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SAFETY CODE FOR ERECTION OF STRUCTURAL STEELWORK

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Indian Standard

SAFETY CODE FOR ERECTION OF STRUCTURAL STEELWORK

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(*Continued on page 2*)

(*Continued from page* 1)

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SAFETY CODE FOR ERECTION OF STRUCTURAL STEELWORK

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 6 February 1974, after the draft finalized by the Structural Engineering Sectional Committee had been approved by the Structural and Metals Division Council and Civil Engineering Division Council.

0.2 Erection of structural steelwork is one of the most hazardous construction operations. For a structure to operate with maximum safety certain fundamental requirements must be recognized and made effective. Everyone involved in the work should be aware that safety drive should be co-operative and continuous in the interest of safety of men, material and the structure as a whole. This standard has been prepared with a view to specifying safety requirements during erection of steel structures.

0.3 In preparing this standard the safety procedures being followed in the field of steel structural erection have been kept in view. Assistance has also been derived from 'Indian Railway Standard specification for erection and riveting of bridge girders, Serial No. B2-63' issued by the Ministry of Railways.

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1. SCOPE

1.1 This standard lays down the safety requirements for erection of structural steelwork.

2. SAFETY ORGANIZATION

2.1 The management of the organization erecting the steelwork should analyze the proposed erection scheme for safety. The idea of safety should be included in the erection scheme right from the planning stage up to the actual execution of the work. Since safety is a part of all operations, the management should emphasize the importance of safety amongst all its staff.

3. SUPERVISION

3.1 The supervisory staff should be well-trained in enforcing safety regulations and be able to distinguish safe and unsafe workmanship.

Newly appointed men should be given an induction course on general safety and then watched for their performance. The safe working methods should be explained and demonstrated.

4. STATUTORY REQUIREMENTS

4.1 Where statutory provisions exist, the same shall be complied with in addition to the provisions contained in this code.

5. SAFETY OF MEN

5.1 General — While engaging men for the job the supervisor should check up and make sure that they are skilled in the particular job they have to perform. A good supervisor can quickly spot an inexperienced, unskilled and often unsafe worker. Helpers and apprentices should be instructed in safety so that they work safely and become skilled workers.

5.1.1 Before a man is engaged he should undergo a thorough medical check up and be certified fit for the duties he is to perform.

5.1.2 The men actually doing the job should be made safety conscious. They should be trained in safe methods of using tools and equipments. The safety equipment provided to the workers should be of good quality and should conform to relevant Indian standard specifications, wherever available. Use of helmets (safety hats), gloves, safety goggles and safety boots should be enforced.

5.1.2.1 Safety helmets should be worn as protection from a fall or falling objects. The helmets should be worn properly and at all times during the work.

5.1.2.2 The safety goggles should be used while performing duties which are hazardous to eye like drilling, cutting and welding. The goggles used should conform to IS : 1179-1969* and should suit individual workers.

5.1.2.3 The welders and gas cutters should be equipped with proper protective equipment like gloves, safety boots, aprons and hand shields (*see* IS : 1179-1967*). The filter glass of the hand shield should conform to IS : 5983-1971† and should be suitable to the eyes of the particular worker.

5.1.3 When the work is in progress, the area should be cordoned off by barricades to prevent persons from hitting against structural components, or falling into excavated tranches or getting injured by falling objects.

*Specification for equipment for eye and face protection during welding (*first revision*).

†Specification for protective filters for welding, cutting and similar operations.

The barricades should be sufficiently away of the location. Red indication lamps should be provided so as to be visible at night. Where flow of traffic is to be permitted when overhead work is in progress, suitable wire netting should be used overhead to catch materials falling from height.

5.1.4 Warning signs shall be displayed where necessary to indicate hazards, for example, (a) 440 VOLTS, (b) DO NOT SMOKE, (c) MEN WORKING AHEAD, etc. Hand lamps should be provided with low voltage preferably 24 V to prevent electrical hazards. Proper lighting should be provided for good visibility for the movement of men and vehicles and for the work.

5.1.5 The electrical cables for the construction works shall be segregated and identified so that no accidental contact is established during construction work. Where work is to be done across a cable line the supply shall be cut off. All electrically operated hand tools shall be provided with double earthing.

5.2 The strength and capacity of ramps used for trucks delivering equipment, supplies or the steel itself shall be checked to prevent their failure. If a level trestle is being used instead of a ramp, for trucks or cranes to operate, this shall also be carefully checked. For both built-up ramps and trestle, the supports, footings, foundation, main material and bracings shall be adequate for the use. An adequate safe design shall be used with materials in good condition.

5.3 Shutterings of the sides of excavations should be checked for:

a) decay of timber used,

b) yielding of shuttering due to earth pressure,

c) warping of timber, and

d) displacement of wedges.

5.4 Anchors for guys or ties should be checked for proper placement. The weight of concrete in which the anchors are embeded should be checked for uplift and sliding.

5.4.1 Split-end eye anchors should only be used in good, solid rock.

5.4.2 The first load lifted by a guy derrick should be kept at a small height for about 10 minutes and the anchors immediately inspected for any signs or indications of failure.

5.5 Shipments on barges, or any other form of carrier, should be inspected for safe loading and unloading. Steel members should be so placed that they will not shift, slide or overturn during transit. The loading should be such that no pieces are liable to move and trap a man as part of the load is removed. There should be room to place

unloading slings safely. The slings should be adequate for the weight and kind of steel being lifted. The unloading equipment should have the reach and capacity to handle the loads being lifted off the carrier and moved to the point where the material is to be unloaded. Sharp edges are to be avoided while slinging. Pipes cut longitudinally into two pieces should be used while slinging sharp edges.

5.6 Men should be kept clear of the load being lifted, should keep out from under a load that has been picked and should be clear of any area where the load could swing unexpectedly, slip or fall. Proper loading helps to avoid the need for men trying to move pieces. Such movement can cause unexpected and dangerous shifting, sliding or rolling of the material being handled, or of other pieces underneath or alongside and can trap the men.

5.7 When a number of trusses or deep girders is loaded in one car or on one truck, all but one being lifted should be tied back unless they have been tied or braced to prevent their falling over and endangering men unloading.

5.8 Floor planks and scaffold planks should be in good conditions, without serious splits, cracks, excessive knot or other hazardous defects, and rigidly fixed on both ends. They should be unpainted as paint can hide hazardous conditions.

5.8.1 The planks should meet the relevant Indian Standard specification for the required purpose. The strength required should be based on the span over the supports including the weight of men, tools, equipment, etc, but should be of such size as to be light enough to be handled by two men.

5.9 The erection gang should have adequate supply of bolts, washers, rivets, pins, etc, of the correct size. Enough number of bolts should be used in connecting each piece using a minimum of two bolts in a pattern to ensure that the joint will not fail due to dead load and erection loads. All splice connection in columns, crane girders, etc, shall be completely bolted or riveted or welded as specified in the drawing before erection.

5.10 Slings for erecting the steelwork should be light and flexible enough to grip the pieces but strong enough to bear the loads. The sling should not slide while erecting diagonal members.

5.11 Girders and other heavy and complicated structural member may require special erection devices like cleats and hooks, which can be shop assembled and bolted or riveted or welded to the piece and may be left permanently in the place after the work.

5.12 If a piece is laterally unstable when picked at its centre, use of a balance beam is advisable, unless a pair of bridled slings can be placed far enough apart for them to be safe lifting points. The too flange of a truss, girder or long beam may be temporarily reinforced with a structural member laid flat on top of the member, and secured temporarily.

5.13 On deep girders, and even on some trusses, a safety 'bar' running their full length will aid the riggers, fitters and others working on the bottom flange or bottom chord to work with greater safety. A single 16 mm diameter wire rope through vertical stiffeners of such members about one metre above the bottom flange and clamped at the ends with wire rope clamps will usually be adequate. If the holes cannot be provided while the steel is being fabricated or if the design requirements would prohibit them, short eye bolts can be welded to the webs of the girder at intervals to be removed and the surface chipped or ground to leave it smooth, after all work on the piece has been completed.

5.14 Safety belts should always be available at work spot to be used whenever advisable. The ropes should be chemically treated to resist dew and rotting. These should not be tied on sharp edges of steel structures. They should be tied generally not more than 2 to 3 m away from the belt.

5.15 On a guy derrick or climbing crane job, the tool boxes used by the erection staff should be moved to the new working floor each time the rig is changed. On a mobile-crane job, the boxes should be moved as soon as the crane starts operating in a new area too far away for the men to reach the boxes conveniently.

5.15.1 While working a tall and heavy guy derrick, it is advisable to control tension in guys by hand winches to avoid jerks, which may cause an accident.

5.16 The proper size, number and spacing of wire rope clamps should be used, depending on the diameter of the wire rope, they should be properly fixed according to IS : 2361-1970*. They should be checked as soon as the rope has been stressed, as the rope, especially if new, tends to stretch under the applied load, which in turn may cause it to shrink slightly in diameter. The clamps shall then be promptly tightened to take care of this new condition. In addition, the clamps should be inspected frequently to be sure that they have not slipped and are tight enough. The working men should be taught the correct way of installing the clamps in accordance with IS : 2361-1970*.

5.17 When fitter, riveters, etc, can work from a planked floor or a planked area, the work can be done safely and often more expeditiously. When this is not feasible scaffolding or floats should be used.

5.17.1 When the men can work safely from the steel structure itself, this is preferable to hanging platforms or scaffolds, as it eliminates additional operations, which in turn, reduces the hazard of an accident.

*Specification for bulldog grips (*first revision*).

Wooden planks in suspended platforms and bullies, etc, should be inspected for cracks, splits, burns, or other damage. Ropes should be inspected frequently for cuts, wear, burns, or other unsafe conditions. The men should be cautioned to check their knots before getting on to a float or scaffold, to be sure that all the ropes are in place and secured

5.17.2 To aid men working on floats or scaffolds, as well as men in erection gangs, or other gangs using small material such as bolts and drift pins, adequate bolt baskets or similar containers with handles of sufficient strength and attachment to carry the loaded containers, should be provided. This reduces the danger of such small material rolling or being kicked, and falling on persons below, either workmen or passing pedestrians or vehicles. It also helps a man to avoid inadvertently stepping on such an object and losing his balance and resulting in an accident.

5.17.3 The men should be trained to use such containers, and to keep small tools gathered up and put away in tool boxes when not in use. Material should not be dumped overboard when a scaffold is to be moved. Rivet heaters should have safe containers or buckets for hot rivets left over at the end of the day. Water should also be on hand in case a hot rivet is misthrown and not taken out as well as to help the heater quench his forge fire at closing time.

5.18 During the erection of tall buildings, it is desirable to use nylon nets at a height of 3 to 4 m to provide safety to men.

5.19 Ladders should be used for safe access between the various levels of the work. The ladder should be set on a good level and solid base. There should be a platform of some sort at the foot and at the top landing, for men to step on safely when ascending or descending. The top and bottom of ladder should be properly secured to prevent the ladder from slipping out of place. When feasible, ladders should not be kept vertical, but should be leaned on quarter of the length for safe use. Cracked, loose or broken rungs or side rails should be watched for and promptly repaired or replaced. The spacing of rungs shall be 250 to 300 mm.

5.19.1 The men should be taught to clean their shoes of mud, grease, oil, snow, ice or other slippery material before climbing a ladder or going on steel or a planked floor, so that they will not slip or drag slippery material for other to slip on. They should avoid carrying tools or other material when using a ladder, they should use a hand rope to raise and lower such material.

5.20 Safety Against Fire—A fire protection procedure should be set up if there is to be any flame cutting, burning, heating, forging, riveting, or any operation that could start a fire. The worker should be instructed not to throw objects like hot rivets, cigarette stubs, etc, around.

5.20.1 During welding and cutting operations precautions as specified in IS : 3016-1965* should be adhered to.

5.20.2 Sufficient fire extinguishers, preferably of soda acid type should be placed at strategic points. Extinguisher should always be placed in cranes, at hoist, at compressors and similar places.

5.20.3 Whenever possible noncombustible material should be used for falsework, storing or temporary construction.

5.20.4 Extreme care shall be taken in storing of inflammable materials like petrol, kerosene and liquid oxygen.

5.20.5 All erection staff shall be explained the risk of fire. They should know the telephone number of nearest fire station so that in case of emergency the help or the fire brigade can be sought without any delay.

5.21 Riding on a load, tackle or runner should be prohibited.

5.22 The load shall never be allowed to rest on wire ropes.

5.23 Ropes in operation should not be touched. Broken wires of the rope may cause injury to the fingers. Wire rope with broken strand should not be used for erection work.

5.23.1 Kinks in hoisting ropes should be avoided.

5.23.2 Wire ropes conforming to IS : 2266 - 1970† or manila ropes conforming to IS : 1084 - 1969‡ shall be used for guying.

5.24 Lifting Appliances

5.24.0 The provisions contained in the 'Indian Standard Code of practice for safe use of cranes' (*under preparation*) shall be adhered to in addition to the following.

5.24.1 Operators of cranes and other lifting appliances and the workmen engaged in slinging should be trained in the safe use of cranes, hoists, etc. They should be instructed to follow the safety rules given in the 'Indian Standard Code of practice for safe use of cranes' (*under preparation*).

5.24.2 A proper signalling system should be developed for the use of workmen and these should be strictly followed. Hand signals should be adopted and no oral signals should be given. Only one man at a time, who is allotted this specific task, should give the signals.

*Code of practice for fire precautions in welding and cutting operations.
†Specification for steel wire ropes for general engineering purposes (*first revision*).
‡Specification for manila ropes (*second revision*).

5.24.3 Before slinging and before lifting load the crane operator and the men slinging the load should ascertain that the load does not exceed the safe lifting capacity of the crane.

5.24.4 Cranes should always be on a level and firm ground and riggers fixed where provided.

5.24.5 The movement of mobile cranes should be carefully planned in such a way that the boom of the crane does not come in contact with electric wires and other structures or objects in the vicinity of work being carried out.

5.24.6 Wire ropes, chains, slings, lifting tackles, etc, should be periodically inspected for their condition. Old lifting tackles should be marked with revised reduced lifting capacity due to deterioration in service, if necessary.

5.24.7 Trucks, jacks, lifts, cranes, etc, should be maintained in good working condition.

5.24.8 Interlocking or other safety devices should be installed at all stopping points of the hoists. The hoist shaft way should be fenced properly.

5.24.9 Toeboards and limit stops should be provided for wheel barrows on the loading unloading platforms. Material should be loaded securely with no projections.

5.24.10 Excessively pitted, corroded or worn chain should be condemned and destroyed by cutting and throwing.

5.24.11 Wire ropes should be uncoiled properly and lubricated regularly. The wires at the open ends should be tied together.

5.25 Slinging

5.25.1 Only properly tested and marked lifting tackle of adequate strength should be used. The safe working load of the tackle should never be exceeded.

5.25.2 Allowances should be made for the weight of tackles.

5.25.3 Chains should not be joined by bolting or wiring links together. They should not be shortened by tying knots.

5.25.4 A chain in which the links are locked, stretched or do not move freely should never be used. The chain should be free of kinks and twists. Proper eye splices should be used to attach the chain hooks.

5.25.5 Pulley blocks of the proper size should be used to allow the rope free play in the sheave grooves and to protect the wire rope from sharp bends under load. Idle sling should not be carried on the crane hook alongwith a loaded sling. When idle slings are carried they should be hooked

5.25.6 While using multilegged slings each sling or leg should be loaded evenly and the slings should be of sufficient length to avoid a wide angle between the legs.

5.25.7 The load shall be free from any obstructions before it is lifted. Hands should be taken away from the sling and the slinging persons should stand clear of the load. The crane hook should be centrally placed over the load to prevent the slipping and swinging of the load when it is raised.

5.26 Riveting Operations

5.26.1 *Handling Rivets* — Rivets covered with slippery materials should not be used in the fabrication work. Care shall be taken while handling rivets so that they do not fall, strike or cause injury to men and material below. Rivet catchers shall have false wooden bottoms to prevent rivets from rebounding.

5.26.2 *Riveting Dollies* — Canvas, leather or rope slings shall be used for reveting dollies. Chain shall not be used for the purpose.

5.26.3 *Riveting Hammers* — Snaps and plungers of pneumatic riveting hammers shall be secured to prevent the snap from dropping out of place. The nozzle of the hammer shall be inspected periodically and the wire attachment renewed when worn.

5.26.4 *Fire Protection* — The rivet heating equipment should be as near as possible to the place of work. A pail of water should always be kept ready for quenching the fire during riveting operations and to prevent fires when working near inflammable materials.

5.26.5 *Falling Objects* — Rivets, bolts, nuts or other loose articles shall be kept in boxes at the working area to prevent hazard from their falling down on men or equipments below.

5.27 Welding and Gas Cutting

5.27.0 The welders and workers engaged in gas cutting should be educated with the provisions of IS:818-1961*. The following recommendations are also applicable.

5.27.1 All gas cylinders shall be used and stored in the upright position only and should be conveyed in trolleys. While handling by cranes they should be carried in cages. The cylinders should be marked 'full' or 'empty' as the case may be.

*Code of practice for safety and health requirements in electric gas welding and cutting operations (*first revision*).

5.27.2 Gas cylinders should be stored away from open flames and other sources of heat. Oxygen cylinders should not be stored near gas, oil, grease and similar combustible materials.

5.27.3 When the cylinders are in use, cylinder valve key or wrench should be placed in position. Before a cylinder is moved, cylinder valve shall be closed.

5.27.4 All cylinder valves shall be closed when the torches are being replaced or welding is stopped for some reason. The cylinder valve and connections shall not be lubricated.

5.27.5 Gas cutting and welding torches should be lighted by means of special lighters and not with matches.

5.27.6 The cables from welding equipment should be placed in such a way that they are not run over by traffic. Doule earthing should be provided.

5.27.7 Before undertaking welding operations near combustible materials, suitable blanketing should be provided and fire extinguishers kept near by. Welding shall not be undertaken in areas where inflammable liquids and gases are stored.

5.27.8 Gas lines and compressed air lines should be identified by suitable colour codes for easy identification, to avoid confusion and to prevent fire and explosion hazards.

5.27.9 Good housekeeping and illumination are to be ensured at places of structural erection to ensure safety of erection personnel.

6. SAFETY OF STRUCTURE

6.0 General—The structure itself should be safeguarded during its erection. The first truss of the roof system should be guyed on each side before the hoisting rope is detached from it. After the second and subsequent trusses and roof purlings are erected, protective guides should be firmly established and the required wind bracings should be erected to prevent the whole structure being blown over by a sudden gale at night. Bracing and guying precautions should be taken on every structure until it is complete. Guying should be specifically done for trusses and structural components which after their erection from an erection device. On structures used for temporary material storage overloading shall be avoided.

6.0.1 Erection of columns should be immediately followed by vertical bracings between columns before the roof structure is erected.

6.1 Erection of Bridge Girders

6.1.1 A careful inspection of plant shall be made by the person in charge of work to ensure that all tackle ropes, chains and other important lifting gear and machinery are in good order and fit for service and well up to the capacity for which they are required.

6.1.2 When chains are used for lashing, care shall be taken to protect the edges of members to avoid the marking and distortion which may be caused.

6.1.3 Temporary bracings shall be provided to take care of stresses from erection equipment or other loads carried during erection.

6.1.4 Adequate allowance and provision for lateral forces and wind loads shall be made according to local conditions.

6.1.5 *Joints*

6.1.5.1 Joints shall normally be made by filling not less than fifty percent of the holes with service bolts and barrel drifts in the ratio of 4 : 1. The service bolts are to be fully tightened up as soon as the joint is assembled.

6.1.5.2 *Special methods of erection* — In cases where the joints have to withstand stresses arising from special methods of erection, provision shall be made to take the whole stress that will or may occur. Cylindrical drifts and turned bolts shall be used to withstand such stresses and no reliance shall be placed on service bolts for this purpose. Up to a maximum of 40 percent of the holes of each member of the joint are to be filled with drifts and balance of strength required is to be attained with turned bolts. The position and number of the drifts and bolts will be intimated by the engineer.

6.1.5.3 *Emergency jointing* — In the event of an emergency arising, such as the structure in danger of being carried away by floods before the riveting can be completed, the joints shall be made secure by filling 40 percent of the holes with cylindrical drifts and an equal number with service bolts fully tightened up.

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