



Technical Specifications

Annex III-B-Volume 2

REHABILITATION OF RURAL ROADS IN RUKHA KIRI DISTRICT, BATTAMBANG PROVINCE

Cambodia, September 2022

A- REHABILITATION OF RURAL ROADS

I- SITE CLEARANCE

1-1 Bush cutting and grass clearing

1. DESCRIPTION

This item covers cutting of bush, clearing grass, rock and dead vegetation removal, grubbing, removal and safe disposal at approved dump sites.

2. MATERIALS

No additional materials are required.

3. METHOD

The area of bush, grass and vegetation which should be cleared and grubbed will be marked by the supervisor. Bush, grass and vegetation should be cleared and grubbed to a depth of 15 cm. The cleared grass, bush and vegetation should be disposed to approved dump sites. Note that no burning is allowed unless authorized by the Project Engineer.

4. EQUIPMENT

This activity requires hand tools, such as bush knives, hoes, slashers, wheelbarrow and rakes.

5. SAFETY ON SITE

- Workers must be well spaced to limit the risk of injury when using cutting tools.
- Refer to the general items in Volume 1 for safety gear.
- Where burning of debris is necessary (authorized by the Project Engineer), care must be taken to prevent fire spreading outside the cleared width. Water and/or sand must be readily available at the site when burning is to be carried out.

6. INSPECTION

The following shall be checked:

- Adequate clearing, cutting, grubbing and removal of the grass, bush and vegetation
- Safe disposal

7. MEASUREMENT AND PAYMENT (MBC)

This item will be paid by the area of cut, cleared and grubbed of vegetation, bush and grass measured in m²

Payment: The unit rate shall be the full compensation for labour, tools, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

II- EARTHWORKS

2.1 Excavate to level

1. DESCRIPTION

This item covers the cutting (or excavation) of common soil from the roadway. The common excavation is defined as the soil to be cut by labour with a shovel or hoe.

The suitable soil, approved by the Project Engineer, may be kept next to the proposed structures to be reused for filling road layer, while bad soil and excessive soil to be exposed to a nearest safe site as directed by the Project Engineer.

2. MATERIALS

No additional materials are required.

3. METHOD

The soil should be excavated by labour as instructed by the Project Engineer.

- If the soil is of good quality (well graded, hard particles, clean of organic material, low plasticity) and a road camber, fill or embankment is to be constructed, the Project Engineer may instruct that the soil should be spread along the road for subsequent use.
- If the soil is to be used for filling road layer, the shaping, watering and compaction work will be done using a separate item.
- If the soil is of poor quality or a camber or leveling layer or embankment is not required, the Project Engineer may instruct that the soil should be disposed to approved dump sites.
- Where a roadside drain is excavated, toe slope and back slope of the side drain shall be included in this activity.

4. EQUIPMENT

The activity requires hand tools, wheelbarrows or a truck for longer haul distances.

5. SAFETY ON SITE

- Slopes shall be excavated as per instruction. Attention should be paid when excavating high slopes to avoid soil, rocks or trees falling uncontrollably.
- Workers must be well spaced to limit the risk of injury when using hand tools.
- Refer to the general items in Volume 1 for safety gear.

6. INSPECTION

The following will be checked

- Cutting and excavating of the soil at the instructed location, to the slope and volume as described in the drawings.
- Spreading or disposal as instructed

7. MEASUREMENT AND PAYMENT (MBC)

This item is paid by the volume of soil cut and removed to either the road surface or to a dump site, measured in m³

Payment: The unit rate shall be the full compensation for labour, tools, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

2.2 Side drain excavation

1. DESCRIPTION

This item is the excavation of side drains by manual labour. The side drain excavation is defined as the soil that is cut by labour with a shovel or hoe. Suitable soils approved by the Project Engineer may be kept next to the proposed structures to be reused for filling road layers, while bad soil and excessive soil to be exposed outside of the side drain of a minimum of 1 m from the toe edge of the side drain or as directed by the Project Engineer.

2. MATERIALS

No additional materials are required.

3. METHOD

The side drain shall be excavated by labour as instructed by the Project Engineer and follow the steps below. Size of the side drain is shown in the Drawings.

- Excavate a rectangular shape with width as the width of the drain bed.
- Slope the inner slope of the drain, then slope the outer side of the drain
- If the soil is of good quality (well graded, hard particles, clean of organic material, low plasticity) and a road camber, fill or embankment is to be constructed, the Project Engineer may instruct that the soil should be spread along the road for subsequent use.
- If the soil is to be used for filling road layers, the shaping, watering and compaction work will be done using a separate item.
- If the soil is of poor quality or a camber or leveling layer or embankment is not required, the Project Engineer may instruct that the soil should be disposed to approved dump sites or a minimum 1 m away from the outer edge of the drain.

4. EQUIPMENT

The activity requires hand tools, wheelbarrows and a truck for longer haul distances.

5. SAFETY ON SITE

- Slopes must be excavated as indicated in drawings or as instructed.
- Workers must be well-spaced to limit the risk of injury when using hand tools.
- Refer to the general items in Volume 1 for safety gear.

6. INSPECTION

The following will be checked

- Excavating the soil at the instructed location, to the instructed slope and volume
- Spreading or disposal as instructed

7. MEASUREMENT AND PAYMENT (MBC)

This item is paid by the volume of the excavated side drain, measured in m³

Payment: The unit rate shall be the full compensation for labour, tools, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

2.3 Fill embankment with transported soil

1. DESCRIPTION

This item is the supply, spreading to level, watering and compaction of selected good quality soil from approved quarries. The selected soil can be used for road fills, road camber, erosion channels or potholes, backfill behind retaining walls or to raise the road levels.

2. MATERIALS

To be of good quality, the soil should have the following characteristics:

- Well graded from fine to coarse with a maximum particle size of 60 mm
- The particles should be strong and not crumble under compaction equipment
- The soil should not contain organic soil, sticks, leaves, etc.
- If the soil is to be covered with another layer, it should have low plasticity
- If the soil is to be used as a riding surface, it should have some plasticity

The Project Engineer must approve all soil before it is used. All soil should be obtained with minimum environmental damage.

3. METHOD

The following steps should be followed (spreading soil to form road camber shall be done by labour):

- The prepared subgrade should be well compacted and cleaned of topsoil and other unsuitable soils such as soft clay before the selected soil is delivered.
- Source or side borrow pits of good quality soil should be approved by the Project Engineer prior to transporting the soil on site.
- Fill and spread the soil in layers no thicker than 15 cm to the required shape.
- Water the soil and allow it to soak until the entire layer is at optimum moisture content. This is achieved when the soil can be squeezed into a ball but water does not drip out.
- Compact the soil using compaction equipment until the point at which it does not compact any more under successive passes of the equipment (this is called 'refusal').
- After one layer has been fully compacted, spread, water and compact another layer as before reaching out to the road shoulder.
- Sloping activity shall be included on fills and embankments.

4. EQUIPMENT

This activity requires hand tools, trucks and compaction equipment (roller and water truck / water bowser) to compact the soil.

5. SAFETY ON SITE

- Workers must be well spaced to limit the risk of injury when using hand tools and equipment.
- All operators must be trained in the use of their equipment (water truck, roller, tampers). Equipment shall be in good condition and safety covers for moving parts should be used.
- Refer to the general items in Volume 1 for safety gear.

6. INSPECTION

When available, simple tests should be used to test the soil for grading, particle strength, particle shape, absence of organic material and plasticity. If not available, the Project Engineer will assess the soil manually and visually for:

- Layer thicknesses
- Moisture content
- Compaction to refusal
- Final shape of the fill, level of the filled and compacted soil.

7. MEASUREMENT AND PAYMENT (MBC)

This item will be paid by the total volume filled, measured in m³ after compaction.

Payment: The unit rate shall be the full compensation for labour, tools, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

2.4 Fill embankment from nearest side borrow pits

1. DESCRIPTION

This item is the excavate good soil from a nearest side borrow pits, haul, spread to level and compaction. The selected side borrow pits shall be approved by the Project Engineer before commencing the excavation. The selected side borrow pits should not be longer than 100 m from the filling section.

The selected soil can be used for road fills, embankments, road camber, erosion channels or potholes and backfill behind retaining walls.

2. MATERIALS

To be of good quality, the soil should have the following characteristics:

- Well graded from fine to coarse with a maximum particle size of 60 mm
- The particles should be strong and not crumble under compaction equipment
- The soil should not contain organic soil, sticks, leaves, etc.
- If the soil is to be covered with another layer, it should have low plasticity
- If the soil is to be used as a riding surface, it should have some plasticity

The Project Engineer shall approve all soil before it is used. All soils should be obtained with minimum environmental damage.

3. METHOD

The following steps should be followed:

- The prepared subgrade should be well compacted and cleaned of topsoil and other unsuitable soils such as soft clay before the excavated soil is placed.
- Excavate the borrow pit by manual labour, haul the excavated soil and place on the road. Depth of the borrow pits should not be greater than 0.5 m.
- Borrow pits of good quality soil should be approved by the Project Engineer prior to commencing the excavation
- Spread the soil in layers no thicker than 15 cm to the required shape.
- Water the soil and allow it to soak until the entire layer is at optimum moisture content. This is achieved when the soil can be squeezed into a ball but water does not drip out
- Compact the soil using compaction equipment until the point at which it does not compact any more under successive passes of the equipment (this is called 'refusal').
- After one layer has been fully compacted, spread, water and compact another layer as before reaching out to the road shoulder.

4. EQUIPMENT

This activity requires hand tools, and compaction equipment (roller and water truck / water bowser) to compact the soil.

5. SAFETY ON SITE

- Workers must be well spaced to limit the risk of injury when using hand tools.
- All operators must be trained in the use of their equipment (water truck, roller, tampers). Equipment must be in good condition and safety covers for moving parts should be used.
- Refer to the general items in Volume 1 for safety gear.

6. INSPECTION

When available, simple tests should be used to test the soil for grading, particle strength, particle shape, absence of organic material and plasticity. If not available, the Project Engineer shall assess the soil manually and visually for:

- Layer thicknesses
- Moisture content
- Compaction to refusal
- Final shape of the fill, level of the filled and compacted soil

7. MEASUREMENT AND PAYMENT (MBC)

This item will be paid by the total volume filled, measured in m³ after compaction.

Payment: The unit rate shall be the full compensation for labour, tools, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

III ROAD PAVEMENT AND SURFACING

3.1 Gravel (laterite) wearing course

1. DESCRIPTION

This item consists of the supply of gravel (laterite) on a well-compacted subgrade layer, spreading by manual watering and compaction. Materials selected for use should be with proper proportion of gradation and fine material that meet the requirements in the specifications and shall be free of lumps of organic, or other deleterious materials.

2. MATERIALS

The gravel (laterite) should have the following characteristics:

- Well graded from fine to coarse with a maximum particle size of 50 mm
- The particles should be strong and not crush under compaction equipment
- The particles should be angular and not rounded
- The gravel should not contain organic soil, sticks, leaves, etc.
- The gravel should have some plasticity
- The gravel should be obtained from an approved quarry or a river bed

If the proportions of stone, sand and clay can be determined (in the field by a settling test in a water filled jar) the proportions by volume should be approximately:

- Stone (>2 mm): 35-65%
- Sand (0.06-2 mm): 20-40%
- Clay and silt (<0.06 mm): 10-25%

If more sophisticated testing is available, the gravel should have the following characteristics:

| Grading | |
|------------------------------------|------------------------------|
| Sieve, mm | Percentage passing by weight |
| 50 | 100 |
| 37.5 | 80-100 |
| 25 | 75-100 |
| 9.5 | 50-75 |
| 4.75 | 35-65 |
| 2 | 25-50 |
| 0.425 | 15-30 |
| 0.075 | 5-20 |
| Liquid Limit (LL) | < 40 |
| Plasticity Index (PI) | 5-20 |
| Linear Shrinkage | 3-10 |
| Grading Coefficient | 16-34 |
| Shrinkage Product | 120-400 |
| CBR% at 95% mdd / Bearing strength | > 20% |

| | |
|-----------------|--|
| CBR% at 95% mdd | |
|-----------------|--|

Note:

Grading Coefficient = $[(\% \text{passing } 28\text{mm}) - (\% \text{passing } 0.425\text{mm}) \times (\% \text{passing } 5\text{mm})]/100$

Shrinkage Product = Linear Shrinkage \times (%passing 0.425mm)

The Project Engineer shall approve all gravel before it is used. All gravel should be sourced with minimum environmental damage.

3. METHOD

The following steps should be followed:

- Before any gravel material is placed, the underlying course shall be prepared and compacted. The surface shall be checked and accepted by the Project Engineer before placing and spreading operations are started. If the cambered surface is old, has lost its shape or dirty, it should be restored and cleaned of topsoil and other unsuitable soils such as soft clay and saturated soil.
- The gravel layer shall be constructed in layers. Spread the delivered gravel material by labour in layers as specified in the drawings, no thicker than 15 cm and to a camber (surface slope/cross fall) of 5-7 %. The material, as spread, shall be of uniform gradation with no pockets of fine or coarse materials. No material shall be placed on a soft or muddy surface. During the placing and spreading, sufficient caution shall be taken to avoid segregation.
- After spreading, the material shall be thoroughly compacted by rolling and sprinkling, when necessary. Sufficient rollers shall be provided to adequately handle the rate of placing and spreading of the course.
- Rolling shall progress gradually from the sides to the centre of the lane under construction, or from one side towards previously placed material, by overlapping uniformly each preceding track by at least 300mm.
- The rolling shall continue until the material is thoroughly set and stable, and the course has been compacted to not less than 100% of maximum dry density at optimum moisture.
- Tests for field density shall be made in at least one location for every 500 square metres of each compacted layer.

4. EQUIPMENT

This activity requires hand tools and haulage equipment (trucks) to carry the base material and compaction equipment (rollers with vibration and water truck/water bowser or mechanical stamper).

5. SAFETY ON SITE

- Workers must be well spaced to limit the risk of injury when using hand tools.
- All operators must be trained in the use of their equipment (water truck, roller, tampers). Equipment must be in good condition and safety covers for moving parts should be used.
- Safety gear includes closed shoes and gloves.

6. INSPECTION

Simple laboratory tests shall be carried out to test the gravel for grading, particle strength, particle shape and plasticity before using the quarry. The strength of the compacted layer should be checked by DCP.

The following will be checked:

- Width of the gravel layer
- Thickness of the gravel layer
- Camber
- Super elevation, if instructed

- Sharp and straight crown
- Smooth longitudinal profile
- The entire layer is at optimum water content when compacted
- The surface has been compacted to refusal

7. MEASUREMENT AND PAYMENT (MBC)

This activity will be paid by the volume of the compacted gravel layer, measured in m³ after compaction and acceptable laboratory testing results.

Payment: The unit rate shall include the full compensation for labour, tools, equipment, materials and any other incidentals that may be required in carrying out the work for this item.

II DRAINAGE STRUCTURES

4.1 Excavation for Foundation and Slope for Structural Work

1. DESCRIPTION

This item covers the excavation, removal, loading, and disposal of any type of soil for foundations of retaining walls/cut walls, hill slopes next to the walls, and other drainage structures. Excavated soils of good quality, approved by the Project Engineer, may be kept next to the planned structures to be reused for backfilling, while poor soil is to be transported and deposited at a safe location as directed by the Project Engineer. Any surplus soils should be used for other nearby construction work if it is needed.

2. MATERIALS

No additional materials are required.

3. METHOD

- Mark the proposed areas to be excavated.
- The foundation or hill slope should be excavated and loaded on a truck by labour where appropriate and as instructed by the Project Engineer and deposited at a safe location.

4. EQUIPMENT

The activity requires hand tools wheelbarrows or a truck for longer haul distances.

5. SAFETY ON SITE

- Workers shall be organized in a manner that provides a safe distance between individual workers to limit the risk of injury when using hand tools.
- Each worker shall be equipped with appropriate safety gear and PPE. Excavations shall be carried out and secured to avoid any landslides that may cause injury. Equally, trenches may need to be marked and fenced to avoid fall accidents.
- Refer to the general items in Volume I for appropriate COVID-19 measures.

6. INSPECTION

The following will be checked:

- Dimension and depth of the foundation.
- Slope of the foundation as stated in the drawings

7. MEASUREMENT AND PAYMENT (MBC)

This item is paid by the volume of soil excavated and removed to an appropriate location. The measurement shall be taken in situ (excavated trench of foundation), in m³

Payment: The unit rate shall cover the full compensation for labour, tools, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

4.2 Backfilling for Structures

1. DESCRIPTION

Backfilling is required for structures, foundation walls, abutment walls, retaining walls, culverts, gabion works and shall be done in accordance with the Drawings. This item includes the supply of selected material, backfilling, or using material from the excavation found in good quality (approved by the Project Engineer), levelling, shaping and compacting the approaches of constructed structures to the dimensions as described in the Drawings and directed by the Project Engineer.

2. MATERIAL

To be of good quality, the soil should have the following characteristics:

- Good soil from the foundation excavation can be used for backfilling. The contractor shall obtain prior approval of the soil to be used from the Project Engineer.
- The soil should not contain organic soil, sticks, leaves, etc.
- If the soil is to be covered with another layer, it should have low plasticity. The riding surface on top of backfills should be of the same quality materials as the road surface.

The Project Engineer shall approve all soil before it is used. All soil should be obtained with minimum environmental damage.

3. METHOD

The following steps should be followed:

- Identify the source of appropriate quality soils.
- Obtain approval from the Project Engineer to use the soil. Excavate, load and transport the soil to the construction site.
- All excavated foundations shall be backfilled around the permanent structure up to original ground levels.
- Any protective supports, bracing, or shoring shall be removed as the backfilling progress.
- After one layer has been fully compacted, spread, water, and compact the next layer as before to reach the level as instructed by Project Engineer.
- The back of abutments and wing walls with weep holes may be provided with a vertical layer of granular fill materials in the specified thickness to serve as a filter.
- Backfilling shall be carried out in layers not thicker than 100mm and compacted at optimal moisture content.
- Any fill for raising the embankment height of the approach roads shall be laid and compacted in layers of not thicker than 150mm. Compact the soil using mechanical compaction equipment until the point at which it does not compact any more under successive passes of the equipment.

4. EQUIPMENT

The activity requires hand tools, truck and compaction equipment (roller, mechanical tamper, and water truck), depending on the specific content of the Works.

5. SAFETY ON SITE

Refer to the general items in Volume I on safety gear, PPE, and COVID-19 measures.

6. INSPECTION

Simple field tests should be used to test the soil for grading, particle strength, particle shape, absence of organic material, and plasticity. The Project Engineer may also assess the soil manually and visually.

- Layer thicknesses.
- Filter material is used for vertical fill layer for abutment walls and wing walls
- Compaction to refusal
- Final shape and level of the fill and compacted soil

7. MEASUREMENT AND PAYMENT

This item is paid by the measured volume of the backfill, in m³.

Payment: The unit rate shall cover the full compensation for labour, tools, equipment, materials and any other incidentals that may be required in carrying out this item.

4.3 Lean Concrete: (concrete proportion 1:3:6)

1. DESCRIPTION

This item covers the supply and construction of concrete structures using lean concrete or mass concrete. This concrete is normally used in situations where high strength is not required, such as a base of retaining walls, abutment walls, and foundations for certain cross drainage structures. Reinforcement steel is not required in this item.

2. MATERIALS

Material required for lean concrete:

- The lean concrete should be made from fresh cement, clean angular sand and aggregate (stones less than 25 mm)
- Ideally the aggregate should be angular
- Fresh clean water should be added to give a workable mix.
- The strength of the concrete after 28 days, shall comply to the table in this specification.
- The Project Engineer shall approve all cement, sand and aggregate before it is used. All sand and aggregate should be obtained with minimum environmental damage.

3. METHOD

- The surface on which the lean concrete will be poured should be prepared and strong and clean.
- Formwork should be fixed in place to the required dimensions.
- The concrete should be mixed using a concrete mixer of a capacity of 1 to 3 bags of cement per batch. The concrete should be used within 30 minutes of water being added.
- The concrete should be placed between the side formwork and then compacted until no more air bubbles are seen.

- The concrete should be protected from use for 2 days after which the side formwork can be removed, and should be cured for a minimum of 5 days by keeping its surface wet.

4. EQUIPMENT

This activity requires hand tools and mechanical or manual concrete mixer and concrete vibrating equipment.

5. SAFETY ON SITE

- Workers shall wear boots, strong gloves and protective glasses when mixing and pouring concrete. When moving or transporting heavy material such as cement bags, sand and aggregate for mixing the concrete, either use a wheelbarrow or assign two workers to lift together.
- All operators should be trained in the use of the equipment. Equipment must be held in good condition and with safety covers for moving parts in use and in good order.
- Refer to the general items in Volume I for other safety measures and safety gear.

6. INSPECTION

The following shall be inspected:

- Quality of the surface on which the concrete will be placed
- Quality of the side formwork
- Quality of cement, sand and aggregate
- Quality of concrete after mixing and after curing
- Protection of the concrete while it is curing
- When possible, concrete cubes will be made and tested for strength after 28 days
- Required strength and slump

7. MEASUREMENT AND PAYMENT (MBC)

This item is paid by the volume of lean concrete constructed, measured in m³. The unit rate includes the cost of the formwork and the curing.

Payment: The unit rate shall include the full compensation for labour, tools, equipment, materials, equipment and any other incidentals that may be required for this work item.

4.4 Reinforced Concrete

1. DESCRIPTION

This item covers the supply and construction of structural concrete. Structural concrete is used in situations where high strength is required, such as high retaining walls, deck slabs of water crossing structures, headwalls, wing walls and aprons of culverts, U channels, and other reinforced concrete structures. Steel reinforcement is normally fixed in structural concrete.

2. MATERIALS

The structural concrete should:

- Be made from fresh cement, clean angular sand, and clean hard aggregate (stones 20 mm down) mixed by volume in the ratio 1:2:4
- The aggregate should be angular
- Have clean fresh water available to give a workable mix
- The strength of the concrete after 28 days, if it can be measured, should be 25 N/mm²

Structural concrete normally includes reinforcement steel. All details relating to reinforcement steel are given in this specification.

All cement, sand, and aggregate need to be approved by the Project Engineer before it is used. All sand and aggregate must be obtained with minimum environmental damage.

Gradations of aggregate for the concrete work

| Sieve Size | | Weight percent of which passes aggregate | | | | | |
|------------|---------------|--|-------------------|-----------------|-----------------|-------------------|-----------------|
| Inch (in) | Standard (mm) | Fine | Coarse | | | | |
| | | | Size max. 37.5 mm | Size max. 25 mm | Size max. 19 mm | Size max. 12.5 mm | Size max. 10 mm |
| 2 | 50.8 | - | 100 | - | - | - | - |
| 1.5 | 38.1 | - | 95-100 | 100 | - | - | - |
| 1 | 25.4 | - | - | 95-100 | 100 | - | - |
| 0.75 | 19 | - | 35-70 | - | 90-100 | 100 | - |
| 0.5 | 12.7 | - | - | 25-60 | - | 90-100 | 100 |
| 3/8 | 9.5 | 100 | 10-30 | - | 20-55 | 40-70 | 95-100 |
| #4 | 4.75 | 95-100 | 0-5 | 0-10 | 0-10 | 0-15 | 30-65 |
| #8 | 2.36 | 80-100 | - | 0-5 | 0-5 | 0-5 | 20-50 |
| #16 | 1.18 | 50-85 | - | - | - | - | 15-40 |
| #50 | 0.300 | 10-30 | - | - | - | - | 5-15 |
| #100 | 0.150 | 2-10 | - | - | - | - | 0-8 |

3. METHOD

- The surface on which the structural concrete will be placed should be prepared and strong and clean.
- Formwork and all necessary falsework/scaffolding should be fixed in place as shown in the Drawings
- Reinforcement should be fixed as shown in the Drawings
- The concrete should be mixed by labour using a concrete mixer of a capacity of 0.2 to 0.4 m³
- The concrete should be used within 30 minutes of the water being added
- The concrete should be placed within the formwork and then compacted until no more air bubbles are seen
- Place the concrete in layers no thicker than 30 cm, remove the air from this layer before placing more concrete
- The concrete should be protected from use for 5 days after which the side formwork can be removed, and should be cured for a minimum of 5 days by keeping it wet by covering it with dampened sand, cloths or sacks
- The underside formwork can be removed after 21 days

4. EQUIPMENT

This activity requires hand tools and concrete mixing equipment.

5. SAFETY ON SITE

- Workers shall wear boots, gloves and goggles when mixing and pouring concrete. When moving or transporting heavy materials such as cement bags, sand and aggregate, either use a wheelbarrow or make sure that two persons lift together.

- All operators should be trained in the use of their equipment. Equipment must be in good condition and safety covers for moving parts should be in good order and used in a proper manner.
- Refer to the general items in Volume I for safety gear, PPE, and COVID-19 measures.

6. INSPECTION

The following will be checked:

- Quality of the surface on which the structural concrete will be placed
- Quality of formwork and falsework, the absence of leaks, and its rigidity against movement
- Quality of cement, sand, aggregate and steel
- Quality of the structural concrete after mixing and after curing
- Protection of the concrete while it is curing
- When possible concrete cubes will be made and tested for strength

Compressive strength and Slump test requirement for concrete mix (minor works)

| Compressive strength and slump test requirement for concrete mix (minor works) | | | | |
|--|------------------------------|---------|----------------------|---|
| Mixed Minimum | Minimum Compressive Strength | | Permitted Slump (mm) | Purpose |
| | Cube 15 cm | | | |
| | 7 days | 28 days | | |
| 1 : 1.5 : 3 | 175 | 260 | 50-125 | Culvert or bridge slab. Reinforced Structure |
| 1 : 2 : 4 | 150 | 210 | 50-125 | Culvert slab. Lightly Reinforced Structure |
| 1 : 3 : 6 | 125 | 150 | 25-100 | Non-reinforced Structure |

7. MEASUREMENT AND PAYMENT (AWD)

This item is paid by the volume of structure concrete constructed, measured in m³. The unit rate includes curing, cost of the formwork, and supports. The cost of reinforcement steel, lean concrete, backfilling and excavation for the foundation are paid in separate items.

Payment: The unit rate shall cover the full compensation for labour, tools, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

4.5 Reinforcement Steel

1. DESCRIPTION

This item covers the supply, cutting, bending and fixing of reinforcement steel within a space into which concrete is poured, typically to form part of a structure.


2. MATERIALS

All reinforcement steel bars as shown in the Drawings shall be of either high tensile or mild steel. All reinforcement steel should be sourced from a known and good quality vendor. Reinforcement steel normally rusts slightly when in storage so it should be cleaned before use with a wire brush. It should be stored in as dry a place as possible.

Good quality fixing wire is required.

It is also necessary to make spacer blocks in advance, normally from mortar with a length of fixing wire embedded in the block. These blocks will be fixed to the outer surface of the steel mesh so that it maintains the desired spacing from the formwork when concrete is poured.

3. METHOD

- The reinforcement steel should be cut and bent to match the dimensions as shown in the Drawings
- Each bend should be made around a post of 5 times the diameter of the steel so that the reinforcement steel is not excessively deformed
- Steel should not be heated as it is being bent
- Bars should be fixed together to match the mesh as shown in the Drawings
- Spacer blocks should be fixed to the reinforcement steel to prevent it moving close to the formwork when concrete is poured
- All fixing wire should be bent inwards away from the formwork
- At no point shall the reinforcement steel or the fixing wire be closer to the formwork than the cover as described in the Drawings, usually the cover must be at least 30mm.
- The entire mesh should be fixed tightly so that it does not bend or move closer to the formwork when concrete is poured or when workers walk on the mesh
- To keep the required spacing of the top reinforcement mat and the bottom mat when workers walk on the mat when concrete is being poured on the mesh, an additional piece of reinforcement bends in a Z shape or  shape and connects/fixes it to the top mat and the bottom mat

When a single length of reinforcement steel is not long enough to form an entire bar as shown in the Drawings, two lengths can be used with an overlap equal to 40 times to the diameter of the steel for rounded bars and 28 times to the diameter of the steel for deformed bars (at least 30 cm). The overlap must be fixed with at least three separate loops of fixing wire.

The reinforcement steel shall be inspected and approved by the Project Engineer before pouring concrete.

4. EQUIPMENT

This activity requires hand tools to clean, cut and bend reinforcement steel and fix it securely in place.

5. SAFETY ON SITE

- Reinforcement bars sticking out where concrete has not yet been poured must be clearly marked to avoid cutting or spearing accidents. The whole of such areas should be clearly marked and sealed off to make sure no one accidentally steps or falls into uncompleted structural works
- Reinforcement bars are sometimes used as offset pegs. In such cases they must be clearly marked and the end pointing upwards must be bent to avoid cutting or spearing accidents;
- Refer to the general items in Volume I for safety gear, PPE and COVID-19 measures.

6. INSPECTION

The following shall be checked:

- The quality of the reinforcement steel
- The correctness of the fixing to match the Drawings
- Cleanliness of the reinforcement steel
- Adequacy of the overlaps
- Placement of spacer blocks

- Adequacy of the cover
- Strength of the fixing so that the reinforcement steel does not move when the concrete is poured

7. MEASUREMENT AND PAYMENT (AWD)

This item is paid by the weight of fixed reinforcement steel, measured in kg. The unit rate includes the cost of overlaps, fixing wire, and spacer blocks.

Payment: The unit rate shall be the full compensation for labor, tools, materials and any other incidentals that may be required in carrying out this work item.

4.6 Supply and installation of reinforced concrete culvert pipes

1. DESCRIPTION

This Item consists of supplying concrete pipe rings, laying and joining the rings on a prepared lean concrete bedding.

2. MATERIAL

- The pipe rings shall be of reinforced concrete with ogee (male and female) joints, of concrete Class 20, at least 28 days cured. The contractor must obtain prior approval from the Project Engineer before delivering the pipe on site. The pipe rings shall be in standard lengths of 1.0 m.
- If the pipe rings are not manufactured on site, the supplier must be approved by the Project Engineer. The ring shall be in standard lengths of 1.0 m.
- The culvert gradient including the outlet shall be at a minimum grade of 2% or as described in the Drawings.
- Culvert joints shall be sealed with 1:3 cement mortar.

3. METHOD

- Supply or manufacture of reinforced concrete culvert pipe rings, cure concrete pipes for not less than 28 days, transport culvert pipes to the work sites,
- Excavate and shape trench to levels described in the Drawings, place pipes and join them, lay to prescribed gradient
- Prepare concrete bedding as specified in the Drawings
- In order to cater for traffic, the excavation of trench and laying of pipe rings shall be carried out in stages to allow vehicles to pass.
- Installation work shall wherever possible start from the outlet side.
- Construction of concrete headwalls, wing walls, and aprons as detailed in the Drawings.
- Backfill with selected soil/gravel and compact in layers of not more than 10 cm by mechanical stamper to refusal.

4. EQUIPMENT

- The activity requires hand tools, mechanical tamper, concrete mixer with a capacity of 1-3 bags of cement per batch.

5. SAFETY ON SITE

- Refer to the general items in Volume I for safety gear, PPE and COVID-19 measures
- Adequate traffic signs shall be installed. Open trenches need to be protected.

6. INSPECTION

The following will be checked:

- Quality of the concrete culvert pipes comply with AASHTO M86
- Ensure the foundation is well prepared and appropriate gradient as per Drawings
- Ensuring the concrete pipes are in good condition before and after transport and laying on the foundation
- Refer to sections “concrete” and “backfill” for quality of concrete works

7. MEASUREMENT AND PAYMENT (AWD)

Measurement Unit = No (number) of pipes installed.

Payment: The unit rate shall be the full compensation for labour, tools, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

4.7 Formwork and Support

1. DESCRIPTION

Formwork shall include all temporary forms required for pouring concrete for slabs of bridges, culverts or other structures together with all temporary construction required for their support. This item include supply, cut and fix timber for the formworks, place timber or wooden support for the formworks and fix necessary wooden / bamboo bracing for the support.

2. MATERIALS

All timber for the formwork shall be approved by the Project Engineer before fixing. Timber plank should be of medium to good quality timber and thickness should not be less than 20 mm. Size of timber for poles should be 50 mm x 50 mm. Size of timber for beams should be 100mm x 50 mm. The support can be timber of size of 50 mm x 50 mm or wooden poles of 70 - 100 mm diameter.

3. METHOD

- Place poles for the support on solid ground. If the ground is not firm enough, place the poles on a rock or piece of timber/wood. The space from one pole to another should be between 40-50 cm. If the height of the poles is more than 2 m, bracing is required to connect from one pole to the other. The bracing should be placed at the middle of the poles.
- Timber beams are placed for each row of the support poles and fixed by nails. The timber beams should be placed and align with the abutment wall of a bridge, culvert or other structure.
- Place timber poles and cross the beams with spacing from one to the other not larger than 50 cm. The crossbeams must be fixed with nails.
- Place timber planks and cross the poles as close as possible to minimize gap at joints between each plank. The planks must be fixed with nails.
- Place side formworks of all edges and fix with nails.
- Removal of formwork. The formwork must be removed after a minimum of 7 days after the concrete is poured. The Project Engineer shall be informed in advance by the Contractor of his/her intention to remove any formwork.

4. EQUIPMENT

This activity requires carpentry tools.

5. SAFETY ON SITE

- Refer to the general items in Volume I on safety gear, PPE and COVID-19 measures.

6. INSPECTION

The following shall be checked:

- The quality of the timber and wooden poles
- The correctness of the fixing to match the Drawings and instructions of the Project Engineer
- Spacing between the support poles and ensuring the support poles are placed on firm ground. Ensure bracings are placed and nailed properly
- The level of the surface of the timber planks after placing and ensuring minimum gaps at the joints of each timber plank

The formworks and support shall be checked by the Project Engineer before placing steel bars.

7. MEASUREMENT AND PAYMENT

This item is measured and paid in m² of the formwork installed including all support, bracing, and other inclusive.

Payment: The unit rate shall be the full compensation for labour, tools, equipment, materials and any other incidentals that may be required in carrying out this work item.

4.8 Cement Stone Masonry

1. DESCRIPTION

This item covers the supply and construction of cement stone masonry retaining walls, abutment walls, and other structures using stone held together with cement mortar (or concrete). All stone masonry structures should be constructed on a stable and prepared foundation. Most structures will be backfilled after completion.

2. MATERIALS

This activity requires stone and cement mortar.

Stone:

- Stone for masonry walls shall consist of field stone furnished in broad flat shapes to the maximum extent practicable. All stone shall be hard, sound, durable and highly resistant to weathering, and shall be suitable as protection material for the intended purpose.
- Samples of the stone material proposed for use in the Works shall be submitted to the Project Engineer for approval prior to its use.
- The minimum apparent specific gravity shall be 2.5 and the maximum water absorption shall be 6% when tested in accordance with AASHTO T 85. The stone shall have an abrasion loss not greater than 45% when tested in accordance with AASHTO T 96.
- Stone for masonry walls shall be angular, neither elongated nor flat: Dimensions shall range from 200-300 mm to approximately 250 mm diameters. Not more than 5% shall be smaller than 100 mm.

Cement mortar:

- Mortar for masonry walls shall consist of 1:3 cement: sand mortar by volume with a compressive strength at 28 days of 5Mpa. Water added shall be the least amount which will yield a mix of suitable consistency to ensure proper mortaring of masonry.

- Mortar for masonry walls shall be composed of 300 kg of cement to one cubic meter of sand and shall be thoroughly mixed prior to the addition of water.
- The Project Engineer must approve all materials before they are used.

3. EQUIPMENT

This activity requires hand tools and mechanical or manual mortar mixing.

4. METHOD

Construction of stone masonry structures should follow normal good construction practice. This practice includes:

- The surfaces upon which foundations and bases are to be placed shall be excavated and compacted to the required grades and lines. The subgrade or base shall be firm or compacted as directed by the Project Engineer,
- The construction of masonry walls shall be carried out in layers perpendicular to the vertical wall surface and no layer shall be started before completion of the previous layer.
- Stones should be wet before mortar is applied. All gaps between stones should be filled with mortar. Smaller stones can be used to fill large gaps.
- Stones in mortared masonry walls shall be laid on a full and even bed of cement mortar with joints between stones filled and not more than 12 mm wide. Bonding stones of a length two thirds the thicknesses of the wall shall be placed, one to every square meter of each side of the retaining wall and staggered. Expansion joints shall be constructed at every 10 meters or at the intervals or places shown on the Drawings.
- The top and faces should be finished without presence of holes or gaps so that water cannot enter the structure or collect on the surface.
- All stone masonry should be cured properly by keeping the surface wet for 7 days – cloths or sacks can be spread over the surface to retain water.
- If backfill is to be placed behind a masonry structure, weep-hole pipes and granular material should be installed as per the Drawings.

The location and detailed design of the masonry structures should be agreed with the Project Engineer before it is constructed.

5. SAFETY ON SITE

- Workers must use boots and strong gloves when mixing mortar. When moving or transporting heavy materials such as cement bags and aggregate for mixing mortar either use a wheelbarrow or make sure that two persons lift together.
- All operators must be trained in the use of their equipment (concrete mixers, trucks). Equipment must be in good condition and safety covers for moving parts should be used.
- Refer to the general items in Volume I on safety gear, PPE and COVID-19 measures.

6. INSPECTION

Samples of the stone material proposed for the Works shall be submitted to the Project Engineer for approval prior to its use. Simple tests can be used to test the stone for particle strength and shape.

Testing mortar:

Mortar that can be worked easily but still provide adequate strength can be identified by two tests:

Spade Test. The mortar should not flow off a spade. If it does easily, it is too wet. If it is too dry, cracks will appear in the surface and lumps will fall off.

Hand Molding Test. The mortar should be able to be molded by hand and retain its shape. To check that it is not too dry, pick a handful of ready-made mortar and form a ball in the hand, drop the ball onto a hard surface from a height of about 20-30cm. If the ball totally disintegrates, the mix is too dry.

Other items to be inspected:

- The stability of the masonry structure
- Dimensions of the masonry structure
- The quality of the materials
- Quality of the masonry
- Protection of the mortar while it is curing
- The final top surface and side faces
- Ensure pointing is properly done with cement mortar

7. MEASUREMENT AND PAYMENT (MBC)

This item is paid by the volume of cement stone masonry constructed including filling (pointing) by cement mortar of all joints between the stone surfaces, **measured in m³**. The unit rate includes curing, formwork and support.

Payment: The unit rate shall be the full compensation for labor, tools, equipment, materials, and any other incidentals that may be required in carrying out this work item.

4.9 Turfing / Grass planting

1. Description

This work shall consist of furnishing turf and sods as required and planting them to give a healthy stable covering of grass which will maintain its growth in any weather and prevent erosion of the material in which it is planted.

2. Materials

Grass shall be of species native to the country harmless and inoffensive to persons and animals and not of a kind recognized as a nuisance to agriculture. It shall be free of disease and noxious weeds, deep-rooted and sufficiently rapid growing (preferably, Smao Chijiean or Smoa Cheun kras). The grass can be taken from the vicinity area and shall obtain approval of the Project Engineer prior to the collection of the grass.

3. EQUIPMENT

This activity requires hand tools and wheel borrows.

4. METHOD

The turfing activity should follow normal good construction practices. This practice includes:

- The slope shall be well-trimmed. There should not be loose materials and overhanging slope. Planting start from the top of the slope under no circumstances should new plants be walked on or otherwise be disturbed.
- Sodding or turfing shall be done by planting sods or turf to give continuous cover of the entire area. Grass shall be planted with their root system substantially undamaged, well buried in firm material, and packed around with moist earth in which they have grown.

- Grass shall be planted at such a time and the work shall be done in such a way that at the time of the final construction inspection all areas to be grassed are substantially covered with healthy, well established, firmly rooted grass and the planted area is free from erosion channels.
- Surfaces to be planted shall be trimmed in such a way that the ground surface after planting is to the satisfaction of the Project Engineer.
- Whenever a slope is completed, dressed and ready, the soil must be watered if it is dry before turfing. The Contractor shall proceed with turfing as detailed in the Drawings or instructed by the Engineer.
- The Contractor shall maintain the grass at his/her expense until the issuance of the end of the maintenance period. Maintenance shall consist of watering, preserving, protecting, replacing grass and such other work as may be necessary to keep it in a satisfactory condition to prevent erosion and to present a dense and uniform appearance.

5. SAFETY ON SITE

Workers shall be organized in a manner that provides a safe distance between individual workers to limit the risk of injury when using hand tools.

- Each worker shall be equipped with appropriate safety gear and PPE.
- Refer to the general items in Volume I for appropriate OSH measures.

6. INSPECTION

The following will be checked:

- Slopes shall be trimmed and level prior to the grass being planted.
- The planted grass shall cover all areas. Stringline shall be used to ensure the top level and bottom level are in straight lines.

7. MEASUREMENT AND PAYMENT (MBC)

This item is paid by the area of the grass planted measured in m².

Payment: The unit rate shall cover the full compensation for labour, tools, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

4.10 Tree planting

1. Description

The planting of trees is intended to replace or restore some of the natural vegetation on the slope and shoulder to be treated. The Contractor is required to supply the trees seeds, fertilizer and to carry out the planting of seedlings to the Project Engineer's specific instructions.

2. Materials

Trees seedlings of minimum 30 cm height (Angkagn or Angkeaday trees), fertilizer.

3. Method

Planting should follow the following steps.

- Ensure that the site will already have been prepared for planting. The condition of the site must be good enough for the successful establishment of delicate young plants.
- The spacing of the plants will be determined according to the individual site conditions and nature of plants. However, it will normally be at two meters way from one to another tress unless otherwise specified.
- The plants should be at least 300 mm in height above the soil surface and strong enough to be planted.

- Keep plants moist and ensure that the soil around the roots does not dry out. Under any circumstances all plants supplied must be planted within three days of removal from the nursery.
- A planting pit wide and deep enough for the main root to be buried in without bending it and wide enough for all the roots and surrounding soil ball should be made at the time of planting.
- The polypots must be removed from the seedling by cutting it away with a razor blade. The plant should then be carefully placed into the hole with compost and soil packed in, and all surrounding soil firmed up taking care not to cause any damage to the plant and its roots. The surface over and around the pit should then be mulched using any appropriate locally available material such as manure, compost, dead leaves or cut herbage.
- The Project Engineer may specify bigger seedlings for areas such as those to be used intensively for amenity purposes. These will normally have been growing in a nursery for at least a year and should have well-developed roots as well as aerial parts. They will be provided either as bare root stock with a substantial root ball or in pots of a minimum of 100 mm x 180 mm laid flat dimensions. These larger seedlings are planted in pits of 300 mm diameter and 300 mm in depth. In addition, well-rotted compost should be mixed with the soil backfill in a ratio of at least one part compost to ten parts soil.

4 Equipment and tools

Measuring tape, planting bar

5. Safety on site

- Refer to item 1.3 for safety gear

6. Inspection

The following will be checked:

- The number of trees
- The quality of the planting
- Spacing from one tree to another

7. MEASUREMENT AND PAYMENT (MBC)

This item is paid based on number of trees planted and surviving.

Payment: The unit rate shall be the full compensation for labour, tools, tree seed, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

END OF VOLUME 2