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8 STRUCTURAL STEEL SUPPORTS


8.1 SCOPE OF WORK

- i) The specifications described herein under relate to the work which includes all labour, materials, equipment and services required for the supply, handling, fabrication and installation of structural steel supports consisting of steel ribs and lagging to be carried out by contractor in the underground excavation to the shape and dimensions as shown on the drawings.
- ii) Structural steel supports shall be installed either as complementary measure to the previously installed rock bolts and Shotcrete when those prove to be insufficient to stabilize the excavated profile, or as immediate supports after excavation in the heading zone when the material encountered in the process of excavation requires such measures.
- iii) Steel ribs shall be furnished complete with bracing, bolts, nuts, washers, plates, tie rods, and other accessories necessary for installation of the supports. Horizontal or bent steel bracing in the invert may be required. Steel Lagging shall be provided separately from steel ribs.
- iv) The contractor, if he considers necessary, may install temporary supports for his convenience and safety of his workmen/equipment during execution without any cost liability to Employer.
- v) The supports shall be bent to the required shape by cold bending process only.

8.2 Submittals

- i) Within 30 days from the date of issue of Letter of Acceptance but before procuring or mobilization to the site, the equipment, the contractor shall submit to the Project Manager the description, and drawings showing sufficient details of the layout, type and capacity of the equipment proposed for the fabrication of steel ribs.

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ii) At least 60 days in advance of the excavation of underground works being carried out on the site, the contractor shall submit to the Project Manager the schedule for fabrication of steel ribs.

iii) The Project Manager reserves the right to require any additional information deemed necessary to be included in the submitted documents.


8.3 Standards

i) The fabrication and installation of structural steel support shall conform to the following latest Indian Standards or, where not covered by these standards, to the equivalent International Standards:

IS: 5878 (Part-IV)	Code of practice for construction of tunnels conveying water
IS: 800	Code of Practice for general construction in steel
IS: 814	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel
IS: 816	Code of Practice for use of metal arc welding for general construction in mild steel.
IS: 1786	Specification for High strength deformed steel bars and wire for concrete reinforcement
IS:2062	Structural steel (Standard Quality)
IS: 2502	Code of Practice for Bending and fixing of bars for concrete reinforcement.
IS: 2751	Code of Practice for welding of mild steel plain and deformed bars for reinforced concrete construction.

ii) In case of conflict between the above standards or any other IS code and the specifications given herein, the specifications shall take precedence.

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8.4 Necessity and Details of Structural Steel Supports


8.4.1 General

- i) Steel ribs girder shall be installed to support crown and walls of underground excavations in all areas where, in the opinion of Project Manager, alternative methods of rock reinforcement shall not provide adequate support either for construction safety or for permanent stability.
- ii) The exact requirement for steel ribs girder in any area shall depend on actual rock conditions encountered as excavation progresses.

8.4.2 Steel Ribs

- i) The steel ribs shall comprise I-beam or built up sections as shown on the drawings.
- ii) Rib splices shall be welded or made of bolted plates in such a manner as not to reduce the section moment of resistance.
- iii) Only one section size of steel rib profile shall be used for each portion of the underground works and the structural requirements due to rock conditions encountered shall be met by varying the spacing of the ribs as directed by the Project Manager.
- iv) All steel section and plates used for ribs and accessories shall conform to IS :2062. "Structural Steel" (Standard Quality).
- v) Material used in splices shall conform to the specification of the material being spliced.
- vi) All steel and fabrication thereof shall conform to the requirements of IS: 800 "Code of Practice for use of structural steel in General Building Construction".
- vii) All welding, welding electrodes and workmanship shall conform to IS: 814 and IS: 816.

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8.4.3 Steel Rib Accessories

Steel rib accessories shall include, but not be limited to, collar braces, spreaders, liner plates, cribbing, foot blocks and sills which are fabricated from steel plates or sections or other steel products. Steel support accessories shall be used with the steel ribs in the underground excavation and shall be used elsewhere when required by Project Manager.

8.4.4 Pre cast RCC / Steel Lagging


- i) Lagging are the longitudinal supporting members placed behind the steel ribs where necessary to support the walls and crown of the underground excavation.
- ii) Steel lagging shall be made of the same material as steel ribs. The minimum thickness of the steel lagging shall be 3 mm.
- iii) Precast reinforced concrete panels of 10 cm thickness may be used as lagging instead of steel lagging. The type of lagging used must be approved by the Project Manager before contractor start with the manufacture thereof. Concrete grade used shall be M-25/A20 and reinforcement at the rate of 60 kg/m³ minimum shall be provided.

8.5 Execution

8.5.1 Steel Ribs


- i) Steel ribs shall be bent with an allowance of one percent to the shape as shown on the drawings. Reshaping of the bent ribs at the place of installation may only be undertaken with Project Manager's consent and only if the material properties would not be impaired.
- ii) Excavation of the underground works shall be completed true to the lines shown on the drawings before installation of steel ribs. The steel ribs shall be placed at the minimum excavation line and at spacing as shown on the drawings or as determined by the Project Manager.

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- iii) Concrete blocks or steel profiles shall be provided as footings for the steel ribs. Use of timber as foot blocks shall be strictly prohibited. The foot plates shall be of sufficient size and rigidity. If required, the legs of the ribs shall be anchored to the rock by the rockbolts. Where invert bracing is required, it shall be fixed securely to the lower legs of the ribs in such a way that buckling is not induced in the steel rib by the presence of such bracing.
- iv) Steel sections and plates shall be cut, welded, bolted or otherwise proposed to the shapes and dimensions indicated on the drawings or as directed by the Project Manager.
- v) Immediately after placing the ribs in a correct position, they shall be interconnected and braced by means of steel bars or beams in order to prevent any displacement and to maintain spacing. Use of timber spreaders shall be strictly prohibited.
- vi) The space remaining between the outer flange of the steel ribs and the rock surface shall be backfilled immediately after the rib has been placed over the entire circumference of the steel rib in order to provide uniform load distribution. In over excavation, the bulk of the voids space may be filled with concrete blocks, followed by shotcrete. If required, shotcrete shall be applied also between the steel ribs to form an arched bracing in the direction of the centerline of the underground excavation.
- vii) The contractor shall survey and record the position of all steel ribs installed in order to facilitate drilling operations. Their position shall be marked on the finished concrete lining surface.
- viii) Blocking and wedges used to set the steel ribs may be steel or concrete blocks.
- ix) Structural steel supports shall be maintained in position by the contractor after installation. Any steel rib installed improperly or damaged by the contractor's operations shall be adjusted, repaired or

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replaced as appropriate by the contractor without delay after notification by the Project Manager.

- x) Lagging shall be placed behind the steel ribs where necessary to support the crown or the sides of underground excavations. Where conditions require, it may, supported on the last steel rib erected, be pushed by pressing and/or hammering into the ground ahead to provide a temporary overhead protection while installing the next steel rib (forepoling).
- xi) The space between the rock surface and the lagging shall be backfilled with concrete.
- xii) Backfilling between rock and lagging with rock spells, bracing with timber and timber lagging shall be strictly prohibited.
- xiii) During the course of work, the contractor shall maintain a sufficient reserve of steel ribs complete with accessories on each work site.


8.6 **Measurement and Payments**

The Unit Rates entered in the Bill of Quantities shall be applied regardless of the excavation method used, i.e., conventional, full face or partial excavation (e.g. heading and benching, multiple drift, full face or any other specialized methods). For the definitions of the various zones mentioned above, refer Chapter -Underground Excavation.

8.6.1 **Steel Ribs**

- i) Measurement for payment for supply, handling, fabrication and installation of the steel ribs will be of the weight of steel ribs actually installed and approved by the Project Manager. Payment will be made at the Unit Rates entered in the Bill of Quantities, which shall include the entire cost of:
 - a) Supply, handling, fabrication, transportation to the place of installation and installation of steel ribs.

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- b) Backfilling with concrete blocks except in geologically accepted overbreak which will be paid separately as set out in Chapter - Underground Excavation.
 - c) Surveying and marking the position of ribs on the finished concrete surfaces.
- ii) For the measurement and payment purposes, the weight of the steel ribs will be based on the unit weight of the steel profile per linear meter (without any accessories) as specified in the relevant IS codes.
- iii) Measurement for payment for tie rods, props, joint plates, all foot plates, foot blocks, bolts, nuts, invert struts and cross bracings (called as Miscellaneous Metal Pieces) shall be of the weight of metal pieces actually installed as approved by the Project Manager. Payment will be made at the unit rate entered in the BOQ which shall include supply, handling, fabrication, transportation to the place of installation and installation of miscellaneous metal pieces.

8.6.2 Steel Lagging and Precast concrete lagging

- iv) Measurement for payment for supply, handling, fabrication and installation of the steel lagging will be of the weight of lagging actually installed and approved by the Project Manager. Payment will be made at the Unit Rates entered in the Bill of Quantities which shall include the entire cost of supply, handling, fabrication, transportation to the place of installation and installation of steel lagging and all other accessories.
- v) For the measurement and payment purposes, the weight of the steel lagging will be based on the unit weight of the steel profile per linear meter (without any accessories) as specified in the relevant IS codes.
- vi) The measurement for payment for precast concrete lagging will be made of volume of precast lagging in m³ used as approved by the Project Manager. Payment will be made at the unit rate entered in the BOQ for supply, handling and installing precast concrete lagging complete in all respect. The cost of formwork, concrete reinforcement,

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finishing and curing of precast concrete lagging is deemed to be included in the unit rate.

- vii) Measurement and payment for the backfilling with concrete behind steel/concrete lagging except unapproved overbreak shall be made at the unit rates of concrete entered in the Bill of Quantity.


8.6.3 Exclusions

- viii) Rock bolts installed to hold the installed steel ribs in position will be measured for payment and paid for as per Chapter- Rock Bolts and wiremesh.
- ix) Shotcrete applied between or encasing the outer flange of the steel ribs girder will be measured for payment and paid for as set out in Chapter - Shotcrete.
- x) Wiremesh used as lagging will be measured for payment and paid for as set out in Chapter – Rockbolts and Wiremesh.

8.6.4 No payment will be made for the following:

- xi) Structural steel supports which have to be replaced, repaired or re-erected as a result of contractor's operation. The contractor shall rectify or replace such steel ribs and lagging at his own expense.
- xii) Structural steel supports which have to be installed as a consequence of the contractor's non-compliance with approved drilling and blasting methods as set out in the Contract.
- xiii) Weight difference in case the contractor prefers installation of heavier or stronger steel supports or for additional ribs due to closer spacing than those approved by the Project Manager.
- xiv) Temporary supports installed by the contractor for his convenience and safety of his workmen/equipment during execution.

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<p>xv) Transport from the underground working zone back to the storage site, of any unused steel supports, and further storage to and/or removal from the Site.</p> <p>xvi) Unused concrete lagging, ribs and other items/ materials.</p>		
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