BHILAI STEEL PLANT

AUGMENTATION OF FUEL & FLUX CRUSHING FACILITIES
(PACKAGE NO. 064)
AT BHILAI, CHHATISGARH

DESIGN CRITERIA
FOR
STEEL STRUCTURAL WORKS

APPROVED

Signature & Stamp

1. Drawing approved for its general conformity with contract drawing and specifications.

2. This approval does not absolve the contractor of his responsibility for adequacy and completeness of design, suitability of materials, correctness of BOQ, fulfilment of parts/plant/equipment offered and performance guarantees and other obligations as per contract.

MECON LIMITED

CONSULTANT

MECON LTD

CONTRACTOR

ENGINEERING PROJECTS (INDIA) LTD.

(A Government of India Enterprise)

PACKAGE DESCRIPTION

AUGMENTATION OF FUEL & FLUX CRUSHING FACILITIES (PACKAGE NO. 064)

DESIGN

SP

DRAWN

SP

CHID

OS

APPROVED

SM

DATE

12-05-2011

SCALE: NTS

EPI DOCUMENT NO. EPI-BSP-064-02-000-00 - BD - 05001

PROJECT DOCUMENT NO.

EPI-BSP-02-064-02-000-40 - BD - 05001

NO OF SHEETS 18

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1. PROJECT INFORMATION

- Owner: BHILAI STEEL PLANT
  Steel Authority Of India Ltd (SAIL)

- Consultants: MECON LIMITED, RANCHI

- Project Title: Augmentation of Fuel & Flux Facilities (PKG-064) of Bhilai Steel Plant

- Location: Bhilai, District- Chhatisgarh.

- Ambient Temperature: 48°C (Maximum)
  9°C (Minimum)

- Relative Humidity: 25% to 100%

- Rainfall: 1288.8 mm (Average Annual)
  15.43 mm/hr (Design rainfall intensity)

- Wind data: Basic wind speed 39 m/s

- Seismic Zone: Zone II as per IS:1893 (Part-1) : 2002

- Plant Levels: Approx. 303 m above MSL (Finished grade level)

2. SCOPE OF WORK

A. COAL HANDLING PLANT:-

- RCC mixing bins (Silos), 5 Nos. each of 500t storage capacity in 3rd row.

- Additional reversible hammer mills, 2 Nos. each of capacity 350t/h in existing row of hammer mills after extending the existing crushing station.

- Up rating & modification of existing collecting conveyors Y7-12 & Y7-13 to 1000t/hr. capacity in the existing location with minimum shutdown.

- Connecting conveyor stream, connecting new coal tower no. 7 with existing Coal Handling Plant.

- Connecting conveyors for new silos & new crushers to the existing Coal Handling Plant.
B. COKE SORTING PLANT:-

- Coke crushing station
- Coke screening station
- Coke breeze bunkers
- Emergency coke storage yard
- Coke dedusting unit
- Junction houses
- Travelling tripper gallery
- Galleries and associated mechanical, civil, structural, electrical works of COBP# 11

C. AUGMENTATION IN FLUX- FUEL PREPARATION AND PLANT RETURN FINES HANDLING FOR SP III FACILITIES:-

- Connecting existing Blast furnace return fines C-line conveyor with new BF#8 return fines conveyor.
- Up gradation / Addition of coke crushing and screening and grinding facilities.
- Up gradation/ Addition of Flux crushing & screening facilities.
- Dismantling of C-line conveyors & Junction houses (including foundation of Junction houses & trestle of conveyors with an undulation of about +500mm) & Re-routing of existing sinter fines conveyors (C-lines)

3. STRUCTURAL WORK

3.1 Codes and Standards

The work shall be carried out as per the following standards but need not be limited to the same. Other standards, if relevant, shall also be followed.

3.1.1 Loads

IS 875 (Part II & III, 1987) : Code of Practice for design live & wind loads (other than earthquake) for buildings and structure

IS 1893 (part-I, 2002) & part-IV, 2005 and IS-1024-1979 : Criteria for earthquake resistant design of structure

Importance factor mentioned in the latest code.
3.1.2 Structural Steel

IS:412 : Expanded Metal Steel Sheet for General Purpose
IS : 800 : Code of Practice for General construction in steel
IS: 806 : Use of steel tubes for general building construction.
IS: 808 : Dimensions for hot rolled steel beam, column channel and angle sections
IS: 813 : Scheme of symbols for welding
IS: 816 : Code of Practice for use of metal arc welding for general construction in mild steel
IS:1038 : Steel doors, windows and ventilators
IS:1079 : Hot rolled carbon steel sheet and strip
IS:1363 (part 1-6) : Black hexagonal bolts, nuts and lock nuts (6 mm to 39 mm dia)
IS:1367 (part 1-20) : Technical supply conditions of threaded fastners
IS : 9595 : Recommendation for metal arc welding of carbon and carbon manganese steel
IS : 3502 : Specification for steel chequered plates
IS : 2062 : Structural steel (fusion welding quantity)
IS:2016 : Plain washer
IS: 8500 : For high tensile steel materials
IS: 1079 : Steel sheets
IS: 3443 : Rails
IS:12886-1986 : ERP Sheets
IS:11592:2000 : FOR CONVEYOR GALLERIES - STRUCTURAL DESIGN.
IS: 6610, 3063, 3548, 3757, 5369, 5372, 5374: Washers,
IS:6623, IS:6649 : Nuts & washers
3.1.3 Handbook and Special Publications

SP:6 (Part 1) : Handbook for Structural Engineering- Structural Steel Section
SP:6 (Part 2) : Handbook for Structural Engineering- Steel Beams and Plate Girders
SP:6 (Part 3) : Handbook for Structural Engineering- Steel Columns & Struts
SP:6 (Part 4) : Handbook for Structural Engineering- Use of High Strength Friction Grip Bolts
SP:6 (Part 5) : Handbook for Structural Engineering- Cold formed light gauge steel structure
SP:6 (Part 7) : Handbook for Structural Engineering- Simple welded girders
SP-7 : National Building Code of India
SP-22 : Explanatory handbook on codes for earthquake engineering
SP-32 : Handbook on functional requirements of industrial buildings (Lighting and Ventilation)
IPSS : 2-03-001-81 Design parameters for galleries and tunnels for belt conveyor in steel plants.

3.1.4 Design Criteria for Buildings

3.1.4.1 Loads

Design loads shall comply with the requirements of IS: 875 & IS: 1893 (relevant parts), as a minimum, unless more stringent requirements are specified herein. The following types of loads shall be considered in general for the analysis and design of structures and foundations.

3.1.4.2 Dead Loads (DL)

Dead loads shall include the weight of all structural/ architectural components, equipment of a permanent or semi-permanent nature including tanks, wall panels, partitions, roofing, piping, drains, electrical trays, bus-ducts etc. Self-weight of materials may be calculated on the basis of unit weights given in IS: 875 (Part-1).

3.1.4.3 Live Loads (LL)

Live loads shall consist of uniform live loads. Uniform live loads are unit loads, which are sufficient to provide for movable and transitory loads, such as the weight of people, portable equipment and tools, equipment, or parts, which may be moved over or placed on floors
during maintenance operations. These uniform live loads shall not be considered on floor area, which are permanently covered with equipment.

Plant loads shall be obtained from the manufacturer and due allowance shall be made for any dynamic or impact effects. Foundations and fixing arrangements for items of equipment, which generates vibration, shall be designed to prevent transfer of such vibrations to the adjoining structures.

Equipment live loads are calculated loads based upon the actual weight and size of the equipment and parts to be placed on floors during dismantling and maintenance or to be temporarily placed on or moved over floors during installation. Floors and supporting members, which are subject to heavy equipment loads shall be designed on the basis of the weight of the equipment, in addition to a uniform load of 5.0 KN/sq.m or specifically defined live loads whichever is greater. Each member in the floor which carry these loads shall be designed for the heaviest piece or pieces of equipment arranged in the most critical position. For loads caused by moving equipment over the floor for installation, consideration shall be given to the propping of beams and floor, from floors below.

100% of roof live load shall be considered in columns. In case floor live load is greater than 5 KN/sq.m, columns shall be designed with reduced live load from floor as per Cl. 3.3 of IS: 875 (Part 2). In case floor live load is 5 KN/sq.m or less than that, there will be no reduction in live load from floors to the columns. In any case total live load reduction from all floors for a member shall not exceed 20% of total live load irrespective of codal provision.

The live loads on floor shall be taken as per IS: 875 (Part-2) but in no case less than the following:

A) All Buildings and structures (Unless noted otherwise):

- Roof (accessible) : 1.50 KN/m² + hung load, if any
- Roof (inaccessible) : 0.75 KN/m² + hung load, if any
- Staircase and treads : 4 KN/m² data
- Walkways and Platforms : 2KN/m²
- Maintenance platforms including crane level walkway : 4 KN/ m²
- Monorail walkways : 4 KN/ m²
- Handrails (Horizontal) : 0.75KN/m run
- Ladder at middle of rung : 0.9 KNata
- Dust load (for buildings and structures Located in dusty zone) :0.5 KN/ m²

B) Conveyor Gallery :shall be

Material load; The material load per running motion shall be as per mechanical load data drawing, In the absence of mechanical load data the same shall be calculated by the formula.
Wt of material/m run in kN=Axpx1.2

A=Area of cross section of load stream compared to IS: 4776-1976
P=Bulk density of material carried in kN/m3
Non-uniformity factor=1.2

i) Walkway/Supporting beams for floor : 4.0 KN/m²
ii) Under the conveyor belt : 0.75 KN/m²
iii) Gallery Girder, for floor load of : 3.0 KN/m²
iv) Dust Load : 0.5 KN/m² (Up to a distance of 300 m from dust producing area)
    : 0.25 KN/m² (At a distance between 300m and 800 m from dust producing area)

C) Junction House :
   i) Live load on floor : 4KN/m²
   ii) Tension from conveyor belt
   iii) Load due to equipment located on floor
   iv) Load due to jamming of chutes
   v) Erection loads anywhere on the floor

3.1.4.4 Crane Loads

The frames shall be analyzed for the maximum wheel loads when the lifted weight is nearest to 'LEFT' row in one case and 'RIGHT' row in another load case. The impact factor for vertical load will be 25% for crane girder and 10% for columns/foundations as per provision of IS: 875 (Part 2) and lateral crane surge of 10% of maximum lifted weight and trolley weight will be considered in the analysis of the frame. The longitudinal surge shall be 5% of the static wheel load. Applied at the top of rail in longitudinal direction.

3.1.4.5 Wind Loads (WL)

Wind loading shall be in accordance with Indian Standard Code IS: 875(Part-3) for a basic wind speed of 39 m/sec.

The building classification shall be with risk co-efficient k1 of 1.0 and topography factor k2 of 1.05 and terrain category-2.

3.1.4.6 Seismic Loads (SL)

The lateral forces will be established in accordance with the recommendations of IS-1893. The site falls in Zone-II, as identified in the map of IS 1893 (Part-1):2002. Importance factor (I) shall be taken as 1.5 (Table 2 of IS 1893 (Part-4):2002). Under earthquake condition, the whole frame except roof shall be assumed loaded with 50% design live load. No further
reduction in column live loads shall be considered. Response spectrum method will be used for analysis.

3.1.4.7 Impact Allowance for elevators and hoists

Impact factor:

a) Elevators - 100% of Lifted Load
b) Monorails

Material Loads at Supports

1. Impact factor of 10% of lifted load of hoist for manual operated for Monorail.
2. Impact factor of 25% of lifted load of hoist for Electrically operated for Monorail

3.1.4.8 Equipment loads (EL)

Major equipment loads specifically obtained from manufacturers shall be considered in design in addition to live load.

3.1.4.9 Temperature Loads / Expansion joint.

Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns. The maximum distance of the expansion joint will be as per provisions of IS: 800 for steel structures.

3.1.4.10 Dynamic Loads

Structures shall be designed to withstand the effects of vibration and impact to which it may be subjected. Each structure and foundation supporting a compressor if any, pump or other machinery having significant dynamic imbalance shall be designed to resist the peak loads specified by the manufacturer. Vibration amplitudes of the supporting structure or foundation shall be kept within acceptable limits for dynamic forces that occur during normal machine operation. In the case of a tall and slender structure, the dynamic effects due to wind gusts, shall be investigated if required.

3.1.5 Load Combinations

3.1.5.1 For Steel Structures:

i) DL + LL
ii) DL + LL + CLA + DLC + CS
iii) DL + LL + CLB + DLC + CS
iv) DL + 0.5 LL + K1(DLC) + (CLA) ± SL
Nomenclature

DL : Dead load (comprising dead weight of structural members, side cladding including equipment loads.)

LL : Live load (i.e. imposed load) Consisting of material load, live load on floors and roof and equipment load.

CLA' : Crane trolley + lifted weight nearest to 'LEFT' row column with impact

CL'B' : Crane trolley + lifted weight nearest to 'RIGHT' row column with impact

SL : Seismic load

WL1 : Wind load with internal suction as per IS:875 Part-3

WL2 : Wind load with internal pressure as per IS:875 Part-3

DLC : Dead load of Crane Bridge with impact

K1(DLC) : Dead load of Crane Bridge without impact

CS : Crane surge

Notes:

1. Equipment loads shall not be considered as a part of DL for checking the stability of the structure.

2. Under seismic condition live loads are reduced by factor 0.5.

3. Weight of equipment, ducts, tanks, pipes, conduits etc. supported by structure shall be considered for maximum possible loading, i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.
4. Wind load and Seismic load shall not be assumed to act simultaneously. The effect of both the forces shall be considered separately.

5. “Lifted load“ of crane shall not be considered in seismic condition.

6. In case two cranes are provided and tandem operation is envisaged for some bays, then the load shall be taken for both the cranes fully loaded and standing side by side for these bays. For other bays, load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane.

3.1.6 Methodology of Analysis

Analysis of building / structure shall be carried out by 3D (Space frame method) or by 2D depending on the type of structure and load details.

For analysis of structures, STAAD Pro computer program will be used. For design of various structural elements like, columns, beams, base plate, bracing, connections etc. in-house developed software or STAAD Pro will be used as applicable. Soft copy of STAAD shall be submitted along with design documents.

3.1.7 Design Philosophy

1. Design Concept.
1.1 Conveyor Galleries.

1.1.1 Conveyor Galleries will be designed as a pair of welded latticed girders braced at top and bottom chord levels through bolted/welded connections to transfer the horizontal forces to the end portals.

1.1.2 The end portals will be designed assuming supports as pinned at base. Gallery longitudinal girder will be analyzed for the condition with the end hinged and other end roller on slotted connection. All end portals shall be vertical and bottom beam connection with end portal shall be moment/shear connection.

1.1.3 A two-legged trestle shall be designed as both ends pinned along the conveyor. Bottom chord of gallery shall act as strut to transfer the longitudinal loads to a four-legged trestle (fixed trestle). For forces across the conveyor, the two-legged trestle shall be designed as a frame (either braced/moment resistant).

1.1.4 a) A four-legged trestle shall support two galleries, one from each side as pinned.

b) The four-legged trestle shall be designed as frame for force acting along and across the conveyor direction.

1.1.5 Besides above, the trestle shall be designed for all loads coming from end portals as mentioned in Para 1.1.2 above.

2.1 Live load

2.1.1 For inclined roof of Conveyor Galleries 75 kg./sq.m (with reduction of live load due to inclination of roof as per IS : 875) + 50 kg. per sq.m (dust load) shall be considered (if dust producing unit is within 500m and at a distance of 700m to 800m this dust load can be considered 25 kg/sq.m.

2.1.2 Provision of loading from cable trays, utility pipe line is fire/drinking water hydrowashing (if required) etc. shall be considered and addition of such facilities shall be shown in cross-section.

2.2 The following load combination will be adopted for checking the design:
   a) DL + LL + EL
   b) DL + LL + EL to WL or SL
   c) DL + EL + WL or SL
   d) (0.9 DL) + WL/SL for uplift on foundation bolt

Notation:
DL = Dead Load
LL = Live Load
EL = Equipment Load
WL = Wind Load
SL = Seismic Load

2.3.1 Gallery roof live load will be considered only for checking of purlins. Two-third of the live load on roof shall be considered for design of roof truss and other supporting structures.

2.3.2 For all other design norms, loads, dynamic factor, temp. load etc. not specifically mentioned, IS : 11592 : 2000 shall be followed:

2.3.3 While calculating transverse wind load on gallery Clause 3.2.3. of IS: 875(Part-3) may be referred for obtaining the value of cf.

2.3.4 Longitudinal wind load shall be taken as wind thrust on projected area of roof gallery. This load shall be taken in fixed trestle.

2.3.5 Load due to belt snapping shall be considered along the conveyor and to be taken to foundation at fixed trestles.
2.3.6 Material load carried by conveyor shall be taken at least 1.2 times the actual load.

2.3.7 Frequency of the conveyor gallery to be checked for DL + material load if span exceed 24 M.

2.3.8 If gallery span is more than 30m camber is to be provided for DL + 1/2 L.L.

3.1.8 Steel Structures

   i) Design of steel structures shall be carried out by working stress method as per IS: 800(latest). Structural rolled sections and plates shall have minimum yield strength of 250 MPa.

   ii) An increase of 33.33% in permissible stresses for different members shall be allowed under wind and seismic conditions. 25% increase can be made for bolt and weld design under similar conditions. (where those loads are predominant)

   iii) Design of base plates shall be based on design pressure on foundation which shall not exceed the following:

   Pedestal in concrete grade M25  = 6.25 N/mm²

   iv) The total horizontal shear force at the base of column shall be transferred to the foundations by shear key or shear lug.

   v) Structural Steel shall conform to IS: 2062 Grade-A for rolled steel members and plates up to 20 mm thickness. For plates above 20 mm thickness, steel conforming to IS :2062 Grade-B shall be used. However in crane girder structure, for plates of any thickness, steel conforming to IS: 2062 Grade B shall be used.

   Anchor bolts, for holding down steel structures, shall conform to IS:5624.

   Connection bolts shall conform to IS: 1367. Welding electrodes shall conform to IS: 814.

   Generally 50mm thick concrete grout of mix 1:1:2 (with antishrinkage compound) shall be provided below steel columns.

   vi) Structure supporting Vibratory/reciprocating equipments shall be designed so as to obviate occurrence of resonance. The ratio of applied frequency to natural frequency shall not lie within the range of 0.7 to 1.5.

   vii) All Columns and column bracing members shall be designed for max. Slenderness of 180. Floor bracing member shall be taken for a max. Slenderness of 250.
FEATURES RELATED TO STEEL STRUCTURES:

A) Conveyor gallery girders and supporting trestles

1. End portal of the gallery shall be designed to transfer all vertical and lateral loads to supporting trestles / buildings

2. Load due to cables, light fittings, pipes, temperature effect (if any), wind loads, effect of gravity take up etc., along with other load combinations will be considered.

3. A dynamic factor of 1.3 on the weight of belt & the material being carried will be considered in the design.

4. Analytical check for resonance is to be carried out for the conveyor gallery truss spanning more than 24.0 m.

5. For the galleries, temperature expansion joints shall be introduced at intervals of approximately 150 m to divide galleries into blocks and thereafter expansion joint (gap) shall be provided between 1st block and 2nd block. At expansion joint of gallery structures, conveyor frame structure shall have expansion joint in each block, at least one four legged trestle will be provided for stability of structure in longitudinal direction. Emergency exit and crossover (min. 600 mm walkway widths) to be provided generally at 100 m apart matching with these four legged trestles.

6. For sliding supports either elastomeric or Teflon sheet bearing or roller supports shall be used.

7. For conveyor gallery slope exceeding 10°, steps will be provided. For slopes between 6° & 10°, anti-skid provision shall be provided for RCC floor of Conv. Gallery.

8. Where conveyor gallery trusses are connected to junction towers or other buildings, such connections shall be made so that the gallery trusses are free to move in the longitudinal direction.

9. Clearance of conveyor gallery over the road crossings will be kept 6000 mm minimum (Road surface & lowest point of bridge) or the height needed for the passage of the largest individual component of the plant equipments whichever is larger.

10. Wind loads on trestle shall be computed based on exposed area as per IS: 875 (Part-3). Effect of wind loads acting on 2 legged trestles shall also be considered while designing 4 legged trestles along with all longitudinal forces.

11. Permanently colour coated (non-insulated) metal sheets troughed galvalume (Zinc aluminium alloy coated) not less than 150g/sq m having high tensile steel sheet (fy=550 map) of 0.5m minimum thickness (BMT), the out side face (exposed face) shall be permanently colour coated with PVF 2 paint of min. DFT 20 micron over primer and inner side (internal face) shall be coated with same paint of min DFT 12micron over primer.

12. Every sixth sheet on side walls of the galleries will be 3 MM thick FRP sheet and staggered on the opposite side.

13. Roof slopes of conveyor galleries shall be 1 : 5 (1 vertical, 5 horizontal)
14. Gallery girders near junction house shall preferably be supported on trestle located as close to the junction house as possible, with part of the gallery girder between junction house and trestle cantilevered from the from the trestle.

15. Column base of conveyor gallery trestle shall be encased by concreting of height 800 mm from underside of base plate.

16. Level of underside of base plate of trestles shall be 300 mm above average ground level of surrounding area.

17. Walk-way for conveyor galleries shall be made of R.C.C over structural beams.

B) Junction towers

1. Design shall be carried out for all belts running along with other relevant load combination cases.

2. Chute loads on floors shall be considered as plugged with material for its entire height.

3. Intermediate floors of junction houses and structural buildings shall be of R.C.C (M25) over structural beams. Suitable plan bracings shall be provided 100 mm. below the top of steel to transfer all horizontal loads to braced frames. While transferring the horizontal loads through the braced frames, the stiffness of the frame will be taken into account.

4. Column base of junction house shall be encased by concreting of height 750 mm from FFL.

5. Beams & slab shall be designed separately without taking consideration of Composite action.

C) Buildings

1. Structures will be designed conforming to relevant safety regulations, factory act, etc. as applicable to the project.

2. Gutters shall be of copper bearing steel conforming to Grade “A” as per IS: 2062. Gutters to be provided between 10m to 25m height of eaves level.

3. Down pipes shall be spaced preferably at 24 m centres. The down-pipes shall be connected to the gutter with suitably designed hoppers with grating at sole level of gutter, made of 8 mm dia rounds at 50 mm centres.

4. Cat ladder of 750 mm. width will be provided at the gable end or other suitable location to access the roof.

5. In Crane building, surge platform with walkway & safety handrail (alongside the crane rail) will be provided. Gable walkway of 1000 mm. width & 6 O/P chequered plate platform will be provided at gable ends.

6. The column base will be embedded below the finished floor level to give the floor a clean look. Column base shear will be transferred to the foundation through the shear key/lug.

7. Crane girders will be designed as simply supported (as per IS: 800 – 1984) with surge & auxiliary girders. As mentioned earlier 6 O/P chq. plate walkway & handrail (1000 mm.
high) will be provided.

8. a) All walkways and stairs leading to working platforms shall have 1000 mm width of walkway/flight of stair.

b) All walkways and stairs leading to areas for maintenance purpose or due to restriction of space shall have a minimum width of 800 mm of walkway/flight of stair, unless required otherwise.

9. For floor beams, horizontal bracing will be provided where necessary at a level 100 mm below the top flange of the beams.

10. Hoppers will be designed for their full capacity.

11. All HSFG bolts shall conform to IS: 3757. Assembly of joints using HSFG bolts shall conform to IS: 4000. Nuts and washers for HSFG bolts shall be as per IS: 6623 and IS:6649 respectively.

12. Gallery walkway
   a) single  800 / 1000
   b) Double  800 / 800
   c) Tripple  800 / 1000 / 1000 / 800

4.1 Permissible Deflections

1. The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members dynamic effects shall not be considered. Also, no increase in deflection limits shall be allowed when wind or seismic loads are acting concurrent with normal loading conditions.

2. The deflection of various structural members of the conveyor system, junction towers, etc. will not exceed the following limits:

   Conveyor gallery/bridge (vertical) : Span / 400
   Trestle supporting gallery in the transverse direction : Height / 1000
   The long deflection of fixed trestle : Height / 1000
   Gallery cross beams ( vertical) : Span / 325
   Gallery walkway supports, floor beams( vertical) : Span / 325
   Floor beams of buildings/JH : Span / 325
End portal of conveyer gallery: Height / 325
(transverse deflection)

3. Horizontal deflections:

The permissible horizontal deflections shall be as below, unless specified otherwise:

- Single storey building = Height / 325
- Multistoried building = Floor Height / 325 & Total height / 500
- Crane columns at crane rail level = Height / 2500
  (due to crane surge only)
- Crane girder due to surge force = Span / 2000
  (From one crane only)

4.2 Minimum Thickness of Steel Elements:

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness.

Rollered sections: 6 mm
Gussets: 8 mm
Stiffeners: 8 mm
Base plates: 10 mm
Chequered plates: 6 mm o/p
Grating flats (main members): 5 mm

Min. thickness of structural members other than gratings, wind tie on top of roof sheet & chequered plates directly exposed to weather, and inaccessible for painting and maintenance: 8 mm.

The above min. thickness for rolled beams & channels do not apply to their webs.

4.3 Painting

Painting to the steel structures shall be as indicated below:

i) Primer paint: All Fabricated structures shall receive two coats of a single pack air drying phenolic modified alkyd composition with zinc phosphate as a primer paint conforming generally to IS 2074(40 DFT/Coat minimum)
ii) Finishing paints: Two coats of a single pack air drying high gloss phenolic alkydmodified synthetic enamel paint suitably pigmented (25 microns DFT/Coat min.)

iii) Application of paint shall be by spraying or brushing as per IS: 486-4983 and IS: 487-1985.

iv) Before despatch all steel structures shall receive one coat of primer at shop after fabrication.

v) Unless otherwise specified all structures after erection shall be given one coat of primer and two coat of finishing paint of approved colour and quality. The undercoat shall have different tint to distinguish the same from finishing coat.

4.4 Connections:

Welding shall be used for both shop and field connection. However for field connections, high tensile bolts can also be used. Field bolts, wherever provided, shall be high tensile of 20 mm dia. or of higher diameter and of property class 8.8 (minimum) as per IS: 1367 (latest) for all major connections. All bolts, nuts and washers shall be procured from manufacturers as approved by the Engineer. The bolted joints shall be designed for friction type connection or bearing type connection, as suitable. However, ordinary connections in the field, as in stairs, sheeting runners etc. may be done with M.S. bolts of property class 4.6, unless specified otherwise.

Welding shall be done in accordance with the recommendations of IS: 816 - "Code of Practice for use of metal arc welding for general construction in mild steel" and IS: 9595 - "Recommendation for Metal arc welding of Carbon and Carbon Manganese Steels".

**Following connections shall be provided:**

1. All shop connections shall be welded type.
2. All field connections shall be welded type with erection bolts (MS bolts – property class 4.6).

**Design of Connections:**

i) Fabrication drawings shall be prepared according to the provision of IS:800, IS: 816, IS: 1367 and IS: 9178.

ii) Connection of vertical bracings with connecting members and diagonals truss members shall be designed for full tensile capacity of the bracing.

iii) Shear connections shall be designed for 75% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. Design shear force shall be more than actual shear.

iv) Moment connections between beam and column shall be designed for design moment at beam end section.

v) All butt welds shall be full penetration butt welds.
vi) The connection between top flanges & web of crane girder shall be full penetration butt weld & for bottom flange, connection may be fillet weld.

vii) Connection of base plate & gusset members with the columns shall be done considering that total load gets transferred through weld.

viii) Splicing: All splicing work shall be designed for actual force. Field splicing shall be done with web/ flange cover plates. Shop splicing for all sections shall generally be carried out by full penetration butt welds with no cover plates.

ix) Steelwork, which will be encased in concrete or galvanized, will not be painted.

4.5 Miscellaneous Details

i) Steel gratings shall be welded type. Chequered plates shall conform to IS: 3502 and minimum thickness shall be 6 mm O/P. Staircases inside the buildings shall be provided with chequered plates.

ii) Steel ladder/ staircase shall be provided for all maintenance/ operating platforms, access platforms, walkways, crossovers etc.

iii) Bearing Type Connection – wherever field connection is not welded

a) All removable type connections

b) Connection of ‘Purlins’ to ‘Roof Truss’

iv) M.S. Bolts (Grade C, Property class 4.6) to be used for stairs, sheeting runners etc.

a) Steel gratings shall be welded type. Chequered plates shall conform to IS: 3502 and minimum thickness shall be 6 mm O/P. Staircases inside the buildings shall be provided with chequered plates. Staircases outside the buildings are to be provided with grating on tread and landing platforms.

b) Steel ladder/ staircase shall be provided for all maintenance/ operating platforms, access platforms, walkways, crossovers etc.