessary to construct chambers with the top flush with the final ground, the Contractor will propose for the Engineer's approval, the construction of the chamber to be partly above ground in order to accommodate the correct installation of valves etc..

Chambers and manholes shall be substantially watertight, with no identifiable flow of water penetrating the Works. If there is any discernible flow of water entering the chamber at a point which can be located by visual inspection, the Contractor shall take such measures as are necessary to stop such infiltration.

### **3.27. Steelwork and Metalwork**

#### **3.27.1 General**

The Contractor shall fabricate, supply, deliver and erect all steelworks, fixing materials and associated parts according to the Specification and Drawings and shall comply with the requirements of the relevant Standards, unless otherwise specified or instructed by the Engineer.

The steelworks shall comprise of the following main items:

- open mesh
- chamber covers
- windows and frames
- doors and frames
- flanges and bolted connections
- anchoring
- step irons, ladders and pipes instructed by the Engineer
- staircases, landings and platforms instructed by the Engineer

The structural steelworks comprise mainly the fabrication and erection of the following constructions:

- columns and beams
- gratings, including frameworks
- hatches, including frameworks
- angles for protection of edges in several lengths, including anchors
- ladders, step irons
- staircases, landing and platforms
- other structural steelwork associated with the specified mechanical and electrical works.

#### **3.27.2 Submissions by the Contractor**

Prior to any steel fabrication work the supplier shall submit full details of his proposed procedure, qualifications and methods of fabrication to the Engineer for approval.

This information shall include (but not be limited to) the following details where they are relevant:

- (i) The method of plate forming
- (ii) Joint design

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- (iii) Proposed welding procedure and proof of competence of welders
- (iv) Method of straightening, sizing and hydrostatic testing.
- (v) Quality control and inspection procedures.

### **3.27.3 Manufacturing and Workmanship**

All Works shall wherever possible be carried out in covered and well equipped workshops. Where work has to be carried out on Site the Contractor shall take adequate measures to protect work against damp, draughts and extremes of temperature. The Contractors proposed measures shall be submitted to the Engineer for approval before site welding commences. The Specification shall apply to all manufacturing, delivery, storage and workmanship.

### **3.27.4 Painting and Galvanising**

Painting and Galvanising of steel surfaces are covered in the General Mechanical and Electrical Specification.

### **3.27.5 Metal Windows, Doors and Frames**

Metal windows and doors with their frames will be of low carbon (mild) steel and shall be hot dip galvanised in accordance with EN ISO 1461.

Windows shall be installed with the number of fixed and inward opening lights, complete including hinges, latches and casement stay, to opening sizes as shown in the Drawings.

Galvanised mild steel doors and frames in two leaves, shall be manufactured in 2.5 mm thick sheet framed, ledged and braced in 40mm x 40mm x 4mm angle, frame in 50mm x 50mm x 5mm angle, 1½ pairs 125mm welded butt hinges per leaf, set lever lock furniture with 5 lever lock and triple point locking arrangement, to suit opening sizes as indicated in the Drawings.

Galvanised mild steel sliding doors, shall be installed with frame and proprietary sliding track mechanism approved by the Engineer. The door shall be manufactured in 2.5 mm thick sheet, framed, ledged and braced in 40mm x 40mm x 4mm angle, locking arrangement by hasp and staple with 5 lever padlock to suit opening sizes as indicated in the Drawings.

Galvanised mild steel window security grill shall be installed in all windows, fabricated from 10mm dia. bars at 40mm centres horizontally cranked to provide 50mm offset from face of wall, bars welded each end and at mid height to 40mm x 6mm flat and all bolted to masonry, to suit opening sizes as indicated in the Drawings.

Door and window frames shall be securely fixed to openings, drilled and plugged at 3 points per jamb and shall have 100 mm by 12 mm diameter galvanised steel dowels to posts let into flooring and bedded in non-shrink grout.

The joint between frames and adjacent walls shall be continuously pointed with gun applied butyl or other approved non-setting mastic.

### **3.27.6 Step Irons**

Step irons shall be either of galvanised iron to an approved Standard or of stainless steel as detailed. Unless otherwise detailed stainless steel step irons shall be fabricated from 25 mm diameter solid bar twice bent to form a 'U' shaped rung with 375 mm tread width and two legs 350 mm long, the ends of the bar shall be ragged and built 175 mm into the concrete wall. The tread of the rung shall be stamped or ribbed to provide a non-slip surface.

### **3.27.7 Ladders (Steel)**

Ladders shall be fabricated of solid mild steel sections. Bolts, nuts and washers shall be galvanised. The stringers shall be flat section not less than 65 mm x 13 mm spaced 380 mm apart and shall be flanged and drilled for wall fixing at both ends. The stringers shall be

radiused over the top where they shall be not less than 600 mm apart. Ladders over 3 metres long shall have additional intermediate stays at not more than 2.5 metre centres.

Rungs shall be 25 mm diameter solid equally spaced at 300 mm centres, shouldered at each end and securely riveted into countersunk holes. Rungs shall be not less than 225 mm from the wall.

All ladders rising more than 2.50 metres from lower platform or ground level to the top rung shall have safety cages which shall be constructed of three flat verticals supported by flat hoops with a diameter of 750 mm. The hoops shall be approximately 700 mm centres and the first hoop shall be 2.4 metres above ground or platform level.

Where the rise exceeds 6.2 metres an intermediate landing shall be provided.

All steel ladders shall be galvanised and coated in accordance with the coating specification.

### **3.27.8 Surface boxes**

Surface boxes for valves or below ground hydrants shall be manufactured of grey cast iron and shall conform to the relevant provisions of RS standard. The minimum load test for the lid shall be 200kN and for the body 400kN. Surface box covers shall show a conical seat.

### **3.27.9 Keys**

Valve keys, lifting keys, tee keys and hooks for manhole and other covers shall be black japanned steel suitable for use with the valves or covers supplied and shall be obtained from the armature or cover manufacturer.

### **3.27.10 Structural Steelwork**

#### **3.27.10.1 General**

Rolled structural steel sections shall be mild steel complying with the requirements of the appropriate RS standard. The dimensions, tolerances and properties of the structural sections shall conform to BS 4 or BS 4848.

#### **3.27.10.2 Bolts and Nuts**

Steel bolts and nuts for structural steelwork shall be high strength friction grip bolts or black bolts as detailed on the Drawings. High strength friction grip bolts shall be used in conjunction with approved proprietary load indicating washers.

#### **3.27.10.3 Welding Consumables**

All welding consumables (electrodes, wire, filler rods, flux, shielding gas and the like) shall comply with the requirements.

Weld electrodes for metal arc welding shall conform with the requirements of the appropriate weld procedure.

#### **3.27.10.4 Welding**

All welding carried out during fabrication or erection shall be in accordance with the requirements. Details of the proposed weld procedures shall be submitted to the Engineer for approval. All connections shall be welded in such a manner as to make the finished connections neat and smooth in appearance and suitable for painting. All slag shall be removed and all sharp projections shall be round smooth.

Before welding is commenced either in the fabrication shop or on Site, weld procedure tests shall be carried out in where directed by the Engineer.

All welders employed either in the fabrication shop or on Site shall pass qualification tests relevant to the weld procedures. Welders shall have satisfactory evidence of having been

engaged in welding for at least 9 months in the preceding 12 month period. If the work of any welders employed on the Contract is unsatisfactory, the Contractor shall carry out such further welder qualification tests as are necessary to demonstrate that the welders are proficient.

Welds shall be subjected to non-destructive testing by processes which may include but shall not necessarily be limited to radiographic, ultrasonic, magnetic particle, or dye penetrate methods, depending on the type of weld and its position in the structure. If any work shows defects or fails to comply with the requirements of the Drawings or Specification for any reason it shall be repaired or rejected, even though it may have been carried out by qualified welders using approved procedures.

#### **3.27.10.5 Dissimilar Metals**

Where dissimilar metals are used in close proximity to structural steel members or their connections, contact between such metals and the steel shall be avoided unless the Contractor can demonstrate to the satisfaction of the Engineer that contact between the dissimilar metals will not lead to galvanic corrosion.

Contact between aluminium or aluminium alloy and galvanised mild steel will be permitted. For fixing aluminium to steel structures, bolts, nuts, washers and screws shall be galvanised.

Where galvanised parts might otherwise become sacrificial anodes to the main structure, or where the electrolytic potential difference exceeds 250 mV, the parts shall be separated by an insulating medium of adequate strength.

#### **3.27.10.6 Galvanised Steel Tube**

Galvanised steel tube shall comply with applicable RS standard.

#### **3.27.10.7 Stainless Steel**

Stainless steel shall comply with applicable RS standard unless otherwise specified.

### **3.28. Fencing and Landscaping**

#### **3.28.1 Submissions**

Prior to commencement of any landscaping work, the Contractor shall submit to the Engineer for approval his detailed proposals for landscaping. The Contractor shall ensure that landscaping is carried out at an appropriate season and in suitable weather conditions. Planting operations shall be suspended in periods of drought, when the soil is frost bound or waterlogged, or in periods of persistent drying cold winds.

#### **3.28.2 Materials**

##### **3.28.2.1 Fences and Gates**

Chain link fencing shall be of minimum height 2.0 m. The mesh will be fixed on galvanised steel angle posts. Intermediate angle posts will be 70 x 70 x 8 mm thick. Stretcher bars will be of galvanised steel, 50 x 6 x 2100 long.

Access gates, both single and double entrance gates, shall be fabricated tubular steel and galvanised after manufacture. Sockets for casting into the roadway shall also be provided. The sockets shall be designed to provide secure and robust support for drop bolts when gates are in both open and closed positions.

Each gate shall be supplied with a padlock and three keys all to the Engineers approval.

### **3.28.2.2 Top Soil**

Existing topsoil stripped from the site and stored in heaps adjacent to the Works may be reused provided it has not become contaminated and is free of rubble and debris.

Where insufficient site topsoil is available humus shall be imported from an approved source. Samples shall be submitted to and be approved by the Engineer before landscaping work is commenced.

### **3.28.2.3 Grasses**

Grass seed shall be appropriate to the area and shall be proposed by the Contractor and approved by the Engineer.

### **3.28.2.4 Gravel**

Gravel for use on the site for landscaping shall be of 28 mm nominal size.

### **3.28.2.5 Irrigation Water**

Water for irrigation shall be taken from the potable water supply main.

### **3.28.2.6 Erection of Fences and Gates**

Fencing shall be constructed as shown on the Drawings and approved by the Engineer.

In areas where the ground has not already been graded during other earthworks operations, the fence shall generally follow the existing ground line. Minor irregularities shall be removed or filled by grading 600 mm on each side of the fence.

Spacing of stretcher bars shall not exceed 66 metres in straight lengths of fence. Intermediate posts will be installed at max. 3 m centres.

## **3.28.3 Landscaping**

### **3.18.3.1 Tree Felling**

Existing trees and shrubs where directed by the Engineer or indicated on the Drawings shall be cut down and all stumps and main roots shall be grubbed up. All vegetation matter thus dealt with shall be removed from the site.

### **3.28.3.2 Preparation of Ground**

Where so required landscaping of the Site shall be undertaken after the Contractor has completed all other earthworks apart from replacing topsoil. The areas to be landscaped shall be brought to final ground levels less the depth required for top soil or other surfacing and all surplus material shall be disposed of offsite.

All areas of the Site which are to be finished with gravel shall be excavated to a level of 150 mm below final ground level. After excavation is complete the area shall be filled to final ground level with compacted gravel.

### **3.28.3.3 Site Preparation**

For Grass Seeding and Turfing the area shall be cultivated to a minimum depth of 100 mm by a mechanical rotovator or similar approved method. Stones over 500 mm in any linear dimension shall be removed. All weeds shall be removed. The area is to be lightly firmed and raked to provide a fine tilth 25 mm in depth. All finished levels shall be even running levels and conform to contours or spot levels shown on the drawings.

3 to 5 days before seeding or turfing an approved pre-emergent weed killer is to be applied to the area according to the manufacturer's instructions and an approved general pre-germination fertiliser is to be applied to the area at the recommended rate and worked into the surface tilth.

#### **3.28.3.4 Planting**

For the Sowing and Planting seed mixture shall be applied at the recommended rate and application. After sowing the ground is to be raked or chain harrowed and lightly consolidated by rolling with an approved flat roller.

If the seed fails to germinate the Contractor shall re-seed in whole or in part until a good even sward is obtained.

When the grass is 75-100 mm high and about two days before topping, the area shall be lightly rolled. Topping shall be by a roto-scythe and reduce the height of the new grass to 50 mm.

Heavy swathes of cuttings shall be removed from the newly grassed area. A second cut at a period of no less than one month after the first shall be undertaken, again to reduce the height of the grass to 50 mm followed by two cuts by cylinder mower at periods of no less than two weeks, the cuttings being removed. Immediately following the fourth cut or at a time directed by the Engineer, the newly grassed area shall be evenly dressed with an approved fertiliser.

#### **3.28.3.5 Maintenance**

Any grassed areas which fails to grow satisfactorily will be re-sown or re-turfed as directed by the Engineer after suitable ground preparation;

The Contractor shall water all grassed areas, hedges, trees and shrubs as necessary.

#### **3.29. Building Works Materials**

All materials and equipment provided by the Contractor shall be new and of the various qualities as required by these specifications.

##### **3.29.1 Sands**

All sands required to comply with relevant RS standards and shall be washed sands.

##### **3.29.2 Hydro Insulation**

Following hydro insulation shall be used for the different parts of building substructure, walls and roofs.

1. Insulation between blinding and structural concrete shall be either hot applied bitumen, min. 500gm/m<sup>2</sup> or bituminous felt 300gm/m<sup>2</sup> properly overlapped by at least 150mm and glued. Care shall be taken that the melted bitumen is uniformly distributed. In case bituminous felt is used the Contractor shall ensure that no damage arises due to upstands or rough blinding surface.
2. Insulation of earth covered walls shall be hot applied melted bitumen, min. 500gm/m<sup>2</sup>. Prior to application the walls shall be brushed or rubbed down, to ensure that all loose particles, dirt or remaining release agent are removed.
3. Insulation of earth covered roof slabs shall be executed as follows:

Breeze concrete, Diffusion layer, Moisture barrier, Two layers bituminous felt 500 gm/m<sup>2</sup>

The bituminous felt shall be overlapped and glued by at least 150 mm. The first layer shall be laid parallel to the fall, the second layer in right angle to fall. All layers shall terminate at the outside walls 200mm below the underside of the roof slab.

##### **3.29.3 Damp-proof Courses**

Damp-proof course material for walls and lintels shall be Bitumen Type B complying with BS 8215 and shall be tropical grade.

### **3.29.4 Damp-Proof Membranes**

The damp proof membrane on concrete floors shall be a cold applied bitumen solution manufacture applied in two coats to give an impervious finish.

### **3.29.5 Building Paper**

Building Paper shall comply with BS 1521 Class A2.

### **3.29.6 Metal Lathing**

Metal lathing shall be galvanised steel lathing having a weight of 1.60 kg/m<sup>2</sup> and complying with BS 1369.

Where necessary mesh to take render coats shall be 13 mm No. 22 galvanised wire mesh to BS 1485.

### **3.29.7 Mastic for Pointing**

Mastic for pointing shall be approved Butyl / Silicon / Acrylate joint sealing compound of approved colour applied by gun in full accordance with the manufacturer's instructions.

### **3.29.8 Carpentry and Joinery**

Whenever possible, cutting and shaping of all timber shall be completed before preservative treatment is carried out. Where any cutting or shaping has to be carried out after treatment, the cut or worked surfaces shall be given 2 coats of the preservative. After treatment, timber shall be thoroughly dried out before use.

The whole of the joinery shall be cut and framed together as soon as possible after the commencement of the work. Workmanship shall comply with the relevant provisions of BS 1186: Part 2 and BS 6446. Except where work is described in the Tender Dossier as being to finished sizes 3 mm shall be allowed for each face. Frames, casings and other joinery fittings shall be secured to hardwood fixing slips built in for the purpose. Where hardwood fixing slips have not been provided, receiving surfaces shall be plugged with hardwood plugs or approved proprietary type plugs.

Manufactured units to be painted shall be primed at the place of manufacture.

### **3.29.9 Joinery Timber**

Timber for joinery shall comply with the relevant provisions of EN 942 or BS 1186.

The sizes of sawn and processed softwood and hardwoods shall comply with the relevant provisions of EN 1313 and BS 5450 respectively.

### **3.29.10 Doors, Windows and Frames**

#### **3.29.10.1 General**

All doors and windows both interior and exterior shall be completely weather and waterproof. Material for doors should be aluminium and has to fulfil the Energy efficiency requirements.

The Contractor shall assemble one finished prototype of each component, fitted with ironmongery for approval of the Engineer before any repetitive production, or fixing of prefabricated frames commences. The Contractor shall also submit to the Engineer for approval samples of locks, handles, latches and similar ironmongery.

All window and door openings in blockwork walls shall be spanned by suitable reinforced concrete lintels.

All opening windows shall be fitted with suitable insect screens.

### **3.29.10.2 Metal Doors, Windows and Frames**

Metal Doors, Windows and Frames as specified.

### **3.29.10.3 Others Doors and Windows**

Frames and leaves of external doors shall be made out of PVC (UV resistant) or aluminium, insulated according to DIN 4108. Recesses to the openings shall be provided for doors or windows set into concrete walls, to avoid inside plastering.

External doors shall be fitted outside with door knobs, inside with handle. All external doors at project location shall be fitted with a master lock system.

Internal doors shall consist of metal frame, and leaves not less than 40 mm thick. The leaves shall be of nature and colour as approved by the Engineer, transparent factory sealed. Frames shall be painted twice with approved white paint after installation. Pre-assembled hinges shall be used. All doors shall be furnished with solid handles and locks.

### **3.29.10.4 Lintels**

Concrete, steel or timber prefabricated lintels shall comply with the relevant provisions of EN 845.

### **3.29.10.5 Door Seals**

Door seals to the outer stiles, the frame and the meeting stiles of double action swing doors shall be of the neoprene brushing type set in with aluminium screws the seals to brush onto PVC inserts in an aluminium alloy channel section similarly fixed.

Threshold seals in neoprene to the bottom of doors shall be set in up stand type aluminium holding channel.

### **3.29.10.6 Ironmongery**

All moving parts of joinery components are to be fixed with equal tolerance spaces all round. Hinges, etc., are to be fitted in perfect alignment, locks and fastenings are to engage properly in their striking plates or sockets without clatter. Screws for fixing ironmongery shall be of the same metal as the hardware. On completion all joinery shall be adjusted and ironmongery oiled and the whole shall be in perfect working order.

All external door locks shall have three keys, and all internal locks two keys. All locks and moving parts are to be oiled and left in perfect working order and all keys shall be properly marked and labelled. Double doors shall have barrel bolts fitted top and bottom to one leaf.

Generally hinges to doors and windows shall be stainless steel butt hinges and be fixed with stainless steel screws.

External doors shall be fitted with 5 level mortise locks incorporating separate dead bolts. Internal doors shall be fitted with single bolt dead locks. All exposed parts and striking plates shall be stainless steel. Three keys shall be provided for each lock.

All doors shall have aluminium level furniture with internal latch springs. The handle plate shall be fixed with stainless steel screws and shall incorporate the keyhole. All door furniture shall be to BS 4951 and 5872.

External doors shall be fitted with overhead door closers to prevent slamming.

### **3.29.10.7 Glass**

All glass for glazing shall generally comply with the relevant provisions of BS 952: Part 1.

All outside glazing in doors and windows shall be double glazing.

Internal screens, doors, inspection panels and aluminium framed glass doors shall be in 4 mm thick wired plate glass, glazed with compound and clips or approved equivalent.

### **3.29.10.8 Glazing**

In aluminium doors and windows glazing shall be set in rubber profiles. No glazing compounds are to be used.

### **3.29.10.9 Emergency Doors**

Emergency doors shall be fitted with approved panic bolt to EN 1125 to the inside of the doors and the doors shall be designed to open outwards.

Roof lights shall be of clear plastic conforming to BS 8213, Part 1 (Cleaning and safety) and BS CP 153, Part 2 (Durability and maintenance).

Roof lights shall be permanently fixed, and shall not be readily interfered with by unauthorised persons. The mounting shall be to up-stand kerbs cast into the roof slab.

### **3.29.11 Natural Stone**

Natural stone shall be of durable quality, uniform in texture, and free from iron bands, spots, sand-holes, flaws, shakes and other imperfections which would adversely affect its strength or appearance. The dimensions of stones shall be adequate for proper coursing and bonding.

### **3.29.12 Dressed Natural Stone Kerbs, Channels, Quadrants and Setts**

New dressed granite and whinstone kerbs, channels, quadrants and setts shall comply with the relevant provisions of EN 435.

Second-hand stone kerbs, channels, quadrants and setts shall not be excessively weathered, worn or chipped, and shall be free from all bedding and jointing materials. Faces which are to remain exposed on completion of the Works shall be free from stains.

### **3.29.13 Cast Stone**

Cast stone shall comply with the relevant standards.

Reconstructed stone masonry units shall comply with the relevant provisions in EN 1015 .

### **3.29.14 Coping Units**

Precast concrete, cast stone, clayware, natural stone and slate coping units shall comply with the relevant RS standards:.

### **3.29.15 Brickwork and Block-work Generally**

Clay bricks, precast concrete masonry units and calcium silicate bricks , brickwork and block-work shall comply with relevant Serbian provisions.

The moisture content of the bricks shall be adjusted so than excessive suction is not exerted on the mortar.

Brickwork and block work shall rise uniformly; corners and other advanced work shall be raked back and not raised above the general level more than 1 m. No brickwork shall be carried up higher than 1.5 m in one day. No bats or broken or broken bricks are required, all cutting shall be carried out with a mechanical cutting disc.

Completed brickwork and block-work shall be protected at all times from scaffold splash, mortar droppings, grout leakage from suspended slabs and the harmful effects of weather. Brickwork and block-work shall be allowed to set thoroughly hard before cutting or chasing is carried out.

Where brickwork or block-work is to be bonded to concrete, this shall be achieved by means of metal ties evenly placed at three per square metre and brickwork and block-work shall be brought up subsequent to the concrete.



Bricks and blocks shall be laid in mortar properly bedded and jointed and all joints filled with mortar at every course.

Centering and lagging used for the construction of brickwork and block-work shall remain in place for such time as is necessary for the brickwork and block-work to develop sufficient strength to prevent sagging or cracking of joints.

Materials used in bricklaying and blocklaying shall be frost free and no bricks or blocks shall be laid when the ambient temperature is below 3° C, unless special precautions are taken. The Contractor shall ensure that any additive used in the mortar does not cause a variation in the colour of the joints. Completed work shall be protected adequately during cold weather.

### **3.29.16 Aerated clay blocks**

Aerated clay blocks shall be used for external walls and shall be of one of the following sizes, as described in the Bill of Quantities.

- 240 x 300 x 238 mm, or
- 300 x 240 x 238 mm, or
- 365 x 240 x 238 mm.

The blocks shall have a specific weight of 0.8 and a crushing strength of not less than 6 N/mm<sup>2</sup>, K-value 0.32 to 0.34 W/m<sup>2</sup>.

Internal walls may be made out of aerated bricks or of perforated clay bricks. The bricks shall be sound, hard, square, well burnt and of uniform size in shape and colour with straight arises. Blocks and bricks shall be laid to break joint in alternate courses and shall be bedded in lime - cement mortar.

### **3.29.17 Metal Ties**

Metal ties for wall construction shall comply with the relevant provisions of RS standards.

### **3.29.18 Roof coverings**

Roof coverings shall comply with the relevant provisions of the appropriate Standard as set out in the following table:

Material/type	Standard
Clay tiles and fittings	EN 538, EN 1304
Concrete tiles and fittings	EN 490 and EN 491
Fibre cement slates	EN 492
Fibre cement sheets	EN 494
Metal roofing – zinc	EN 501
Metal roofing – copper	EN 504
Metal roofing - Sheet Steel	EN 505
Metal roofing – aluminium	EN 507
Slate and stone	EN 12326
Felt	EN 13707

### **3.29.19 Slating and Tiling**

Slating and tiling work shall comply with the relevant Serbian standards.

### **3.29.20 Roofing**

#### **3.29.20.1 General**

Reinforced concrete roof slabs shall be covered by an approved concrete insulating screed with a minimum thickness of 50 mm and a three layer built- up bituminous roof sheeting.

When required, joints shall be formed in the insulating screed. A vapour barrier and ventilation to the bituminous roof sheeting shall also be provided.

The hatch in the roof shall be provided with an insulating sandwich panel in a thickness of minimum 50 mm consisting of coated polyurethane foam or similar approved.

The insulation of roofs of buildings which need heating in winter and / or cooling in summer shall be calculated such that the whole building complies with the building regulations for thermal isolation in Serbia.

#### **3.29.20.2 Rainwater Gutters and Outlets**

Rainwater pipes, gutters, fixings and accessories shall comply with Serbian Standards and /or the following appropriate standards:

Material	Standard
Cast iron	-
Aluminium	EN 612
PVC-U	EN 607
Pressed steel	EN 612

They shall be fitted with circular gratings and sized for the downpipes. A sample of the type of rainwater outlet to be used shall be submitted to the Engineer for approval.

Gutters shall be of galvanised steel with a minimum thickness of 0.8 mm formed from pressed elements, fitted with stop end pieces, and shall be fixed by gutter brackets, to a fall not less than 1% to the rafters. Down end pieces shall be tapered to fit a 100 x 100 mm down pipe. Eaves flashing shall be made of min. 0.5 mm galvanised iron sheets.

Down pipes, swan neck pieces, bends and down pipe shoes shall be prefabricated, and made out of 0.8mm galvanised steel. The down pipes shall be properly fastened to the walls by galvanised brackets, spaced not more than 1.50m.

#### **3.29.20.3 Galvanized Steel Sheet**

Galvanized steel sheet for covering roof movement joints shall comply with BS 2989 and be 20 gauge (1.00 mm thick).

#### **3.29.20.4 Movement Joint Sealant**

Sealant for protecting joints in movement joint covers shall be one-part gun grade polysulphide.

### **3.29.21 Tiles**

#### **3.29.21.1 General**

Tiles shall comply with the relevant provisions of the appropriate Serbian or EN Standard.

All sheet or tiles of the same type, colour and pattern, which will be visible together, shall be from the same batch.

The Contractor shall supply samples and certification documentation to the Engineer for the approval of tiles.

### **3.29.21.2 Floor tiles**

Floor tiles in operation office and service buildings shall be of the right Class for the purpose. Floor tiles shall comply with the relevant provisions of the following standard as appropriate.

Type	Standard
Ceramic	EN ISO 10545
Thermoplastic	EN 649
Semi flexible PVC	EN 654
Un-backed flexible PVC	EN 649
Terrazzo	BS 4131

### **3.29.21.3 Wall tiles**

Wall tiling shall comply with the relevant Serbian provisions:

The tiles shall be 150 x 150 mm<sup>2</sup> and of the best quality ceramic tiles available.

### **3.29.22 Internal flooring**

#### **3.29.22.1 Granolithic Flooring**

Granolithic flooring shall have a minimum thickness of 75 mm.

#### **3.29.22.2 Tiling**

Quarry floor tile joints shall be not more than 3mm.

#### **3.29.22.3 Protection**

All finished surfaces shall be properly protected until completion of the Contract. Terrazzo tile and in-situ flooring shall be protected with a layer of clean sawdust. PVC tile floors and carpets shall be protected with polythene sheeting.

### **3.29.23 Walls, ceilings and paint work**

#### **3.29.23.1 Wall-Tiling**

Walls or part of walls which have to be tiled shall be floated off with mortar consisting of Portland cement, shell lime or similar approved and sand in the volume ratio 1/2 : 1 : 4 before tiling. The tiles shall be fixed evenly with an approved adhesive.

The joints shall be narrow and of uniform width and shall be filled with approved white proprietary tile grout. Glazed ceramic wall tile joints shall be minimum 2 mm wide.

Filling with grout shall be according to the manufacturer's instructions. Where necessary, tiles shall be cut and properly fitted.

### **3.29.23.2 Cement Plastering**

Internal walls and ceilings shall be plastered with 1 : 4 Portland Cement-sand mortar. Total thickness of plaster on internal walls shall be 20 mm. Before plastering is carried out, the joints shall be raked out to a depth of at least 10 mm.

The surface of the wall shall be cleaned of all foreign matter before application.

### **3.29.23.3 Wall Painting**

The surface of the cement plastered walls and ceilings shall be primed and painted with washable and weather proof wall paint. The paint to be used shall be the best quality plastic emulsion paint available. The colour will be proposed by the Contractor for the approval by the Engineer. If necessary, walls and ceilings shall be cleaned beforehand to the satisfaction of the Engineer.

All paint shall be applied according to the manufacturer's recommendations.

### **3.29.23.4 Rendering with Plain Finish**

Plain finished cement-mortar rendering shall comply with the relevant Serbian requirements except where otherwise specified below.

Plain finished rendering shall be carried out with a suitable cement-sand-mortar in two or three coats. Three coat layers shall be carried out on metal lathing and on other backgrounds which the Engineer determines by inspection to be too uneven to permit two coat work.

Sand Cement rendering of external walls is not accepted. Rendering and coating of external walls is only permitted if the total system of wall insulation, rendering, coating is done in one system which has proven to be suitable for the application.

Where rendering is to be applied to surfaces of concrete or blockwork such surfaces shall be treated such as to provide a mechanical key for the rendering.

Surfaces shall be cleaned of all residual mould oil dust loose particles and other deleterious material before rendering work is begun.

Particular care shall be taken to cure newly applied rendering as specified herein for concrete.

### **3.29.23.5 Metal Lathing, Expanded Metal and Wire Mesh**

Metal lathing for plastering, expanded metal and wire mesh shall be in galvanized steel. Samples of lathing etc., shall be submitted to and be approved by the Engineer before use in the work.

### **3.29.24 Signs**

Room designation sign, name plates and fire exit direction signs shall be made from engraved plastic laminate, screw fixed in required positions.

All signs shall be in Serbian and English to the approval of the Engineer.

### **3.29.25 Plumbing**

Plumbing materials and workmanship for domestic water supply, sanitation and heating installations shall comply with the relevant Serbian standards and to EN 806-2.

### **3.29.26 Cement Mortar**

Cement mortar shall consist of cement and sand gauged by volume in wrought wooden boxes in the proportion of 1 part of Portland Cement to 3 parts of sand.

Mortar shall be mixed until the colour and consistency are uniform and shall be mixed only as and when required.

Plasticizers shall be used strictly in accordance with the recommendation of the manufacturer..

### **3.29.27 Chemical Resistant Mortar**

#### **3.29.27.1 General**

Chemical resistant mortar shall be used in corrosive environment for internal pointing of blockwork in underground structures and for internal rendering of concrete surfaces including concrete blockwork where specified or where the installation of plastic lining is impractical.

The purpose of the mortar is to resist bio-degradation in septic sewage environments which include sulphuric acid up to 10% concentration (w/w) and up to 35°C. Chemical resistant mortar shall be of a type and make approved by the Engineer.

This section covers the requirements for chemical-resistant resin mortars for bedding, jointing or pointing bricks, concrete blocks or tiles, to be used as a corrosion-resistant lining in sewers, manholes, chambers and related structures. The mortar may have to be applied and cured in damp or wet conditions. Mortar required for pointing may have to be applied by gun, through a small diameter nozzle reaching to the bottom of the pointing groove.

Internal concrete surfaces not protected with plastic lining shall be protected with chemical resistant mortar at least 10 millimetres deep. The concrete surface shall be prepared to provide a key for the mortar strictly in accordance with the mortar manufacturer's instruction. The connection between the plastic linings shall be detailed and constructed in accordance with instructions and recommendation of both material manufacturers.

#### **3.29.27.2 Information to be submitted by the Contractor**

The Contractor shall supply the Engineer with certificates and/or manufacturer's product information and test results for the approval by the Engineer.

The Contractor shall apply the mortar in strict compliance and with the tools as prescribed by the manufacturer.

#### **3.29.27.3 Material and Properties**

The mortar shall be an intimate mixture of liquid resinous material and a setting agent and may contain appropriately selected filler materials. When mixed these components shall form a mortar, with a workability suitable for the proposed method of application, that subsequently hardens.

The liquid resin shall be any solvent-free resinous material capable of forming a chemical resistant mortar when mixed with a suitable catalyst and if required, a filler material. The filler material if used, shall be compatible with the liquid resin, of the chemical resistance required and of a size that will permit the preparation of a minimum joint thickness of 3.0 mm. The mixed mortar shall not adversely affect or be affected by other construction materials with which it will properly come into contact, including fixtures and fittings.

The colours of individual components of the chemical-resistant resin mortar shall be sufficiently different from each other so that complete, homogenous mixing of the components will be apparent by visual inspection. The colour of the completely mixed chemical-resistant resin mortar shall be appreciably different from that of the bricks and tiles to be pointed.

#### **3.29.27.4 Packaging**

The components of the chemical-resistant resin mortar shall be pre-measured and packaged by the manufacturer in units sized to suit the method of application. All packages shall be

clearly marked as to size, contents, mixing instructions, safety precautions, storage requirements and date of expiration of the contents.

The unmixed components of the chemical-resistant resin mortar shall have a minimum shelf life after delivery to the site of 12 months when stored at a temperature between 5°C and 45°C.

Where it is proposed to apply the mortar by trowel the working time after initial mixing of the resin, filler material and hardener shall be a minimum of 60 minutes at a temperature of 20°C and 30 minutes at 45°C. The pot life of the mortar shall be considered exceeded when the mortar can no longer be applied to a prepared surface without curling behind the trowel. If it is proposed, subject to the approval of the Engineer, to apply the mortar by some other method (e.g. by gun) the working time after mixing shall be of a length suitable for the proposed method of application. Mortar applied at any time during the pot life shall have the specified properties when cured.

### **3.29.27.5 Storage and Application**

The manufacturer's recommendations for storage of the components of chemical-resistant resin mortar shall be followed. In all cases, storage shall be in a dry, cool place with containers tightly sealed and away from open flame. Components that have exceeded their shelf life or have become wet shall not be used.

The manufacturer's recommendations for the safe use of the chemical-resistant resin mortar shall be followed. Workers shall wear gloves when handling the product. In the mixing and working areas there shall be no open flame and adequate ventilation shall be provided.

The components of the chemical-resistant resin mortar are to be supplied in pre-measured quantities. Under no circumstances shall these quantities be divided to mix smaller batches.

Mixing of the chemical-resistant resin mortar shall be in strict accordance with the manufacturer's recommendations. The temperatures of the component shall be such that the temperature of the mixed mortar is between 15°C and 40°C. Mixing shall be thorough and complete such that the mortar is a homogeneous colour and free from lumps and air bubbles. In no case shall mixed mortar that has become unworkable be re-tempered with resin liquid or by any other means. Once mortar has become unworkable, it shall be discarded.

The manufacturer's recommendations for surface preparation and for application and spreading of the mortar shall be followed. The joints shall be completely raked out to a depth of 25 mm. The surfaces to which the mortar is applied shall be free from dirt, debris, grease, oil and other materials that would prevent the formation of a sound bond. Where surfaces are damp or wet such special measures as are recommended by the manufacturer for these conditions shall be adopted. The joints shall be carefully inspected by the Contractor prior to mortar application. The mortar shall only be applied during the pot life as determined in accordance with ASTM C308 for the actual temperature of the mortar. A smooth, even surface shall be achieved, flush with the surface of the blocks or tiles.

The manufacturer's recommendations for curing the chemical-resistant resin mortar shall be followed. The temperature during the curing period shall be kept within the range of 5°C to 40°C. Special consideration shall be given to curing in damp or wet conditions.

### **3.29.27.6 Testing**

Requirements for testing shall follow the Serbian Code.

### **3.30. Plastering and Paint Work**

#### **3.30.1 Plaster and Plastering**

Premixed lightweight plaster shall comply with the relevant provisions of BS 1191. Final coats shall be Type b.1 and undercoats as set below:

<b>Application</b>	<b>Type</b>
Brickwork and blockwork	a.1 or a.3
Concrete	a.3
Metal lathing	a.2

Before plastering, concrete ceilings, ceiling beams, columns and stanchions shall be dubbed out as necessary before plastering is commenced unless a bonding agent is used and the mix used for dubbing shall be similar to that used for first undercoating. The surface of in-situ concrete shall be clean of dust, loose particles and other matter. Surfaces shall be wetted immediately before plastering is commenced.

Plastering shall normally be applied in two coats in accordance with the manufacturer's instructions and batches shall be used as soon as possible after water has been added. The total thickness of both coats shall be of the order of, but shall not exceed, 13 mm.

#### **3.30.2 Paints and Painting Materials for Buildings**

Ready mixed paints for buildings shall be external quality. Paint colours for building purposes shall comply with the relevant standards.

Paint remover shall be non-flammable and solvent based.

Painting of structural steelwork shall comply with the relevant RS standards.

#### **3.30.3 External Rendering**

External rendering shall comply with BS 5262 and shall be applied to a total thickness of not less than 20 mm. The mix for both coats shall be as for Class M4 mortar and the first coat shall be applied, levelled, scratched and left to dry for not less than 3 days in warm weather and not less than 7 days in cold or wet weather. The suction of the surface of the first coat shall be adjusted as necessary by wetting before applying the second coat which shall be coloured as directed, levelled and lightly trowelled with a wooden trowel.

#### **3.30.4 Concrete floor finishes**

Concrete floor finishes shall comply with the relevant provisions of BS 8204: Part 2.

### **3.31. Piling**

Pile foundation may be necessary for supporting structures where the subsoil is considered to have insufficient bearing capacity. The Contractor shall carry out Main Design of these structures in accordance with the Contract Conditions and Specification and shall determine the type of foundation required the number of piles and their working loads and the optimum arrangement of piles required for supporting the structures.

