महानिदेशालय, के.लो.नि.वि.
महा. नि./दि.द.अनु/04
निर्माण भवन, नई दिल्ली–110011

कार्यालय ज्ञापन

Sub:- In corporation of New technology item Delhi Schedule Rate 2021.

The following new items for providing "Tunnel Formwork System" for wall panel and Floor/Roof panels are proposed for inclusion in DSR -2021 under SH:- 26 (New Technologies and Materials).

Code No	Description	Unit	Rate (in Rs)
26.94	Designing, shop fabricating, supplying , erecting, stripping and shifting of customized Modular Tunnel Formwork system for cast-in-situ monolithic RCC structures, using precision steel cubical formworks are molds with minimum 3mm thick **hot rolled plain painted/hot dip galvanized M.S. sheets** for panel in contact area with necessary framing and allied accessories as per CPWD specificationsincluding transporting, storage, assembly, hoisting and placing in position for supporting and holding the formwork in place till initial setting of the concrete then stripping the formwork, propping to support horizontal surface cleaning and oiling etc. for shifting to the next cycle, inclusive of all labour, machines and T&P requirements taking all safety measures etc. as per design and cycle programme all complete as per directions of the Engineer-in-Charge. Design of Tunnel Formwork system shall be provided by concerned service provider/vendor and the rate is inclusive of all the elements and all operations for all heights.	sqm	232.00

यह ज्ञापन सक्षम अधिकारी के अनुमोदन से जारी किया जाता है।

(इं. सी. एस. आजाद)
कार्यपालक अभियता (टास–II)
सी.एस.क्यू. के.लो.नि.वि. नई दिल्ली

फाईल सं0 133/अधी अभि. (टास)/दि.द.अनु./2022/263-80 दिनांक 27/06/2022

प्रतिलिपि : सभी विषेश महानिदेशक/अपर महानिदेशक/मंख्य अभियन्ता/मुख्य परियोजना प्रबन्धक/परियोजना प्रबन्धक को के0 लो0 नि0 वि0 की वेबसाइट http://cpwd.gov.in के द्वारा.

कार्यपालक अभियता (टास–II)

महानिदेशालय, के.लो.नि.वि.
महा.नि./दि.द.वि/05
निर्माणभवन, नई दिल्ली–110011

कार्यालय ज्ञापन

Sub:- In corporation of New technology item Delhi Analysis Rate 2021.

The following new items for providing "Tunnel Formwork System" for wall panel and Floor/Roof panels are proposed for inclusion in DAR -2021 under SH:- 26 (New Technologies and Materials).

26.94	Designing, shop fabricating, supplying , erecting, stripping and shifting of customized Modular Tunnel Formwork system for cast-in-situ monolithic RCC structures, using precision steel cubical formworks are molds with minimum 3mm thick **hot rolled plain painted/hot dip galvanized M.S. sheets** for panel in contact area with necessary framing and allied accessories as per CPWD specificationsincluding transporting, storage, assembly, hoisting and placing in position for supporting and holding the formwork in place till initial setting of the concrete then stripping the formwork, propping to support horizontal surface cleaning and oiling etc. for shifting to the next cycle, inclusive of all labour, machines and T&P requirements taking all safety measures etc. as per design and cycle programme all complete as per directions of the Engineer-in-Charge. Design of Tunnel Formwork system shall be provided by concerned service provider/vendor and the rate is inclusive of all the elements and all operations for all heights.					
Code	**Description**	**Quantity**	**Unit**	**Rate**	**Amount**	
	Details of cost for 530 sqm (Total contact area) Horizontal (plan/floor area) = 124 sqm Vertical (Walls area)= 406 sqm Accessories include vertical support, slant support, tunnel lifting equipment, wallstopper, slab stopper, starter caster, doors/ window boxout, tie road, safety platforms brackets and anchors, inner safety & working platform, outer safety & working platform					
	MATERIALS: Horizontal Panels 124 sqm @ 90 kg/ sqm = **11160 kg** Vertical Panels 406 sqm @ 135 kg/ sqm = **54810 kg** = **65970 kg** Additional steel for accessories @ 20% = **13194 kg** = **79164 kg** Add 5% wastage = 3958 kg = **83122 kg**	83122.00	kg	77.50	6441955.00	(a)
	Painting with synthetic enamel paint over priming coat with red oxide primer on the opposite side of contact area and accessories of tunnel foam work system = 875 sqm {(530 sqm + 65% of 530 sqm for framing & accessories) = 530 + 345 = 875 sqm say 875 sqm)} Rate as per item 13.50.3 + 13.61.1 excluding W.C. , GST , CP & OH and Labour Cess (414.94 + 962.61 = 1377.55/10 = 137.75)	875.00	sqm	137.75	120531.25	(b)
	Designing, Fabrication and transportation cost on 79164 kg	79164.00	kg	50	3958200.00	(c)
	Total formwork and accessories cost				10520686.25	

	Add maintenance charges @ 5% on net cost of formwork and assuming fabrication cost being 60% of b i.e. 60% of 3958200 = 2374920 therefore 5% of 8908203.25 (6441955 + 2374920 + 91328.25) = 445410.16				445410.16	(d)
	Add salvage value at the rate of Rs. 25/kg on (b)	79164.00	kg	20	-1583280.00	
7343	Adjustable telescopic Props 3 mtr for supporting slab area after removal of tunnel form (7x36=252) = 252 Nos	252.00	each	955	240660.00	
	Net cost for 150 repetitions				9623476.41	
	Cost for using once				64156.51	(A)
	Labour :					
,0160	Supervisor/technician	1.00	day	833.00	833.00	
,0116	Skilled fitter	4.00	day	784.00	3136.00	
,0114	Helpers/beldar	16.00	day	645.00	10320.00	
	Hire charges for crane (upto 40 tonne capacity)	1.00	day	9600.00	9600.00	
5773	Shuttering Oil (@ 20 sqm per litre for 530 sqm =26.50 litre)	26.50	litre	90.00	2385.00	
Sub-AR	Add for GP2 compound for tie rod holes found out of conical concrete pegs @ 1 hole/sqm of wall area i.e. 406.5 / 2 =203.25 Say 204	204.00	each	8.00	1632.00	
					92062.51	(W)
	Add 1% water charges				920.63	
					92983.13	(X)
	Add GST @ 12% (0.1405)				13064.13	
					106047.26	(Y)
	Add CPOH @ 15%				15907.09	
					121954.35	(Z)
	Add 1% LWC				1219.54	
	Total cost for 530 sqm				123173.90	
					232.40	
	Say				**232.00**	

सक्षम अधिकारी के अनुमोदन से जारी किया जाता है।

(इं. सी. एस. आजाद)
कार्यपालक अभियंता (टास–II)
सी.एस.क्यू. के.लो.नि.वि. नईदिल्ली

फाईल सं0 133/अधीअभि. (टास)/दि.द.वि./2022/ 264-80 दिनांक 27/06/2022

प्रतिलिपि : सभी विषेश महानिदेशक/अपर महानिदेशक/मंख्य अभियन्ता/मुख्य परियोजना प्रबन्धक/परियोजना प्रबन्धक को के0 लो0 नि0 वि0 कीवेबसाइटhttp://cpwd.gov.inके द्वारा.

कार्यपालक अभियंता (टास–II)

महानिदेशालय, के.लो.नि.वि.
महा.नि./विर्निदेश/18
निर्माण भवन, नई दिल्ली–110011

निर्माण भवन, नई दिल्ली

दिनांक 30/06/2022

कार्यालय ज्ञापन

Sub:- **Addition of specification for item No. 26.95 in CPWD Specification 2019 Vol-II.**

The following specification may be added after para No. 26.46 in CPWD Specification 2019 Vol-II under **SH:- 26 (New Technologies and Materials).**

26.47 **Brief Description:**

Tunnel Formwork is a **semi-**mechanized system for cellular structures. It is based on two half shells which are placed together to form a room or cell. Several cells make **a dwelling unit**. With tunnel forms, walls and slab are cast in a single day. The structure is divided into phases. Each phase consists of a section of the structure that will be cast in one day. The phasing is determined by the programme and the amount of floor area that can be poured in one day. **For example,** the formwork is set up for the day's pour in the morning **(i.e. 0 hour).** The reinforcement and services are positioned and concrete is poured in the afternoon **(i.e. 8 hours).** Once reinforcement is placed, concrete for walls and slabs will be poured in one single operation. The formwork is stripped the early morning **(i.e. 20 hours)** and positioned for the subsequent phase. **(i.e. 24 hours)** The formwork is manufactured **in fully automated plant with CNC machines using laser cutting and laser automatic welding robots.**

The on-site implementation of 24 hour cycle is divided into following operations.

1. Stripping of the formwork from the previous day. **(6 hours) *1**
2. Positioning of the formwork for the current day's phase, with the installation of mechanical, electrical and plumbing services. **(8 hours) *2**
3. Installation of reinforcement in the walls and slabs along with MEPs. **(8 hours) *3**
4. Concreting and if necessary, **heating with equipments. (10 hours) *4**

Note: All the above four activities (*1, 2, 3, 4) are field management activities and based on intricacy of the pouring system, several or one can be parallel activity. The field control should give a clear plan for Quality checks and measurement recording on hourly basis.

26.47.1 **Types of Formwork System**

26.47.1.1 **Modular Tunnel form**

Tunnel forms are room size formworks that allow walls and floors to be casted in a single pour. With multiple forms, the entire floor of a building can be done in a single pour. Tunnel forms require sufficient space exterior to the building for the entire form to be slipped out and lifted up to the next level.

This tunnel form consist of inverted L- shaped half tunnels (one vertical panel and one horizontal panel) joined together to create a tunnel.

Articulated struts brace the horizontal and vertical panels. These struts enable the adjustment of

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the horizontal level of the slab and simplify the stripping of the formwork. The vertical panel is equipped with adjustable **screw** jacking devices and a triangular stability system. Both devices are on wheels.

A range of spans is possible by altering the additional horizontal infill panel's dimensions. Due to the distribution of the horizontal beams on the vertical plank, the formwork also cast staggers and offsets in the layout of the walls as well as differing wall thicknesses. The half-tunnels will be equipped with back panels to cast perpendicular shear walls or corridor walls. Assembly and leveling devices ensure that the formwork surfaces are completely plumbed and leveled.

Standard characteristics

Standard dimensions:
Unit width: **Minimum box span (two horizontal panels combined) 2.40 m. Maximum box span size 6.00 m without accessory units and 7.00 m with accessories unit.**
Type 1 horizontal panel **of half tunnel:** from 1.20 m to 1.60 m
Type 2 horizontal panel **of half tunnel:** from 1.80 m to 2.40 m
Type 3 horizontal panel **of half tunnel:** from 2.40 m to 3.00 m
Span which can be adjusted by fitting an additional panel measuring between 0.05 and 0.60 m
Package length: Up to 12.50 m in length as a function of the hoisting facilities and availability **of Crane capacity and space.**
Basic length: 1.25 m
Average weight: 125 kg/m^2
Handling: Lifting triangle or sling

26.47.1.2 **Wall forms**

Wall forms are temporary molds in which concrete is poured in order to build a structure. Once the concrete is poured into the formwork **and has obtained the de-shuttering strength as per IS code requirements**, the formwork is stripped to expose a perfect finished concrete. These forms constitute a system approach for construction and are particularly suited to build structural walls, columns, bridge piers, culverts etc. This system adapts well to daily work-phase of both repetitive and non-repetitive tasks. The equipment used each day is productive and is reused in subsequent phases. The four daily operations which outlines the daily production cycle for wall form equipment are identical to those for tunnel form equipment with the exception that it is solely used for casting concrete walls. The slabs are cast as a secondary phase. The existing equipment can be adapted on a day-to-day basis by the addition of standard elements and corner-wall formwork to take into account different wall configurations on site. All safety and stability devices will be fully integrated in to the standard version of wall form equipment.

Wall form

These wall forms are tools specially designed to be used on specific buildings and structures. This vertical wall forms panel is a multi-purpose formwork system. This system has been designed and developed to ensure that it is simple and quick to assemble and position the following:

- A full range of standard dimensioned components
- Multiple combination of panels of simple adoption to specific configurations
- Basic standard equipment incorporates complete safety, circulation
- and stability equipment
- Caliper- device opposing wall form packages are craned into position in one **operation**.

Standard characteristics

Standard dimensions:
Standard height: 2.80m
Upper extension: 0.50m
Lower extension: 1.00/1.50m
Average weight: 135 Kg/m2
Assembly: 0.80 H/m2 of formwork

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Use: 0.15 to 0.30 H/m2 of formwork, depending on complexity
Wind stability: by prop
Access: inner ladder accessed via hatch
Superposition: up to 22.5 m with specific engineering performed to determine hoisting and stability characteristics

26.47.1.3 **Angle Formwork**

Inner and outer angle configurations are designed to attach to 1.25m wall forms **to obtain required wall thickness.** Spacers will be installed for producing **desired** wall thicknesses.

26.47.1.4 **Back Panel**

The back panel allows pouring of cross walls, other walls, walls and slab in one operation.

26.47.1.5 **Slab Stop End and Wall stop**

These can be adjusted to fit the lengths of wall and slabs **i.e. the ends can be either straight or curved.** These remain fixed to the form during all handling operations.

26.47.1.6 **Kicker Form**

In order to guide the walls of the upper floor precisely above the walls of the floor below, a kicker form is fixed to the tunnel form before pouring the concrete **after placing of horizontal slab reinforcement**. Slab and starting walls are then poured during the same phase.

26.47.1.7 **Box Out**

During each phase, window box out, door box out and slab box out are mounted on the tunnel using a magnetized system **or by mechanical arrangements**.

26.47.2 **Tolerances**

26.47.2.1 **Manufacturing Tolerance T**

The manufacturing tolerance T will **be the sum of the permissible manufacturing deviations, positive and negative, of the structural member concerned.**

Thus $T = m_{pos} + m_{neg}$ where m_{pos} is taken as equal to $m_{neg} = \frac{1}{2}T$. The values to be adopted for ½ T are given in **Table 1**

Table 1

Specified dimension of the member in mm	½T in mm
< 200	4
400	5
600	6
800	7
1000	9
1500	11
2000	13
3000	16
5000	20

Intermediate values should be determined by linear interpolation.

26.47.2.2 **Positional Tolerance P**

The positional tolerance P is composed of the measuring tolerance P_1 and the positioning tolerance P_2.

26.47.2.3 **Measuring Tolerance P_1**

The measuring tolerance P_1 is the sum of the permissible measuring deviations, positive and negative, for the relevant grid lines or other reference lines in relation to the specified location of these lines. The values to be adopted are given in Table 2, the permissible positive deviation being taken as equal to the permissible negative deviation = ½ P_1

Table 2

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Specified distance between two gridlines or other reference lines in m	½P_1 (in mm)
1	2
2	3
5	4
10	5
20	7
50	12
100	20

Intermediate values should be determined by linear interpolation.

26.47.2.4 Positioning tolerance P_2

The measuring tolerance P_2 is the sum of the positioning deviations, positive and negative, for the relevant concrete face of the structural member in relation to the grid lines or other reference lines set out on the job. The values to be adopted are given in Table 3, the permissible positive deviation being taken as equal to the permissible negative deviation = ½ P_2.

Table3

Specified distance from the concrete face to the set out grid line or other reference lines in mm	½P_2 (in mm)
<200	6
400	7
600	8
800	9
1000	11
1500	13
2000	15
3000	18
5000	22

Intermediate values should be determined by linear interpolation.

This table is not applicable to top and under surfaces of floors and beams (see Clause 26.47.2.7)

26.47.2.5 Vertical Concrete surfaces

Vertical concrete surfaces should additionally conform to the requirement of not being inclined by more than 0.3% with respect to the vertical.

26.47.2.6 Floor and Beam Surfaces

Notwithstanding the requirement of **Clauses 26.47.2.2 to 26.47.2.7**the permissible deviation, both positive and negative, of top and under surfaces of floors and beams at supports on, or connections to, columns or walls shall not be allowed to exceed 8 mm.

26.47.2.7 Combination of tolerances

It is not possible to combine tolerances linearly in order thereby to arrive at the largest or the least deviation of the dimensions or the position of a structural member.

26.47.3 CHARACTERISTICS OF THE SYSTEM

26.47.3.1 Maximum span between walls

Maximum span between walls will **be 6.00 m without accessory units and 7.00 m with accessories unit.**

26.47.3.2 Height of the formwork

The forms are designed for floor to ceiling height of 2.51 m minimum with the possibility to increase this by action of the leg jacks or with the use of movable panels in the event of extra heights.

26.47.3.3 Appearances of the faces after form removal

The surfaces obtained allow direct application of finishing paint or wallpaper after sanding off the

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fins at the joints connecting the units and smoothing with paint filler **as per the superior quality of surface finish required**.

26.47.3.4 Working rhythm using the system

Under average temperature conditions, with the use of **Regular RMC** the normal rhythm is two days per cycle with **18 hours for setting and hardening** of the concrete.

26.47.3.5 Manpower necessary for execution of the process

The time required for execution shall vary according to the cell plan. For a type cell consisting of two formed wall surfaces and a floor surface, the average time is less than one & one half hours per square meter of building i.e. an average unit time less than 45/100 hour to the square meter formed. This time includes the form removal, oiling, displacement of the units, formwork and adjustment.

26.47.4 USES OF THE TUNNELFORM AND ITS LIMITATIONS

26.47.4.1 Uses

Designed to cast concrete load-bearing walls and slabs in a single monolithic pour, tunnel forms are suited for the construction of following structures:

i) Multiple residential dwellings
ii) Housing projects
iii) Garden apartments
iv) Town homes
v) Condominiums
vi) Hotels etc.

26.47.4.2 Limitations

i) The floor spans executed with movable forms shall not be more than 6.00 m, unless accessory units are used.
ii) The thickness of vertical in-situ walls shall **not be less** than 120 mm, unless justified by special provisions.

26.47.4.3.1 Special Aspects of use:

1. The structures to be constructed using The Tunnel Formwork System will be in accordance with the specifications prescribed in the Formwork & Technology provider's brochure and designed by competent structural Engineers.
2. Mechanical, and Electrical services will be governed by the provisions and details given by the manufacturer and good engineering practices will be followed. **It should be well planned that no plumbing lines are laid inside the structural system.**
3. The Tunnel Formwork System should be used only with technical support or supervision by qualified engineers of service provider based on structural designs complying with prevailing standards and specifications; this is applicable even for low-rise and affordable mass housing to provide safety of structures.
4. It is strongly recommended that structural engineers and building designers associated with Tunnel Formwork system providers engaged by the agency should be thoroughly familiar with various structural aspects. It is also recommended that architects and construction Engineers who undertake building design and construction gain familiarity with the characteristics of Modular Tunnel form and Wall form and their applications.

26.47.5 Technical Conditions

1. The formwork of suspended floor will be built by the "movable forms' without any special units being wedged between these forms.
2. The required flatness conditions are nevertheless more difficult to obtain in the case of suspended floors with very long spans where it is necessary to put in tables between the "movable forms", and it would seem reasonable to limit the use of the system to floors with a maximum span of **6.00 m**, in housing construction.
3. The number, the arrangement and the condition of wind bracing walls will be such that the horizontal stability of the work is ensured during construction.
4. It is obligatory that these wall be built of in-situ concrete to the cross walls by reinforcement starter bars where the buildings are higher than six levels.
5. A periodic check of the concrete's hardening will be carried out prior to removing forms (**by the**

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compressive strength of the cubes taken from the concrete used and preserved under identical conditions).

6. The design of the forms does not make it possible to check the homogeneity of the concreting while it is being done and it seems prudent, under these conditions, to limit the minimum thickness of the poured walls to120 mm.
7. System provider shall provide necessary training to the technical persons of the agency engaged for design and construction of the structures.
8. The System provider shall provide a detailed Quality Assurance System for production and execution of the system in the field.

26.47.6 SPECIFICATIONS FOR THE MODULAR TUNNELFORM SYSTEM & DESIGN INFORMATION

26.47.6.1 Technical Specifications

The Modular Tunnel form System consist of inverted L- shaped half tunnels (one vertical panel and one horizontal panel) joined together to create a tunnel. These forms are made up of factory cut, 80mm x 80 mm angle sections in accordance with the line of building forms. The panels are built of 3 mm sheet steel, stiffened by folded sheet metal sections.

26.47.6.2 Raw Materials Specifications

(i) 3 mm thick Hot rolled M.S. sheets shall conform to E-250 C grade designation IS 2062:2011 (with application of Red oxide Zinc Chromate primer & protective paint on non-contact face of concrete surface)

Or

Wherever hot dip galvanized sheets with 120 GSM coating is to be used in place of plain HR M.S. Sheets, the galvanizing shall conform to IS: 277-2003.

(ii) Angle section – 80x80x6mm shall conform to IS 2062:2011

(iii) Cold rolled U-sections – 60x30mm shall conform to IS 2062:2011.

Mechanical properties:

Yield strength : ≥ 235 MPa
Breaking load : ≥ 360 MPa
Elongation : ≥ 20%

26.47.6.3 Steel for spacer pins

Apart from the requirements given in para 26.47.6.2 the steel used for the manufacture of the spacer pins, the gripping mechanisms, anchoring points for the rear stabilizing and adjusting mechanisms shall guarantee a minimum KCV resilience as per service providers specifications.

26.47.7 Design Hypothesis and Information

26.47.7.1 Design Hypothesis

The wall forms will be designed to simultaneously resist the stress caused by the following:

- Their own weight and their handling.
- Operating loads
- Movement of staff
- Concrete pressure
- Climatic loads caused by wind.

26.47.7.2 The essential elements to be considered are:

- The gripping mechanisms.
- The concreting platform and its access.
- The protection against any risk off allying from a height from the platform **and all other safety precautions.**
- The structural frame and the form work face.

26.47.8 DESCRIPTION AND UTILIZATION OF THE FORM WORK SYSTEM

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26.47.8.1 Description of The Formwork System

The tunnel formwork system consists of the following elements:

26.47.8.1.1 The Starter Forms

These forms are made up of factory cut minimum size 80mm x 80mm metallic angle sections (or larger, if necessary) in accordance with the line of the building walls. These angle sections, marked with respect to one another, are assembled on the working site in accordance with the indications of an assembly plan having the same markings. They are erected by means of steel support wedges on the tunnel form prior to concreting of the walls and the slab. Their location automatically ensures the correct positioning of the wall and the frames.

26.47.8.1.2 The Movable Forms

The standard form unit (half-shell) take the form of a right hand dihedral, whose vertical plane is made up of a storey–height panel, less 4 cms (or more, if necessary) and the horizontal plane of a panel representing the half-span of the floor slab **(maximum 3.00 m for slab span of 6.00 m).**

The panels are built of minimum 3 mm sheet of steel, stiffened by folded sheet metal sections, welded at every 250 mm **by TIG or MIG welding by Robots.** These are assembled rigidly to each other by bolts which enable slight deformations of the dihedral. These are usually 2.50 m long. The wind bracing of the two panels is ensured by two diagonals having a length adjustable by screw jacks which are fitted with an adjustable stop so that when the screws are at the stop the dihedral remains perfectly straight.

The standard form unit shall be also equipped with the following devices:

i) At the base of the vertical panel, minimum two screw jacks permitting adjustment of the height and level of the upper panels.

ii) At the key of the upper horizontal panel; a tubular knee brace, also fitted with a screw jack, permitting height adjustment.
This knee-brace, which is hinged, is folded towards the vertical panel after assembly of the various units.

iii) Two horizontal cross pieces, incorporated in the height of the vertical panel are pierced with holes top permit passage of the spacers ensuring adjustment of the wall thickness.

iv) The lateral extremities of the panels will be made of minimum **60x30x6mm**, cold rolled U-sections which carry the connecting devices making it possible to ensure the correct flush fitting of consecutive units. Assembly is carried out using spring levers.

v) The end of the horizontal panel, built of a minimum **80x80x8mm**, steel angle section, carries the key locks permitting the assembly of two units face to face.

vi) At form removal, the half-shells weighing from 600 to 700kg (depending on the surface) will be removed on the service platforms using light, 4-wheel dollies (two dollies are sufficient to handle a form surface of 500 sqm).

vii) The half-shells will be supported on the dollies by means of two lugs welded to the dolly base and two telescoping props will also form part of the dolly.

viii) The half-shells will be cleaned on the dollies on the service platforms then hosted out by the crane to be set up on the next higher storey (the dollies will stay on the plat form to be re-used immediately).

26.47.8.1.3 Service Platforms

These platforms will be built of a **High grade Exterior grade chequered plate embossed ply wood so that no loose particle falls from the platform** fastened with lag bolts to metal trusses forming a console. Each truss will be composed of upper horizontal steel I - Beam **generally** of 5.25 m **or as per the assembled depth of tunnel** long up to which three 40 /49 mm tubes are welded to form a triangular beam. These trusses, arranged in consoles between two successive stories, already poured, will be assembled in pairs.

The usual platform width outside the building will **generally** be 2.85 m **or as per the assembled depth of tunnel,** a guard railing will be setup at the outside edge of the platform floor.

26.47.8.1.4 Special Units

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The maximum width of the horizontal panels of the usual form units is 3.00m, making possible the execution of floors having a span up to 6.00 m. whenever a greater span will be required, **table form i.e.** some additional horizontal panels can be inserted between the opposite half-shells. These panels built in the same manner as the normal units.

26.47.8.2 Utilization of the Formwork System

26.47.8.2.1 At each stage, utilization of the system requires the following Successive operations:

i) The placing of the vertical wall reinforcement of the floor and possibly the door frames would be provided for in the erection drawing.

ii) Dismantling of the movable form units of the preceding storey will be carried out in two stages.

a) Loosening of the normal units (half-shells), by removal of the spacers passing through the walls, by unlocking the tunnel keys and disassembling of the sections. This work will be executed in principle by two non-specialized maneuvers.

b) Striking and removal of the forms will be carried out by using the special dolly and two maneuvers in the tunnel and by two other maneuvers at the new location (usually on the storey, above).

This suite of operations will be carried out by bringing the dolly under the half-shell to be removed and then operating the different jacks for the striking operation itself. The leg jacks are lifted first, then a slight deformation of the half-shell is provoked by adjusting the diagonal bracing jacks (shortening). This deformation should be sufficient to strip the form progressively.

The dolly half-shell assembly will then be rolled across the service platform where the form is cleaned and oiled with a sprayer, then picked up with a crane **by lifting triangle** and hoisted to its new location site, the dolly remaining in place. The half-shell design makes it possible to remove the whole side of a tunnel, then to prop the slab near the key before removing the other half permitting (if necessary) a faster rotation of the equipment.

iii) Reassembling of the units on the floor, above.

This will consist of the following operations:

a) A half-shell will be positioned on its leg jacks and knee brace, and adjustment will be squared by blocking the diagonal bracing jacks and then adjusting the height and plumb by operating the leg jacks and the knee brace jacks.

b) The half-shells will be assembled together.

c) The opposite half-shells will be positioned, and adjacent half- shells of the 'tunnel' will also be positioned using the same procedure.

d) The half-shells will be blocked by constituting the two faces of the wall on the 'starters' with the help of the lower spacers, the upper spacers will be tightened without being forced, only after verification of the general adjustment and positioning of the butt end forms of the walls and floors.

e) The key locks solidifying the opposite half-shells will be positioned and blocked. If necessary, a slight adjustment on the knee brace and diagonal bracing jacks will be used to bring the locking units in alignment.

f) The starter forms will be positioned and block outs, if necessary for anticipated door and window frames.

g) The overall adjustment and finish making–up will be verified, if necessary, after lifting of the knee braces.

h) The suspended floor will be reinforced and concrete will be poured in the walls and slab.

iv) The service platform will be removed. The platform will be installed on the storey, above.

26.47.9 HANDLING, STORAGE AND ASSEMBLY OF THE TUNNEL FORMWORK SYSTEM

26.47.9.1 24 Hour Cycle

The 24 Hour cycle defines the works to be done each day. To establish this cycle, the overall structure is divided into a number of more or less similar construction phases, corresponding to a day's work. The necessary manpower and equipment are then determined according to the size of these phases. To reach maximum efficiency, the phases done every day are similar.

The cycle is divided into the following activities:

Each cycle is divided into the following activities:

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- Initial striking operations
- Movement of forms
- Final preparation
- Pouring

However, early removal of formwork for wall is possible with proper design of concrete mix, accelerated warm curing and using suitable chemical admixture.

The implementation of 24 Hour Cycle will be in accordance with IS 456:2000 – Code of practice for plain and reinforced concrete. However, the structural engineer will furnish details about the actual process of removal of formwork after casting of concrete.

26.47.9.2 Handling, Storage & Assembly of tunnel form work

Upon its arrival at site, the equipment will be loaded, stored and assembled as follows:

i) The vertical panels will be set on the ground on timbers in the order of the packages. When there is enough room, all the equipment will be spread out (speeds up greatly the assembly).

ii) Sufficient equipment will be supplied to the panels (positioning lugs, inclined hinged struts, triangulation) and their fixing will begin.

iii) At about the same time, the horizontal panels will be supplied sufficiently at the position of the vertical panels and assembled.

iv) The half tunnels shall will be brought together and assembled. Either the assembly will be permanent and the half tunnels are bolted together and some alignment fish plates are added in the profiles or the assembly is temporary and swelling ties are set in place and tightened.

v) The lifting beam will be supplied and bolted in place.

vi) The tunnel packages will be set vertical using a crane and the special assembly lifting rings. The lifting triangles shall not be used to set right the tunnel forms.

vii) The equipment for the hand rails will be set in place.

viii) Once the assembly is complete and if time allows, a pre-assembly can be accomplished to check everything. This will save time during first cycle.

26.47.9.3 Kickers (Curbs)

The kickers are short concrete walls, usually built at the same time as the slabs on which they lie, at the location of the future real-size walls

26.47.9.3.1 Roles of the Kickers

The tunnel methodology relies on the use of the kickers. The kickers have several roles:

i) Kickers to guide the positioning of the forms.

After the floor is cleared, the forms are brought in with the crane and pushed against the kickers using crow bars. Later on the bolting of the ties between the forms will ensure that they are properly set against the kickers.

ii) Kickers to facilitate the stripping of the forms.

At the time of pouring, the bottom of the vertical panel of the tunnel form is located a few centimeters above the slab level (typically 6 cm = 2.5 cm from bottom of form to bottom of wheel + 3.5 cm for the stripping of the form and lack of flatness of the slab). This allows lowering of the form in order to strip it.

In general, the kickers are 8 cm high. However, it is sometimes useful to make them higher, e.g. when the ceiling in the building to be built is slightly higher than the one in the previous building (reuse of same tunnel forms with taller kickers).

iii) Kickers to provide a support on which to draw the level.

The kickers provide a support on which the level can be drawn. The line facilitates the adjustment of the forms; the bottom of the tunnel is simply set flush with that line by using the jacks. The line drawn on the kickers corresponds to the height of the ceiling minus the height of the vertical panel (excluding wheels and jacks)

The level of the line on the kicker should not be directly measured from the slab (as the slab is not always very smooth) but rather materialized using a point of reference.

26.47.9.3.2 Making of the Kickers

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The kickers are usually cast along with the slab, using kicker forms, concrete crosses and some clamps. The kickers need to be vibrated and troweled flat and flush with the kicker forms to get a nice finishing with the tunnel forms. The concrete crosses are set in place along with the reinforcements. Then, once all the reinforcements are finished, the kicker forms are installed and held using the clamps.

The concrete crosses are positioned above the walls that are being cast, in between the forms, to hold the kicker forms (when the location of the walls at the same floor to the next). There are two types of concrete crosses, some with four branches and some with three according to its used in a middle wall or at the end of the slab. As the concrete crosses define the thickness of the walls and of the slab, it is sometimes necessary to make crosses with branches of different sizes when the walls superimposed and /or the slab have different thicknesses for instance.

i) **Number of concrete crosses**

The number of concrete crosses is so chosen that the kicker forms are stable. Typically – one cross for every 3.5m of kicker form and three crosses for an angle.

ii) **Making of the concrete crosses**

The concrete crosses are made using a mould and are casted every day. Both types of crosses (3 & 4 branches) are made using the same mould, by adding a piece of form inside the mould. The mould for the concrete crosses is scraped and oiled. The mould is closed (casting position).

26.47.9.3.3 Foundation Kickers

i. **With concrete crosses**

When the foundation slab is cast in place, the foundation kickers are made in a similar manner as those for the floors above, using concrete crosses (held by small concrete sumps cast beforehand).

ii. **Without concrete crosses**

However, if the foundation technique does not allow the use of concrete crosses, the kickers can be set on the slab without using crosses.

iii. **Rule of 3-4-5 to position accurately the kickers**

When the main axis of the construction has been materialized, the perpendicular axis can be drawn using the 3-4-5 rule:

1. Draw the main axis along with the position of the perpendicular axis (point A)
2. From A, materialize 4m along the main axis (point B)
3. Find point C which is 3m away from A and 5m away from B. AC gives the perpendicular.

26.47.10 Hanging of the Forms to the Crane

26.47.10.1 The Asymmetrical Triangle

The asymmetrical lifting triangle is designed to move packages of tunnel forms. It is linked to the tunnel forms via two steel rods – a main one, the lifting bolt which is bolted underneath the horizontal panel on the lifting beam and another smaller steel rod (a few centimeters only) that fits in a hole on the horizontal panel that blocks the rotation of the triangle on the form.

The lifting triangle is designed so that it can be set in place with the center of the gravity of the tunnel still inside the building. The stripping platforms are not designed to take the total load of a tunnel longer than 2.50m. Once the lifting bolt is has been unscrewed from the half-tunnel form, it has to be held up using the hook fixed on the frame of the lifting triangle, to avoid bending it, or damaging the tunnel roof. A welded ring will be added to the triangle that allows to handle it with its base horizontal (easier to set on the form). The welded ring cannot take the load of a tunnel form.

The asymmetrical triangle is used:

1. With stripping platform
2. Without stripping platform, for buildings up to 3 storey high without staggers between spans, and with tunnel form packages longer than
3. 2.50m. When the length of the package is too small (1.25m), the lifting triangle can no longer be used. Some lifting hooks are then incorporated to the package so that it can be lifted with chains.
4. For packages of 2.50m, an additional wedge is added to the lifting triangle.

26.47.10.2 Movement of Forms

The forms can be lifted by the crane with some cable or chains. The greater the angle of the chains, the bigger the load in the chains and in the lifting rings. The angle made by the chains

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should never be more than 60°.

26.47.10.3 **Initial Striking Operation**

- The kickers are stripped
- The opposite slab stop-end is removed and fixed to the other side
- The roof locks are operated
- The ties are removed
- The jacks are raised until the half-tunnel rests on its wheels

26.47.10.4 **Setting in Place**

- The level of the bottom of the vertical panel of half-tunnel is drawn on the kickers;
- The half-tunnel is pushed out through the façade;
- The form is scraped and oiled;
- The lifting triangle is bolted;
- The half-tunnel is completely pulled out;
- The slab that was stripped is propped;
- The tunnel form is set down on the last jacks on the slab;
- The bottom of the vertical panel is set flush with the line drawn on the kicker;
- The other jacks are lowered to the slab;
- The verticality of half-tunnel is adjusted by turning the triangulation jack bolt. The reference will be taken by a plumb line on magnetic support.
- The second half-tunnel is pushed out and the lifting triangle bolted;
- The second half-tunnel is brought in front of the first one;
- As it was done for the first tunnel form, the triangulation wheels are lowered along with the extreme jacks;
- The tunnel form is set on the slab, the bottom of the vertical panel is set flush with the line drawn on the kicker and the other jacks are lowered;
- The verticality of half-tunnel is set using the triangulation jack;
- The horizontal panel of the first half-tunnel provides an easy mean of checking the verticality of the second half form;
- The roof locks between the forms are bolted;
- The tunnel form is brought above its position;
- While the tunnel form is still in the air, the triangulation wheels are lowered;
- The jacks at the extremities of the tunnel form and that will rest on the slab are lowered;
- The tunnel form is lowered on the jacks and the lifting triangle is unbolted;
- The electricity conduits & fixtures is integrated in to the walls;
- The wire mesh is prepared for the ties and plastic cones;
- The ties are inserted partly into the tie-holes;;
- The plastic cones are installed on the ties and the tips of the ties are set flush with the ends of the cones;
- The door block outs and wall stop ends are set in place;
- The door block out and wall stop end are leveled using the plumb line;
- The ties are completely tightened and the triangulation wheels are raised;
- The concreting starts with the inside walls and the external walls are then poured;
- Finally, the slab is poured with the kickers, starting from the cold joint;
- The slab is surfaced with a straight edge sliding on the kicker forms;
- The tunnel form is lowered through the gap;
- The bottom of the vertical panel is set flush with the line drawn on the kicker using the jacks;
- The verticality of half-tunnel is set using the triangulation wheel
- The roof locks are bolted.
- The ties are pushed completely through the tunnel forms and loosely bolted on the other side;

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- The slab is scraped and oiled;
- The slab stop ends are set in place;
- The wall form is hung to the crane and stripped;
- The wall form is scraped and oiled;
- The wall form is set in place;
- The jacks are lowered, thus pushing the wall form against the half- tunnel and the form is unhooked;
- The concrete crosses are set in place at the location of the walls;
- The kicker forms are installed on the concrete crosses.

26.47.10.5 Propping

26.47.10.5.1 Propping of the Slabs

When using tunnel forms in a 24 Hour cycle, the concrete has little time to dry, even though the setting of concrete is accelerated. Thus it is necessary to get some props in place as soon as the first tunnel is removed to prevent deflection. The position and number of props is governed by

- The concrete strength
- The architecture of the structure
- The loads applied on the structure

Typically, one prop every 1m of tunnel is sufficient for a regular width.

26.47.10.5.2 Propping methodology:

- The first half-tunnel is stripped;
- The slab is propped while the second half-tunnel is in place;
- The second half-tunnel is stripped once the slab is propped.

The props stay in place for several days. It is good practice to leave the props in place two floors below the one where the forms are set so that the concrete reaches a sufficient strength.
However, it would be necessary to place proper props, typically one prop at every 1 m for regular width may be sufficient. It would be necessary to leave the props in place for several days before the concrete gained required strength.

26.47.10.6 Transmission of the load by the half-tunnel forms

Once the roof locks are bolted, most of the load is transmitted through the jacks close to the tunnel wall. Raising the triangulation wheels insure that no load at all is exerted on the middle of the slab; all the load is directly transmitted to the walls below.
Since all the weights are concentrated on the jacks, it should be checked before pouring that those jacks have been lowered to the ground.

i) The triangulation wheels must be raised before pouring.
ii) The jacks close to the tunnel wall must be lowered.

26.47.11 Ties

The forms are held together using ties. There are two types of ties:

a. Standard ties
b. Conical ties

The ties are designed to take the force resulting from the pressure of the concrete on the forms, via the horizontal beams. The number of ties depends on the length of the form. There are two ties on the height of the tunnel form.

c. Insertion of tie.

26.47.11.1 Standard ties

i) Bolt that does not turn while tightening the tie (square end that goes inside the beam and prevents rotation).
ii) Bolt that is turned to tighten the tie (round end that turns inside the beam and allows tightening).
Plastic cones are used to protect the standard ties in order to strip them. These cones are also used to set the thickness of the walls. They are put in advance on the ties that are partially inserted in the forms. The tip of the tie is then set flush with the end of the cone.
iii) Standard tie partially inserted
iv) Plastic cone flush with tie

Different methods used for removal of plastic cones are:

v) Removal using a hammer
vi) Cone extractor with a mace

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vii) Cone extractor '"corkscrew"

26.47.11.2 Conical ties

The conical ties are only threaded close to the tip. The rest of the tie is smooth and conical so that it can be stripped. This removes the need for plastic cones. Further more, the conical tie is tightened in one operation. The thickness of the wall is set by the length of the tie once it is completely tightened.

The conical tie is used along with two plates that are bolted to the forms:

- A plate with nut
- A plate without nut

The plate without nut is bolted on the side where the tie is inserted and the plate with nut on the other side, where the threaded part enters the nut. Both plates are bolted to the forms from the start.

26.47.11.3 Concrete cones

Both types of ties leave some holes in the walls (small ones with the conical ties and bigger ones with the plastic cones of the standard ties. These holes are to filled using concrete cones once the forms are stripped:

1. Concrete cones for conical and standard ties
2. Mold to cast the concrete cones on site (at least one pour one day)

26.47.11.4 Installation process

The hole must be cleaned with no trace of grease.

a) Dampen the hole and the concrete cone especially in hot and dry weather;
b) Make a plastic mortar- excess water damages the quality of the setting mortar;
c) Bard the concrete cone and hole with setting mortar or resin;
d) Insert the barded concrete cone in the hole with a rotating movement;
e) Position the concrete cone by tapping lightly on the large end;
f) Carry out the surface fitting with mortar or resin.

26.47.12 Protection Platforms

26.47.12.1 There are four main types of platforms:

i) Stripping platforms

The stripping platforms are used as protections for the open façade through which the forms are stripped. The stripping platforms artificially extend the slab in front of the tunnel forms. They provide the necessary safety for the workers around the forms especially during the stripping.

The stripping or dismantling platform is slightly inclined backward when moved with the crane. This is to facilitate its setting in place.

Once the platform is in place, the side jacks are unscrewed in order to prevent the platform from moving sideways. Further more, the platform should be properly set in place using wooden wedges at the top and bottom, and should be secured at its bottom using either a supplied steel chain with a plate that is fixed to a tie hole or using a prop.

ii) Gable wall scaffolds

The Gable wall scaffolds are used to support the gable wall forms. They are fixed on gable shoes. Some holes are left in the upper part of gable walls for the gable walls of the next level. Once the scaffolds and the shoes have been removed, the holes are filled with concrete cones.

a) Every time part of a level is finished in concrete, the gable wall scaffolds are removed to the next level.
b) The gable shoes are sometimes located above or besides an opening in the façade. When this is the case, the lintel should be properly reinforced and minimum distances should be followed.
c) There is at least one shoe per steel frame located within 41 cm left or right of the frame axis. The forbidden zone should be marked with paint.
d) When possible, the holes for the ties are also used to fix the gable shoes. To do so, the distance x from the hole axis to the top of the slab above should be comprised between 35 & 55 cm.

iii) Circulation platforms

When there is no wall to be cast and it is still necessary to have access, a circulation platform can be set in place. There are basically two types of such platforms:

a. Horse-head platforms that are attached to the edge of the slab;.
b. V shaped platforms that transmit the loads to the slab below via inclined struts.

iv) Platforms on slab openings

It is often necessary to often fill holes in the slab to enable people to work on it. A special platform can be

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set in place for that purpose.

a. Platform held by steel U profiles resting on steel rods going through the walls;
b. Platform held by steel Z profiles resting on the slab.

The platforms made of steel frames are supplied to the site.

26.47.12.2 Concreting

26.47.12.2.1 Stopping of the Concrete (Slab and Wall stop-ends, Cold-joint)

The concrete is stopped by using slab stop-ends on the horizontal panels and wall stop-ends on the vertical panels. However, it often happens that the whole slab cannot be cast the same day. In this case, temporary stop- ends have to be installed, allowing the reinforcement steel to pass.

i) Slab stop-ends

The slab stop-ends are used to stop the concrete at the perimeter of the slabs. These are generally bolted to the forms but they can also be held in place using magnets. Many shapes can be designed for balconies, for instance.

ii) Wall stop-ends

The wall stop-ends are bolted to the form and are used to stop the concrete at the extremities of the walls. These can be linked to narrow horizontal strips in order to make full height openings.

iii) Cold-joint

A large floor is typically divided into several phases and the same equipment is re-used for each phase. In order to do so, the half-tunnel form location at the intersection of the phases stays in place during the concrete pour, creating a cold-joint. One-fifth of the span is poured during the first phase and the remaining four-fifth phases are poured subsequently.

26.47.13 Windows and Doors Box-outs

26.47.13.1 Window box-out

The setting in place of a window box-out using magnets can be decomposed as follows:

a. The position of the box-out is drawn on the form, the wire mesh to be cut before hand
b. Some magnets are set on the lintel line minus the thickness of the box-out
c. The box-out is assembled on the ground and positioned on the lintel Magnets
d. Some magnets are set on the side to prevent it from moving side ways
e. The magnets are bolted (or nailed) to the box-out.

26.47.13.2 Door box-out

The setting in place of a door box-out using magnets can be decomposed as follows:

a) The position of the box-out will be drawn on the form, the wire mesh will be cut before hand.
b) The box-out will be assembled on the ground and the magnets will be bolted (or nailed) to it, with the Magnets handles raised so that the magnet does not adhere to the form.
c) The box-out is raised against the form and leveled using the bottom jack.
d) Once the box-out is in place, the magnets handles are lowered.

26.47.13.3 Order of Pouring

The concrete will be poured so as to stabilize the tunnels. Typically, the internal walls will be first poured (walls with half-tunnel forms on both sides), then the external walls and finally the slab and kickers. The gable wall will not be poured first.

These operations shall be repeated for each row of tunnel form.

When pouring the walls it is good practice to stop the concrete slightly before reaching the level of the slab. This leads to a better finishing of the slab, especially if the concrete sets rapidly.

26.47.14 ANTI-CORROSION PROTECTION

The wall forms will be protected via an anti-corrosion procedure, except for the form faces. The same applies to the gripping mechanisms. All the mechanical, adjusting, maintenance and other mechanisms will be lubricated.

26.47.15 HEALTH AND SAFETY

The Formwork System manufacturer's relevant manuals and instructions will be consulted for guidance for health and safety requirements such as personal protective clothing, protective glasses etc.

26.47.16 CHOOSING SIZE AND THICKNESS

Appropriate size and thickness of the formwork panels will be chosen to suit the structural, fire, acoustic and thermal requirements of the structure.

26.47.17 SERVICES TO BE PROVIDED BY THE TUNNEL FORM MANUFACTURER / CONTRACTOR TO THE DEPARTEMENT.

26.47.18 MANUALS

26.47.18.1 (a) Operating Manual

An operating manual will be included with each delivery of the material. The manual shall give the following information to the user:

- The nomenclature of the parts, accessories and their weights;
- The rules for assembling of the individual parts or for deploying the wall forms and lifting of The wall forms;
- All the possibilities of the inter-assembly of the wall forms; wall forms with additional Components and the corresponding weights;
- The handling, storage and transportation instructions;
- The operating modes for stabilization and use, the corresponding weights and the values of the stress to be exerted on the anchoring points of the stabilizing systems (fixation on the slabs);
- The recommendations for maintenance;
- The limits of use, specially the permissible pressure of concrete;
- The measures to be taken to ensure safety for wind speeds

26.47.18.1 (b) Other Manuals

All the manuals relating to quality of Wall form, Maintenance and Repair, Health and Safety etc. will be provided for each project incorporating the Tunnel Formwork System by the service provider.

26.47.18.2 DATA SHEET

The wall forms shall be delivered with a data sheet providing information, which should allow the user to handle and stabilize them in proper conditions, and a summary of the essential operations taken from the operating manual.

26.47.18.3 RESPONSIBILITY

- Specific structural design using the Tunnel Formwork System is the responsibility of the designer with the instructions, supervision and guidance of the recommended /chosen Tunnel Formwork manufacturer.
- Quality of installation of the system on site is the responsibility of the trade persons engaged by the agency, duly trained and certified by the tunnel form manufacturer.

26.47.19 QUALITY ASSURANCE PLAN FOR TUNNEL FORMWORK

The quality assurance plan for Tunnel Formwork system to be followed is elaborated in the table given at Annexure-A.

26.47.20 MEASUREMENTS

26.47.20.1 The total contact surface area post stripping of Formwork will be measured up two decimal points. This includes the entire wall area on both external/internal faces as well as slab soffits (bottom of slabs) area. The area of openings less than 0.60 sqm shall not be deducted. The area of door & window Jambs / sills /lintel soffits are not to be measured. However, areas larger than 0.60 sqm shall deducted on either side of the wall face and in such case jambs/ sills/lintel soffits would be measured.

26.47.21 RATES

The rate of the tunnel formwork includes the cost of labour and materials required for all the operations described above.

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QUALITY ASSURANCE PLAN FOR TUNNEL FORMWORK

S.No.	Parameters to Be inspected	Requirement Specified	Test Method	Frequency of Testing
1	**Raw Material– L-profile & L-angle**			
1.1	Visual	Shall be free from any surface defects	Visual check	For Each Lot
1.2	Dimensions	Shall be as per drawings	Measuring tape/ Vernier caliper	For Each lot
2	**Raw Material –M.S. Angle, Steel Tubes, Round tubes, flats etc.**			
2.1	Visual	Shall be free from any surface defects	Visual	For Each Lot
2.2	Dimension	Shall be as per drawings	Measuring tape/ Vernier caliper	For each Lot
3	**Raw Material–Steel Sections**			
3.1	Visual	Shall be free from any surface defects	Visual check	For Each Lot
3.2	Dimension	Shall be as per general notes for Tolerances given In drawings	Measuring tape/ Vernier caliper	For Each lot
4	**Raw Material – Cold rolled U - Sections**			
4.1	Visual	Shall be free from any surface defects	Visual	For Each Lot
4.2	Dimensions	Shall be as per drawings	Measuring tape/ Vernier caliper	For Each Lot
5	**Raw Material–Hot Dip Galvanized steel sheet**			
5.1	Visual	Shall be free from any surface defects	Visual	For each Lot
5.2	Dimensions	Shall be as per drawings	Measuring tape/ Vernier caliper	For Each Lot
5.3	Hot Dip Galvanizing	Coating shall not be less than 85 micron	Shall conform to relevant Indian Standards	Sample check For each (supplier)
5.4	Adhesion of Galvanized Coating	Shall not peel any portion of the coating in Knife Test	Shall conform to relevant Indian Standards	For Each lot
5.5	Fitments	Nut shall fit easily on bolt threads without being too loose and washer shall pass the bolt with proper fitments	Shall conform to relevant Indian Standards	For Each lot
6	**Steel fabrication**			
6.1	Visual	i) Shall be free from any surface defects ii) All the items shall be straight & grind finished iii) Holes shall be of exact shape & free from blurs & burrs	Visual	For Each Lot
6.2	Dimensions	As per general Tolerances given in the drawings	Measuring tape/ Vernier caliper	For Each Lot
6.3	Hole Orientation	As per general Tolerances Given in the drawings	Shall conform to the drawings	For Each Lot

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6.4	Diagonal	As per general Tolerances given in the drawings	Shall conform to the drawings	For Each Lot
6.5	Welding	All the steel shall be properly welded	Shall conform to relevant Indian Standards	For Each Lot
7	**Assembly Work**			
7.1	Visual	i) Shall be free from any surface defects ii) All the fabricated items shall be smooth, straight & grind finished iii) Holes shall be of exact shape & free from blurs & burrs. iv) Riveting in all the items shall be of exact punch	Visual	For Each Lot
7.2	Dimensions	As per general Tolerances given in the drawings	Shall conform to the drawings	For Each Lot
7.3	Hole Orientation	As per general Tolerances given in the drawings	Shall conform to the drawings	For Each Lot
7.4	Diagonal	As per general Tolerances given in the drawings	Shall conform to the drawings	For Each Lot
8.	**Paintwork**			
8.1	Visual	i) Shall be free from any surface defects ii) Polyester surface coating with thickness from 60 to 300 micron iii) Liquid painting rework for all area with lack of protection	Visual	For Each Lot

यह सक्षम अधिकारी के अनुमोदन से जारी किया जाता है।

(एस एन जायसवाल)
कार्यपालक अभियंता (टास– I)
सी.एस.क्यू. के.लो.नि.वि. नईदिल्ली

फाईल सं0 136/अधीअभि. (टास)/विर्निदेश/2022/267 - हि. दिनांक 30/06/2022

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