



## **ANNEXURE-I**

# **TECHNICAL SPECIFICATION PART-A STRUCTURAL REHABILITATION / REPAIR WORK**

## **TECHNICAL SPECIFICATIONS**

### **GENERAL SPECIFICATION:**

1. These specifications are for work to be done, item to be supplied and materials to be used in the works as shown and defined in the specification / drawings / bill of quantities or at other relevant locations in the tender document and herein to the satisfaction of the Owner / Consultant.
2. The workmanship is to be the best possible and of a high standard. The Vendor shall take all steps immediately to make up deficiency if any noticed by the Owner / Consultant. Use must be made of special tradesmen in all aspects of the work and allowance must be made in the rates for the same.
3. The materials to be provided by the Vendor shall be in accordance with the samples already got approval from the Owner / Consultant by the Vendor and in conformity with specification approved list of manufacture / brand / make. The Vendor shall produce all invoices, vouchers or receipts for any materials if called upon to do so by the Owner / Consultant.
4. A sample of all materials is to be submitted to the Owner / Consultant for their approval before the Vendor orders or delivers the material to the site. Samples together with their packing are to be provided free of charge by the Vendor and should any materials be rejected they will be removed from the site at the Vendor's expense; All samples will be retained by the Owners / Consultant for comparison with materials which will be delivered at site. Also the Vendor will be required to submit specimen finishes, colours, etc. for approval of the Owners / Consultant before proceeding with the works.
5. Vendor shall maintain uniform quality and consistency in workmanship throughout the execution of the work.
6. The Vendor shall provide: All materials, labour, maintenance, fixing, carrying, cleaning, and making good, etc. Temporary canvas, plastics and any other requisite protection of the works, all the necessary equipments, labour and removal of the same at the completion of the work. The Consultant will be the sole judge in deciding as to the suitability of the tools or plants that may be brought on the works by the Vendors, for the proper execution of the work.
7. The head masons and the supervisors on the works shall always carry with them a two feet rule, a measuring tape (5 mts.), a spirit level, a plumb bob and a square and shall check that the work is being done according to the drawings and specifications. The Consultant or its representative will use any OR all measuring instruments / tools belonging to the Vendors in checking the works executed.
8. All measuring tapes shall be of steel and scaffolding and ladders that may be required for taking measurements shall be supplied by the Vendors.
9. The Vendor shall place at the disposal of the Consultant / Owner and the advice of himself and his firm, and their staff or supervisor of site or other skilled person employed by him or them for the conduct of the works comprised in the Contract.
10. The Vendors shall take full care in loading and unloading materials for the works, so that the roads and footpaths are not obstructed, damaged or the traffic impeded, and they must conform with the Police / MCGM Regulations for carrying, loading and unloading all materials, plant,

debris, etc. To and from the civil structure.

11. The Owner / Consultant shall have full powers and authority to issue such instructions as to the order of proceeding with or carrying out the work as he may deem necessary for the guidance of the Vendor and Vendor shall be bound by such instructions of the Owner / Consultant or any person authorized by the Owner / Consultant to give such instructions.
12. The Vendor should verify himself regarding condition of existing site. No claim or allowance whatsoever will be entertained hereafter on account of any errors or omission in the description of the site turning out different from what was expected.
13. The Vendor shall work in co-ordination with, all electrical, Fire Fighting / Detection, Security System and any other Vendors working for other works involved in, the project and provide all necessary assistance to them for successful completion of the project.
14. The Vendor shall work in co-ordination with and in accordance with the safety rules and security norms set by the owner/Consultant for the civil structure, person, premises and plants.
15. Any loss or damage caused due to fault or negligence on the part of Vendors labours, staff etc. During working in the premises will be made good by Vendor at no extra cost or the damage and repair cost will be reimbursed in full to the Owner.
16. The Vendor shall be responsible for providing and maintaining any boxing or other temporary coverage's required for the protection of dresses or finished work if left unprotected. He is also to clean out all shavings, cut ends and other waste from all parts of the work before coverings or in-fillings are constructed
17. The Vendor should consider the below mentioned points before quoting for the job.
  - a) The expenses for paying Municipal Taxes for dumping materials on/off site, etc. To be borne by the Vendor.
  - b) Vendor should be responsible for the security of the materials on site.
  - c) Vendor should be responsible for lifting of the material to the respective floors and expenses of the same should be borne by him.
18. Skilled head masons / tradesman for the respective trades shall be employed by the Vendors to check the work in progress and to instruct and extract the right kind of workmanship from the men employed on the works. Instructions given to such Head masons by the Owner / Consultant or his Representative shall be carried out with, a view to get the work executed in a neat and workman like manner/according to the specifications. The Owner / Consultant may order for the inspection of any finished work as he chooses and in a manner he decides, and the Vendors shall bear all expenses in this connection. If the results of such inspection prove that the material used and / or workmanship is not of the standard required, the work will be rejected and removed forthwith and be replaced by works of the accepted standard of quality and material.
19. For work Items, whose specification is not mentioned, relevant CPWD Specification / Manufacturer Specification /BIS Code/International standard as the case may be would be followed.

## **GENERAL METHODOLOGY OF REPAIR & CONSTRUCTIONS**

### **GENERAL**

The Vendor under this contract commits himself to use best quality material and assume full responsibility for the quality of all material incorporated or brought for incorporation in the work. The work shall be executed in accordance with the best engineering practice and as per instruction of Consultant. All materials shall confirm to respective Indians Standards. The Vendor must allow in his rates all applicable wastages in all the materials.

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### **SECTION: 1**

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#### **SALIENT NATURE OF WORK:**

The civil structure is a framed structure founded on RCC footing. The main construction materials used are RCC and Structural Steel. The frame of structure may/may not be without any infill wall. The main work involves following.

1. In the first stage of work the structure shall be propped temporarily prior to work at the locations simultaneously, where columns are in dilapidated condition and temporarily weakened during retrofitting. For this purpose a steel framed structure shall be erected at the site to act as bracing and to take the repair borne stresses.
2. In the second stage of work treatment of structural members shall be taken up using the materials and method indicated in the document.

#### **WORKING CONSTRAINTS:**

Building is in use and shall remain operational during the work progress. The nature of surrounding are fire hazard prone. Also the entire premise is sensitive from security point of view. There will be the constraints in working.

A congested network of pipes, electrical wires and other fixtures are running very closely to the structural elements to be retrofitted.

The working space will be less and there will be loss of time due removal and relocating these.

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### **SECTION: 2**

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#### **1.WATER**

Water shall be potable. Fresh, clean and free from impurities & should be from an approved source. Potable water shall generally be considered satisfactory for mixing and curing. Vendor will provide and maintain sufficient storage accommodation for the water as and where directed by Owner / Consultant.

#### **2. SAND:**

Fine aggregate (Sand) shall consist of natural river sand or from any other source approved by the Consultant and shall confirm IS:383. Creek sand shall not be permitted. Grading zone of sand proposed for use shall be supplied by the Vendor and got approved from the consultant before use. Sand shall be of siliceous materials, clean, sharp, hard strong, and durable and shall be free from any clay films, dust, alkali, organic material, deleterious matter, salt, earth lumps and other adherent / coating. It shall be washed with clean water if required by the Consultant.

Natural sand shall be used by screening or washing, or both as necessary, to remove all objectionable

foreign matter while separating the sand grains to the required size fraction. Natural sand shall be washed with clean water unless specific written permission is given by the Consultant to use and that meets specifications and standard of cleanliness. The soluble contents shall not exceed 5 % by volume if tested by settlement in water. For concrete work, the sand shall be coarser than for masonry / plaster work. Sand shall be used after screening as directed by the Consultant.

### **3. BRICKS:**

The bricks of uniform size, table moulded from kilns and of good quality approved by the Consultant shall be used. It shall be evenly burnt for getting brick which are sound, hard and with sharp edges and corners, and which shall be given the sound when strike with a metal. It shall be free from grit and other impurities such as lime, iron and deleterious salts. No brick with 24 hours immersion in water shall absorb more than 20% its weight.

### **4. COARSE AGGREGATE**

This shall be machine crushed from hard trap stone, grading of aggregate shall be within the limits to produce a dense mix; and shall conform to IS: 383 & IS: 515; mix will work into position without segregation and without excessive quantity of water being required it also shall be strong and durable and shall be free any clay films and. Other adherent/coating. This shall be well graded between the limit as specified in the items of the work and the grading tests shall be carried out.

### **5. CEMENT:**

Fresh quality cement shall be procure only from approved manufacturer / supplier and shall be subject to prior approval from Consultant.

Following types of cement shall be used:

i). All cement used for the work shall be Ordinary Portland cement conforming to IS: 8112 - 1976 (43grade). In case 43grade is not available the Vendor may use 53grade cement conforming to IS:12269:1987 for specific work only with prior permission from consultant. Twenty bags of the cement shall be taken to weight one tone.

ii) Cement shall be stored in a dry place or in a higher ground on water tight platform and shall be protected from moisture while in store. Cement which has remained in bulk storage for over 6 months, or which has remained in dealer's storage for more than 3 months, or which has remained at project site for more than 3months shall be re-tested before use. Cement which is moisture before use in any way will not be allowed to be used at all. Record of the cement brought to the site and consumed and balance in the work must be maintained properly.

### **6. SCAFFOLDING JOB:**

#### **6. A: GENERAL:**

Scaffolding shall consist of double legged steel scaffolding with necessary bracings and planks. All members before installation shall be checked for their strength and stiffness and other requirements as per the owner's concerned Maintenance Engineer and as per bellow described 'Safe Erection of Scaffolding & Ladders'.

1. Erect Metallic Scaffolding (including supply of all Scaffolding materials like Pipes, Planks, Clamps, Pins, Ladder arrangements), wherever required to reach Tanks, Spheres, Pipe Racks, around Vessels etc. As per instructions of the owner.

2. All Scaffolding erection and dismantling activities must compulsorily follow the procedure of 'Safe Erection of Scaffolding & Ladders' given in 6. B: Safe Erection of Scaffolding & Ladders' this below.
3. However, in case of difficulty and to suit the Site conditions, Scaffolding may be modified as per the instruction of owner's Supervisor / Engineer in-Charge.
4. In cases of Site restrictions, Vendor may have to carry out necessary improvements / alterations in Scaffolding, wherever required, keeping in mind the Site conditions and Safety requirements. Erection of additional Support Base, cross-Bracings and other alterations, as required to fulfill Safety requirements of the Scaffolding, shall be done as a part of the job at no additional Cost. Such alterations must be carried out as per instruction of the owner's Supervisor / Engineer in-Charge and after obtaining approval of owner's Fire & Safety Department.
5. All Scaffolding will be subjected to inspection & approval of owner's Maintenance and Fire & Safety Sections, after its erection. After owner's inspection & approval, Scaffolding shall be provided with a Tag 'Safe to Use'. In case any Scaffolding is required to be re-built from Safety point of view, as recommended by the Fire & Safety Supervisor of owner, it shall be re-done at no extra Cost to owner.
6. For calculation purpose, Height of Scaffolding shall be considered from its Base level from where the same is constructed, which is not necessarily from the Ground Level. Dismantling of Scaffolding arrangements shall be carried out only after obtaining clearance from Operations / Maintenance Supervisor / Engineer in-Charge of owner.

#### **6. B: SAFE ERECTION OF SCAFFOLDING AND LADDERS**

Scaffolding is applicable to all jobs done at an elevation of above 2 Meters, where permanent Platform / Railing is not provided and where Scaffolding & Ladder shall be used. This procedure contains detailed precautions to be observed while erecting and using Scaffolding / Ladder. Tubular Scaffoldings are an assembly consisting of Tubes, which serve as Posts, Bearers, Braces, Ties and Runners, a Base supporting the Posts and special Couplers, which serve to connect the Uprights and to join various members of Scaffolding.

##### **6. B. I : Specifications and Procedures of Scaffolding erection:**

1. All Scaffold components shall conform to relevant Indian Standard, IS:4014 (*for Steel Tubular*), IS:3696 (*Part-1*). These shall be maintained in good condition. Damaged or deteriorated components shall not be used. Tube shall be free of cracks, surface flaws and other defects. Also, Tubes shall be straight. All tubes should be maintained in good condition and regularly inspected.
2. Fittings should be regularly examined. Moving parts should be regularly lubricated for easy movement.
3. Metallic Planks shall only be used and Timber or Aluminum Scaffolding shall not be used. The Planks of Scaffold should overhang not less than 6" but not more than 12" on either end. They should be securely fastened on both ends and laid tight.
4. All elevated Structures / Working Platform areas should be guarded on all sides.
5. All Platforms shall be provided with Guardrails, Toe-Boards and means of access. Planks shall be secured from movement by Metal Wire or Clamp. Nylon or other Combustible materials should not be used.
6. Scaffolds should be designed to support at least 4 times the anticipated Weight of Men and Materials.
7. Ensure that all Scaffolds are in true plumb and level at all times.

8. Manila / Cotton Ropes should not be used for erecting Scaffolds.
9. Scaffolding must be constructed with at least 2 Planks width.
10. A good Base for the Scaffold is essential. So, the resting Ground or Floor on which the Scaffolding should be carefully examined. Loose Soil or backfilled Ground shall be avoided to support load of the Scaffold. Sole Plates of at least 9" x 1½" (230mm x 40mm) cross-section are required to spread the Load on Earth, made-up Ground, Asphalted surface, etc.
11. Standards / Posts shall be pitched on the Base Plates and Sole Plates or Sleepers. Standards shall not be spaced more than 2 Meters Longitudinally and 1.2 Meters Transversely.
12. Joints in Standards should not occur in the same lift. Joints should be arranged so that they occur as near as possible to a Ledger / Runner. All Standards shall be Vertical.
13. Ledgers / Runners shall be securely fixed to the Standards with Double or Universal Load-bearing Couplers and shall be Horizontal. Joints in Ledgers should be staggered, i.e. Joints in adjacent Ledgers should not occur in the same bay. It is desirable that these Joints be made with Sleeve Couplers. If Joint Pins are used, they should be placed at about ¼<sup>th</sup> to 1/3<sup>rd</sup> the Span between the Standards and not at the mid-Span.
14. Ledgers shall be started not beyond 150mm of the Base/Foundation of Standard. Maximum Vertical Spacing between the Ledger should not exceed 1.8 Meters.
15. Transverse bracing, forming a 'X' across Width of the Scaffolding, shall be installed at the Scaffold ends at least at every 3<sup>rd</sup> Set of Posts Horizontally (measured from only One end) and every 4<sup>th</sup> Runner Vertically.
16. All Scaffolding shall be effectively tied to an adjacent Structure to prevent any movement of Scaffold either towards or away from the Structure.
17. Maximum Vertical Spacing of Ties shall not exceed 4 Meters.
18. Supports for Scaffold Planks shall be spaced with due regard to the nature of Platform and the load it will bear. Maximum distances between Supports for Scaffold Planks/Boards should not exceed 5 Feet.
19. Except on Deck bordering the curved surface of a Cylindrical or Spherical Structure, Boards shall be laid flush wherever possible.
20. Planks shall be laid with no opening of more than 1" between the adjacent Boards or Scaffold members.
21. All Platforms shall be kept free from unnecessary obstructions and from materials, rubbish and projecting Nails. Platforms, which have become slippery with Oil or other substance, shall be immediately replaced.
22. Working Platforms, from which Persons or material could fall a distance exceeding 6 Feet, shall be provided with Guards. This should consist of top-Rail, mid-Rail and Toe-Board. The Toe-Board shall be of minimum 6 Inches Height and secured in position by Toe-Board Clips or other means, while the mid-Rail and the top-Rail shall be at Heights of 2 Feet and 4 Feet respectively.
23. Guardrails and Toe-Boards shall be fitted to inside of the Standards to prevent any outward movement.
24. If Guardrails and Toe-Boards are removed for movement of materials, e.g. Heat Exchanger jobs, they shall be restored as soon as practicable.
25. Where Scaffolds are erected above Walkways or work areas, Space between the Toe-Board and Railing should be screened.

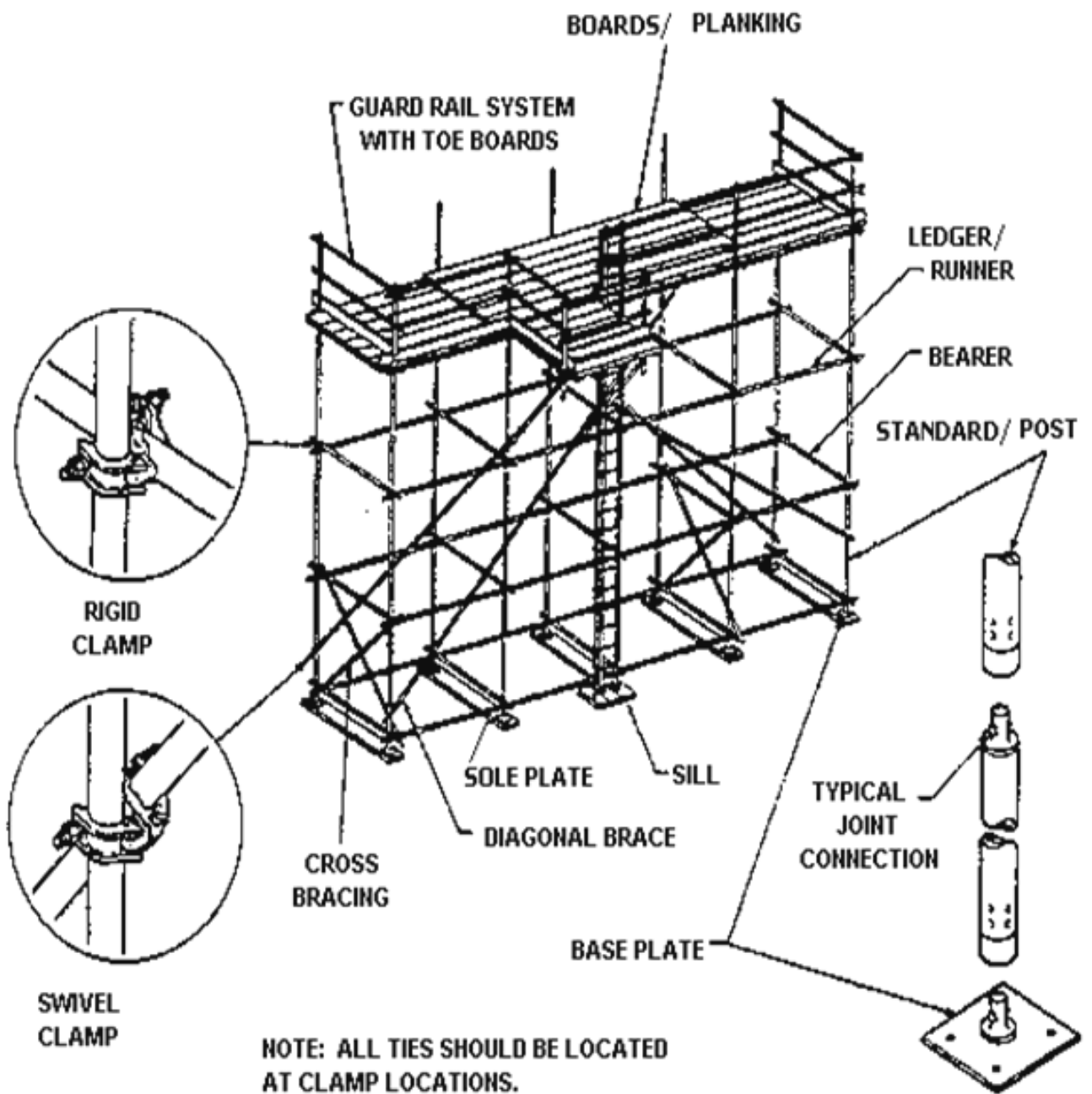
26. A safe and convenient means of access should be provided to the Platform level. Means of access may be a Portable Ladder, Fixed Ladder, Ramp or Runway or Stairway. Do not climb on the cross braces.
27. In no case use of Ladders or makeshift Devices on top of Scaffoldings to increase the Height is permitted.
28. Access to a working Platform can be best achieved by providing a separate Ladder Tower or Cantilevered Access Platform so as not to obstruct the Platform and to minimize the possibility of Persons falling through gap in the Guardrail or Deck (*refer Figure:1*). If this is not practical, top Handrail should be hinged or a hinged Short Bar provided at the access point.
29. Scaffolding shall be erected, altered and dismantled by experienced Workmen working under the direction of a competent Supervisor.
30. Procedure for erection & dismantling should be such that an unstable condition is not reached at any point of time. Progress should be symmetrical to prevent any load imbalance.
31. All Scaffolders shall wear Safety Harness with Double Lanyard. When changing positions they shall secure the 2<sup>nd</sup> Lifeline before unhooking and re-hooking the 1<sup>st</sup> Lifeline.
32. Scaffolding Couplers should be tightened with proper Tools. Scaffolding materials and other objects shall not be dropped, thrown, tipped or shot from Heights. Drop area shall be barricaded.
33. Bracings and Ladders shall be constructed as the Scaffolding progress.
34. During dismantling, no Component, which endangers stability of the remaining Structure, shall be removed. Procedure of dismantling shall be orderly & planned and should proceed generally from the top in Horizontal sections. Components shall be lowered hand-to-hand in an orderly fashion or brought down by Crane, Pulley or other suitable means. Dismantled Scaffold materials shall be lowered to the Ground and not stored on the Scaffold.
35. To protect Persons working below from falling material as well as Persons working above from falling down, Safety Nets should be deployed wherever practicable. For protection from falling objects, Safety Nets should be deployed at 10 Feet elevation. For protection of Person falling down, Safety Net should be deployed in such a way that fall is not more than 20 Feet. The nets should cover falling distance below work area and at least 1.8 Meters Width.
36. During the erection stage of any Scaffolding, Warning Notice with the wording "Scaffolding incomplete – Do not use" should be fixed to the Scaffolding at all access points. This warning will be in the form of a painted Board. Also, in the event of any doubt concerning the integrity of particular Scaffolding, "*Scaffolding incomplete – Do not use*" Boards shall be put.
37. After erection, but before use of Scaffolding, the erected Scaffolding shall be inspected and approved by the Scaffolding Supervisor. The certified Scaffolding shall then be handed over to the Retrofitting / Repair persons / Maintenance department of owner for use. Once erected, the Scaffolding shall be inspected every Week. The Checklist given below shall be used for their audit. When the completed Scaffolding is handed over for use, it is the responsibility of the Vendor to ensure its correct and safe use.
38. The Status Board with the wording "Scaffolding Complete, Safe For Use" should be displayed when the Scaffolding is ready for use. Tags shall be displayed near access points at Eye level.



39. No portion of the Scaffold should be utilized unless that portion is fully decked, braced, tied, demarcated and certified.
40. Scaffolding materials such as Tubular, Plank, Clamp, etc. Shall be inspected periodically by the Scaffolding Supervisor, to ensure they are free from defects. The inspected lot of material shall be painted on the edges with different colors for ease of identification.
41. All Workers engaged in Scaffolding erection/dismantling shall use Safety Belt / Harness, with Double Lifeline. One Harness of the Safety Belt shall always be anchored to the firm support.
42. All Platforms shall be provided with Guardrails, mid-Rails and Toe-Boards.
43. A Ladder of proper Length shall be provided for the job to be done. If it is used as a means of access or as a working place, it shall rise to a Height of at least 3'-6" (*1.07 Meters*) above the landing place or above the highest Rung to be reached by the Feet of the Person, using the Ladder. Ladders shall be examined before use for missing, broken, loose or damaged Rungs and Splinters.
44. Wooden Ladders shall not be used.
45. Where a Ladder is carried single-handed, the front end should be kept high enough to clear Person's Head and special care taken at corners and blind spots.
46. The Stiles of a Ladder shall be equally supported on a firm level surface. Boxes, Bricks, Barrels, etc. Shall not be used as a means of support and under no circumstances shall Wedges or other loose material be used as Packing.
47. Ladders shall not be supported on their Rungs and Rungs shall not be used to support Scaffold Boards.
48. Ladders shall be set 1' (*300mm*) out of each 4' (*1.210 Meters*) of Height, i.e. At an angle of 75° (degrees) to the Horizontal. Where extension Ladders are used fully extended, minimum overlap of sections shall be Four Rungs. Splicing or Lashing Ladders together to obtain an extension will not be permitted.
49. Both Stiles of a Ladder shall be evenly supported and securely lashed to prevent any movement.
50. Where Lashing at the upper resting place is impossible, a Person shall be stationed at the Foot to control a Ladder not more than 20' (*6 Meters*) in Height.
51. Where there is possibility of a Ladder being struck by moving Vehicles, a Person should be placed on guard or space at the Base of the Ladder fenced off. Similarly if a Ladder is erected close to a Door, the Door should be locked, shut or secured in the open position with a Man on guard.
52. Ladder Landing places or Platforms are required at every 30' (*9.140 Meters*) of Height and shall be provided with Guardrails and Toe-Boards. Holes in Platforms through which Ladders pass shall be as small as practicable.
53. Tools and Materials should not be carried by the Persons ascending or descending Ladders, except that Tools may be carried in Pockets or special Belts, provided they do not impair movement.
54. A Person working on or from a Ladder must always have both Feet on the Rungs and a secure handhold. If the work to be done necessitates the use of both Hands, Safety Belts should be used. Only One Person should be on a Ladder at a time.
55. Ladder shall extend 3' to 4' above the point of Landing and topmost 3 Rungs shall not be used.
56. The following practices shall be followed when placing Ladders:
57. Ladder is checked visually for defects before every use.

58. Place a Ladder so that the Horizontal distance from the Base to the Vertical Plane of the support is approximately  $\frac{1}{4}$ <sup>th</sup> the Ladder Length between Supports which is considered as the safe angle.
59. Ladder shall not be used as a work base. It is to be used only as access to Height.
60. Ladders shall not be used in a Horizontal position as Runways or Scaffoldings.
61. Top of the Ladder shall be fixed to stable support and tied securely with a strong Rope.
62. Ladders shall not be placed in front of a Door that opens toward the Ladder, unless the Door is locked, blocked or guarded.
63. Ladders shall not be placed against a Window Pane or Sash.
64. Portable Ladder shall be placed so that both side Rails have secure Footing. Provide solid Footing on soft ground to prevent the Ladder from sinking.
65. The Ladders' Feet shall be placed on a substantial and level Base, not on movable objects.
66. The ladders shall never be leaned against unsafe backing, such as loose Boxes or Barrels.
67. Extend the Ladder side-Rails at least 3' above the Top Landing.
68. Ladders shall not be placed close to live Electric Wiring or against any operational Piping (*Acid, Chemical, Sprinkler System, etc.*) Where damage may occur.
69. The following safe practices shall be observed when ascending or descending Ladders:
70. Hold on with both Hands when going up or down. If material must be handled, raise or lower it with a Rope either before going down or after climbing to the desired level.
71. Always face the Ladder when ascending or descending. Never slide down a Ladder.
72. Be sure that Shoes are not greasy, muddy or slippery before you climb. Do not climb higher than the 3<sup>rd</sup> Rung from the Top on Straight or Extension Ladders or the 2<sup>nd</sup> Tread from the Top on Step Ladders.
73. Do not use makeshift Ladders, such as Cleats fastened across a single Rail.
74. Be sure that a Step Ladder is fully open and the Divider locked before you start to climb it.
75. Before using a Ladder, inspect it for defects. Never use a defective Ladder. Tag or mark it so that it will be repaired or destroyed. If a Ladder is to be discarded, cut it in half immediately to prevent any re-use.
76. Do not splice short Ladders together. They are designed for use in their original Lengths and are not strong enough for use in greater Lengths. Also, most Splicing methods, particularly "on-the-job" methods are not safe.
77. Keep Ladders clean and free from Dirt and Grease, which might conceal defects.
78. Do not use Ladders during a strong Wind, except in emergency and only when they are securely tied.
79. Do not leave placed Ladders unattended, especially outdoors, unless they are anchored at the Top and Bottom.
80. Ladders shall be allowed inside some Vessels having specific metal or lining only after proper approval.
81. The Fixed Ladders shall be used with suitable Fall Arrestors, if Cage Guards are not provided. Platforms are not required when such devices are used. Fall Arrestors allow a Climber to attach his Safety Belt to a Sliding Fixture that travels along a Carrier Rail. The Traveling Fixture will lock and suspend a Man even if he loses his grasp. Generally, such Devices are preferable to Cage Guards.

82. All Portable Ladders shall be equipped with non-slip Bases or bottom of the Ladders be held, tied or securely anchored to prevent any Slipping. For Cylindrical objects, like Poles and Columns, it is preferred to have a Chain replacing the Top Rung to prevent sliding sideways. Alternately, a Rope Lashing to tie the Top of the Ladder to the Pipeline or other object being worked on shall be done.
83. The following safe practices shall be followed while using Roof-top Ladders:
84. Work on fragile Roof shall be carried out with the help of appropriate Roof Ladders only.
85. Prior to use, the Ladders shall be inspected thoroughly.
86. Persons working on fragile Roofs shall be familiar with the use of Roof Ladder.
87. Life Rope shall be used in addition to Safety Belts, in case of Pipe Rack and Roof Top jobs. Means of access shall be kept free from any obstruction.
88. The area shall be cleaned and cleared off after the job is completed.



## TUBE and COUPLER SCAFFOLD

Figure : 1

**6. B. II : SCAFFOLD CHECKLIST:**

<b>LOCATION (Unit / Equipment)</b>		<b>PURPOSE OF SCAFFOLD</b>		<b>ERECTED BY</b>
<b>Item</b>	<b>Checkpoint</b>	<b>Condition</b>	<b>Comment</b>	<b>Action</b>
Base Plates	In place			
Sole Plates	On loose Ground			
Tubes	Proper size, straight			
Standards (Uprights)	Vertical			
	Staggered Joints			
	Right Spacing			
	Not damaged			
Ledgers Transoms	Level			
	Staggered Joints			
	Not loose			
	Not damaged			
Bracing	In place			
Ties	None missing			
	Not loose			
Fittings	Right fitting			
	Not damaged			
	Check Couplers			
Boards (Planks)	Not damaged			
	Not loose			
	Right support			
Ladders	Proper Angle			
	Right Length			
	Properly secured			
	Separate landing			
	Right extension			
Guardrails	Top Rail			
	Mid Rail			
	None missing			
Toe-Boards	In place			
Toe-Boards				
General				
Comments				
<b>Week</b>	<b>Date &amp; Time</b>	<b>Supervisor (or above) Signature / Employee no.</b>		
		<b>Scaffold Vendor</b>		<b>Maintenance / Project Engineer</b>

## 7. REINFORCING STEEL:

Steel work shall comply with the IS specification IS:1786-1985 and high strength reinforcement. High strength deformed bars for use as reinforced in concrete shall be of grade Fe 415, Fe 500 and Fe 550 conforming to IS 1786. Nominal sizes, cross sectional areas and their mass shall be as specified in IS 1786, allowing due consideration for tolerance specified therein. The manufacturers shall give a certificate stating mechanical properties. All reinforcement material shall be free from loose mill scale, excessive rust, loose rust, pitting, oil, grease, paint, mud or any foreign deleterious material present on the surface. Cleaning shall be done to the satisfaction of the owner / consultant. Each batch brought at site shall be tested prior to use for respective specification / physical properties. Cost of all such tests shall be borne by the Vendor. Material acceptable as per IS shall be allowed into the works. All rejected material shall be removed from site by the Vendor within 3 days of rejection. Reinforcement bars received at site shall be stored on hard concrete platform and clear of the ground with the use of timber sleeper, concrete sleeper or any other means. Reinforcement material shall be kept covered by tarpaulins or plastic to avoid corrosion and other contamination. The weight payable per meter shall be as follows:

Nominal Dia.	Weight per meter	Nominal Dia.	Weight per meter
6 mm.	0.22 kg/rmt	22 mm.	2.98 kg/ kg/rmt
8 mm.	0.40 kg/rmt	25 mm.	3.85 kg/ kg/rmt
10 mm.	0.62 kg/rmt	28 mm.	4.83 kg/ kg/rmt
12 mm.	0.89 kg/rmt	32 mm.	6.31 kg/ kg/rmt
16 mm.	1.58 kg/rmt	36 mm.	7.99 kg/ kg/rmt
20 mm.	2.47 kg/rmt	40 mm.	9.85 kg/ kg/rmt

Binding wire shall be 16 or 18 gauge galvanized wire conforming to IS 80. Binding shall be done with double wire. It shall be free from rust, oil, paint, grease, loose mill scale or any other deleterious material undesirable for the reinforcement and concrete or which may prevent adhesion of concrete with reinforcement.

Reinforcement shall have concrete cover and the thickness of such cover (exclusive of plaster or other decorative finish) shall be as specified in drawing or as directed by the consultant. The following guidelines are to be observed in the absence of the above.

- A) At each end of the reinforcing bar, not less than 50 mm, nor less than twice the diameter of such bar.
- B) For a lateral bar in a column, not less than 50 mm., nor less than the diameter of such bar.
- C) For longitudinal reinforcing bar in beam, not less than 50 mm. Nor less than the diameter of such bar.
- D) For reinforcement in slab not less than 25 mm. Nor less than the diameter of such bar.
- G) For concrete members totally buried in ground or immersed in seawater, the cover shall be 40 mm. More than specified above.
- H) Concrete cover should not exceed 75 mm. In any case. Cover to reinforcement as specified in the drawing shall supercede above provisions

Details given above are for guidance and shall be followed in absence of any specific direction.

Cover blocks shall be of non-corrosive material such as plastic but not wooden or broke bricks or stone. Specially PVC / micro-concrete made cover spacers shall be used in the works. Concrete cover spacers may be permitted by consultant. Such concrete spacers shall be cast from concrete and not cement mortar. Strength of these blocks shall be equal to the strength of concrete in use. These should be fully cured prior to use in works.

Greater horizontal distance between the reinforcing bars should be provided. But when needle vibrators are used, sufficient space is to left between groups of bars to enable the vibrator to be immersed. Where there are two or more rows, the bars shall be vertically in line and the minimum vertical distance between the bars shall be the nominal maximum size of the aggregate or the maximum size of bar, whichever is more. Correctly cut and bent bars shall be accurately placed in position as detailed in the drawing. Any deviation from those as shown in the drawings or instructions shall be rectified by the Vendor at his own cost and responsibility.

Length of different diameters of bars actually used included authorized overlaps shall be measured nearest to a centimeter and their weight calculated as given above shall be used. Chairs and spacer bars shall not be measured and paid. The Vendor shall account for all these in his quoted price. In case of welded coupled joints, measurement for payment shall be equivalent to the length of overlap, as per design. Welding rods used shall conform to IS 814 covered electrodes for metal arc welding of structural steel. Work shall be carried out by a competent welder. Rate quoted shall include, in addition to cost of material.

- a) Cover blocks of PVC or concrete.
- b) Spacer bars, chairs and unauthorized overlaps (allowed for convenience).
- c) Cutting, bending, placing and fixing in position.
- d) Binding wire as approved.
- e) Wastage / rolling margin.
- f) Cleaning of bars.
- g) For purpose of reconciliation, maximum wastage permitted shall be 5% of the actual material used. In case of free issue material the balance shall be charged at 1.5 times the actual market rats as penalty.

#### **8. FORM WORK:**

All props, planks, plates braces, tiles, bolts wedges etc. Shall be provided and all form work shall be sufficiently strong and sound for the purposes. Form work shall be thoroughly cleaned with wire brush etc. After use oiled (clear/ fresh) or greased each time before use. Wooden form work shall be replaced from time to time with new timber as necessary and steel plate shall be got repaired from, time to time. For all exposed work, all the forms of fresh and raw steel shall be used as per pattern given by Consultant for the various members of the structure. All centering, formwork and temporary works shall be constructed according to drawings and specifications prepared by the Vendor and approved by the consultant. The design criteria and loading for these works shall be as per the relevant specifications, listed below:

- (a) Before placing concrete the surface of all forms shall be coated with suitable non-staining form releasing agents such as raw linseed oil so as to prevent adhesion of concrete and to facilitate removal of forms.
- (b) The form releasing agent shall cover the forms fully and evenly without excess over drip. Care shall be taken to prevent form releasing agents from getting on the surface of the construction joints and on reinforcement bars. Special care shall be taken to thoroughly cover form strips for narrow grooves, so as to prevent swelling

of the forms and the consequent damage to concrete prior to or during removal of forms.

- (c) Immediately before concrete is placed, care shall be taken to see that all forms are in proper alignment and the supports and fixtures are properly secured and tightened.

Where forms for continuous surfaces are placed in successive units, the forms shall lap and fit tightly over the completed surface so as to prevent leakage of cement slurry from the fresh concrete and to maintain accurate alignment of surface.

- A. Forms shall be left in place until their removal is authorized and shall then be removed with care so as to avoid injury to concrete.
- B. Removal of forms shall never be started until the concrete is thoroughly set and adequately hardened such that it can carry its own weight, besides the live load which is likely to come on the work during construction. The length of time for which the forms shall remain in place shall be decided by the Architect, with reference to weather conditions, shape and position of the structure or structural member and nature and amount of dead and live loads.
- C. In normal circumstances and where ordinary Portland cement is used, forms can be allowed to be struck as under:
- |  |                   |
|--|-------------------|
| 1) Beam sides, walls, unloaded columns | - after 24 hours. |
| 2) Slabs and arches (props left under) | - after 4 days    |
| 3) Props to slabs and arches           | - after 14 days   |
| 4) Beam soffit (props left under)      | - after 8 days    |
| 5) Props to beams                      | - after 21 days   |
| 6) Lean concrete (sides)               | - after 2 days    |

Note: Time shall be measured from last batch concreted in respect to the structural member under consideration.

In no case shall forms be removed until there is an assurance that removal can be accomplished without damaging the concrete surface. Heavy loads shall not be permitted till the concrete has reached its design strength. The forms shall be removed with great caution and without jerking the structure.

## **9. CONCRETE:**

The ordinary concrete mix shall generally be specified by volume. For cement, which normally comes in bags and used by weight, volume shall be worked out taking 50kg of cement as 0.035 cubic metre in volume, shaking ramming or hammering shall not be done. Proportioning of sand shall be used as per its dry volume and in case it is damp, allowance for bulking shall be made.

For all works concrete shall be mixed in a mechanical mixer, which along with other accessories shall be kept in first class working condition and so maintained throughout the construction. Mixing shall be continued till materials are uniformly distributed and a uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate shows a complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after putting all ingredients into the mixer. Mixers, which have been out of use for more than 30 minutes, shall be thoroughly cleared before putting in a new batch. Unless otherwise agreed to by the Architect, the first batch of concrete from the mixer shall contain only two thirds of the normal quantity of coarse aggregate. The mixing plant shall be thoroughly cleaned before changing from one type of cement to another.



Vibrators to be used at the time of concreting as per the required needle of dia like 25mm, 50 mm etc. Immediately after compaction, concrete shall be protected against harmful effect of weather, including rain, running water, shocks, vibration, traffic, rapid temperature changes and premature drying out. It shall be covered with wet sacking, Hessian or other similar absorbent material approved by the Architect soon after the initial set, and shall be kept continuously wet for a period of not less than 21 days from the date of placement. Masonry work over the foundation concrete may be started after 48 hours of its laying but curing of concrete shall be continued for a minimum period of 21 days. If necessary, chemical curing may be done without any extra cost. The cost shall be borne by the Vendor.

Works strength tests shall be made in accordance with IS 516. Each test shall be conducted on ten specimens, five of which shall be tested at seven days and the remaining five at 28 days. The cubes shall be made at the rate of one set for every 50 cubic meter of concrete or a part thereof for each grade. However, if in each grade concreting done in a day is less than 15 cubic metre, the number of cubes can be reduced to 6 with the specific permission of the consultant.

Similar works tests shall be carried out whenever the quality and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimens' may be suitably increased as deemed necessary by the, Consultant, when procedure of tests given above reveals a, poor quality of concrete and in other special cases.

All necessary labour, materials, equipment, etc. For sampling, preparing test cubes, curing, etc. Shall be provided by the Vendor. Testing of materials and concrete may be arranged by the consultant in an approved laboratory at the cost of the Vendor.

## **10. STRUCTURAL STEEL WORKS:**

### **10A. MATERIAL**

All structural steel shall conform to the requirements of any one of the following Indian Standards as specified.

IS800 – 1984 Code of Practice for General Construction Steel

IS 2062-1992 (MTD) 4 Structural Steel (Standard quality / Fusion welding quality) Weldable Structural Steel

IS 1975 – 1977 Structural Steel (Ordinary) Fe 410-0

SP 6 (I) – 1965 Handbook for Engineers (Structural Steel Section)

IS 262 – 1975 Structural Steel (Standard Quality) 5<sup>th</sup> Revision

Structural steel not conforming to the requirements of any of the above standards may be used only if permitted in writing by the Owner / Consultant. This permission may be granted after the steel is tested for yield stress, ultimate tensile stress, elongation, ductility, weldability or any other property as required by the Consultant. The Vendor shall furnish a mill certified report of the tests for each grade of steel from which the material is to be fabricated. The certification shall contain the results of physical tests required by the specification for the material. In the event the results of any test are not in conformance with the requirements of these specifications, the Consultant reserves the right to make additional tests. When additional tests are required, the Vendor shall furnish, cut and machined additional test specimens in accordance with I.S. requirements. The additional costs of furnishing, cutting and machining additional test specimens shall be borne by the Vendor. The Consultant at his discretion may require conducting non-destructive tests on material, welds and workmanship to ensure that the requirements as described in the codes, specifications and drawings are achieved. Any rectification and/or replacement of faulty

material or workmanship shall be at the Vendors expense. Remedial work shall not be carried out without prior approval of the consultant. Cost of satisfactory testing shall be to the Employers expense. Costs of re-testing areas, which are unsatisfactory, or of extensive testing to isolate unsatisfactory areas will be charged to the Vendor.

All bolts and nuts shall conform to the requirements of IS: 1367 – 1967: Technical supply conditions of threaded fasteners. (First Revision). All mild steel for bolts and nuts shall be in accordance with IS: 1680-1960 : Method for Tensile Testing of steel Products Other than Sheet, Strip, Wire and Tube and IS: 1367-1960 : Technical Supply Conditions for Threaded Fasteners shall have a tensile strength of not less than 44 kg/mm<sup>2</sup>, and a minimum elongation of 23 percent on a gauge length of 3.65√A. Plain washers shall be made of steel conforming to IS: 226-1962 : Specification for Structural Steel (Standard Quality) (Third Revision), or St 44-0 of IS: 1977-1962 : Specification for Structural Steel (Ordinary), or IS: 2062-1992 : Specification for Structural Steel Fusion Welding Quality. Electrodes shall conform to the requirements of the following Indian Standards as specified. 1). IS: 814 – 1991 Specifications for covered electrodes for metal arc welding of structural steel. Part 1 and 2, 2). IS: 816 – 1996 : Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high-tensile steel, 3). IS: 822 – 1970 : Code of procedure for inspection of welds. The electrode to be used for all steel welding unless otherwise advised shall be EC6013 60 KSE UTS. The filler wire & flux combination for submerged arc welding shall conform to the requirements for the desired application as laid down in IS 3613 – 1974 : Acceptance tests for wire flux combination for submerged arc welding. The dimensions, form, weight, and tolerances of all hot rolled shapes (and other members) shall conform to the following Indian Standards and other relevant standards: 1). IS: 1852-1985 : Specifications for rolling and cutting tolerance for hot rolled steel products, 2). IS 808 – 1989 : Dimensions for hot rolled steel Sections, 3). IS: 1730 – 1989 : Dimensions for steel plate, sheet and strip for structural and general engineering Purposes, 3). IS 7215 – 1974

Tolerances for fabrication of steel structures:

The dimensions and tolerances of all bolts, nuts and washers shall conform to the requirements of the following Indian Standards: 1). IS 6639-1970: Specifications for hexagon bolts for steel structures, 2). IS 5624-1993: Specifications for foundations bolts, 3). IS 6761-1994 : Specification for countersunk head screws with hexagon socket.

For requirements of welds and welding, reference shall be made as per IS: 816-1969 : Code of Practice for Use of Metal Arc Welding for General Construction in Mild steel.

Other materials used in association with steel work shall, wherever appropriate Indian Standard specifications for the materials exist, conform to such specifications.

## **10B. FABRICATION**

### **10B.1 Workmanship**

Workmanship shall be of the highest quality for all phases of the work. Supervising engineers, welding supervisors and welders shall be qualified in accordance with the Standards and Codes designated. The Vendor shall not adopt any practice, which will damage materials.

The whole of the structural steel fabrications shall be done in the Vendors workshop unless specific approval has been obtained from the owner for the sub-contracting of any part of the work prior to the placing of the sub-contract. All steel shall be new and each member shall be free from any butt-welded or other form of splice for the full length between joints shown in or indicated by the drawings unless such splices shall have been shown in the approved shop drawings and/or approved in writing. Steel sizes shall be as indicated on the drawings. Under no circumstances can any other member size or type be made without the written approval of the Consultant who will consider only written application showing specified size and dimensions and required substitute size and dimensions. Clamps, magnets, holding

devices or other setting up fixtures shall be used in assembling structural members in order to avoid tack welding whenever practicable. Finished members shall be free from kinks or bends. Shearing shall be accurately done, and all portions of the work neatly finished. Corners shall be square and true, unless otherwise shown on the drawings. Where shearing cannot make re-entrant cuts, a rectangular punch may be used. Re-entrant cuts shall be filleted, unless otherwise approved by the Consultant. Approved dies shall make bends, except for minor details, or bending rolls. Where heating is required, precautions shall be taken to avoid overheating the metal and it shall be allowed to cool in such a manner as not to destroy the original properties of the metal. Hammer marks shall not be evident. Steel with welds will not be accepted, except where welding is definitely specified, called for on the Drawings, or otherwise approved. All bolts, nuts, and screws shall be tight. The ends of pipes, except for hand railing, shall be reamed.

Fabrication in general shall conform to the requirements of IS 800-1984, Code of practice for use of structural steel in general building construction.

### **10B.2 STRAIGHTENING**

All materials before being laid off or worked shall be straight and free from twist. If rectification is necessary, it shall be affected by cold working and applying pressure, but not by hammering or any other method that will affect or injure the metal. Material with kinks or bends shall be rejected.

### **10B.3 DIMENSIONAL TOLERANCE**

Dimensions shall be measured by means of an approved steel tape of the same temperature as the structure at the time of measurement. An allowable variation of 1 mm is permissible in the overall length of members with both ends milled. Members without milled ends, which are to be assembled to other steel parts of the structures, shall not deviate from the dimensions shown on the drawings by more than 1.8 mm for members 10 meters or less in length, and by not more than 3 mm for members over 10 meters in length. The erection clearance for cleared ends of members connecting steel to steel should preferably be not greater than 2.0 mm at each end. The erection clearance at ends of beams without web cleats should be not more than 3 mm at each end, but where, for practicable reasons, greater clearance is necessary, suitably designed seating should be provided.

### **10B.4 CUTTING**

Cutting shall be done by shearing, cropping, sawing or gas cutting and shall be reasonably square and free from distortion with all burrs removed. If directed by the Consultant the edges shall be ground afterwards. For gas cutting high tensile steel, sufficient metal shall be left beyond the required profile so that all metal that has been flame hardened cube removed later by machining. Except where the material is subsequently joined by welding, no load-transmitting surface shall be gas cut. Plates in built-up members shall be end and edge planed, except where flats with square edges are used. Plates specified to be planed, milled or chipped, shall be cut in the first instance to such size as to allow 3 mm to be planed, milled or chipped, from the sides and ends. Edges of gussets up to and including 8 mm in thickness may be sheared in a machine, which can take the full side in one cut. Planning, milling or grinding shall prepare edges of gussets of greater thickness. Edge preparation for surfaces to be welded shall be carried out by grinding planning but not shearing or cropping.

### **10B.5 DRILLING & PUNCHING**

Holes through more than one thickness of material for members, such as compound stanchion and girder flanges shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 3 mm less in diameter than the required size and reamed, after assembly, to the full diameter. The thickness of material punched shall be not greater than 16 mm. Drilled or reamed holes shall be cylindrical and perpendicular to the surface. They shall not be more than 1.5 mm larger than the specified diameter of bolts up to and including 25 mm

in diameter. When holes are drilled in one operation through two or more separable parts, these parts, when so specified by the Consultant, shall be separated after drilling and the burrs removed. Holes in connecting angles and plates, other than splices roof members and light framing, may be punched full size though material not over 13 mm thick, except where required for close tolerance or barrel bolts. Matching holes for bolts shall register with each other so that a gauge of 1.5 mm or 2.0 mm (as the case may be, depending on whether the diameter of the bolt is less than or more than 25 mm) less in diameter than the diameter of the hole will pass freely through the assembled members in the direction at right angle to such members. Finished holes shall be not more than 1.5 mm or 2.0 mm (as the case may be) in diameter larger than the diameter of the rivet or black bolt passing through them unless otherwise specified by the Consultant. Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to H8 tolerance specified in IS: 919-1959 Recommendations for Limits and Fits for Engineering. Preferably, parts to be connected with close tolerance or barrel bolts shall be firmly held together by tacking bolts on clamps and the holes drilled through all the thickness at one operation and subsequently reamed to size. All holes not drilled through all thickness at one operation shall be drilled to a smaller size and reamed out after assembly. Where this is not practicable, the parts shall drilled and reamed separately through hard bushed steel jigs. A gas cutting process shall not form holes for bolts. All holes shall be free of burns, fins and other defects. Except otherwise permitted no holes shall be drilled in structural members at locations.

#### **10B.6 ASSEMBLY**

The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged, and shall be prepared that the specified combers, if any, are provided.

#### **10B.7 BOLTS, PINS, NUTS & WASHERS**

General: All bolts shall be of such a length that at least one full thread but not more than 12 mm of the threaded part of the bolt is exposed beyond the nut, after the nut-has been tightened. Bolts shall comply with IS: 281 and IS: 3757. All bolts shall be fitted with one washer under the nut. Where a nut or bolt bears on an inclined surface, a leveled washer of the correct shape shall be used between the surfaces. Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. Bevelled washers shall not be allowed to move out of their correct positions during fabrication and erection. No connection shall be made with less than two bolts and both shall be not less than 16 mm diameter, unless otherwise indicated on the drawing. In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together.

Bolt Tightening: Bolts shall be “sung tightened” as defined as the tightness attained by a few impacts of an impact wrench or by the full effort of a man using a standard podgier spanner. Snug tightening shall be achieved by using a standard wrench to ensure intimate positive contact between mating surfaces. Bolts, nuts and washers that are snug tightness shall be hot dipped galvanized and centrifugally spun to remove excess spelter.

#### **10B.8 WELDING**

Welding Steel: All welders to be employed on the works shall be qualified to an appropriate standard as per the procedures outlined in the relevant Indian Standard. Testing of all welders shall be carried out before any work is commenced. Only Welders who pass the test shall be permitted to work only for those positions for which they were tested and passed. ii) Welding shall be in according with the following Indian Standards as applicable. 1). IS 816-1969 : Code of Practice for use of metal are welding for general

construction in mild steel, 2). IS 822-1970 : Code of practice for inspection of welds, 3). IS 1323-1982 : Code of practice for oxy-acetylene welding for structural work in mild steel, 4).IS 9595-1980 Recommendations for metal-arc welding of carbon and carbon manganese steels Unless otherwise stated all welds shall be electric metal arc welds. All welding procedures shall be arranged, to suit the details of joints indicated on the drawings. Welding shall be carried out shall be such as to ensure that the weld metal is full and satisfactorily deposited throughout the length and thickness of all joints. Members to be welded shall be securely held in their relative position during welding, either by jigs or tack welding. Profile of fusion faces may be prepared by shearing, chipping, or gas cutting. In all cases the faces should be dressed by chipping, filing or grinding and made regular. For thickness of metal 16 mm and above, electrodes used shall be Supercito (E-7018) or equivalent. For thickness of metal below 16 mm the root run shall be with Phillippe 31 (E 6010) electrodes, (or equivalent) and subsequent runs shall be with Overchord – SS (E- 6013) electrodes (or equivalent). The electrodes shall be dried in an electric oven as per the recommendations of manufacturers. Only DC current shall be used for welding and the Vendor shall make his own arrangements of all welding power and for equipment. Vertical down welding shall not be permitted. All welds shall be back-gouged and welded from the backside unless specifically approved otherwise. All welds shall be carried out in such a sequence and manner as to cause minimum distortion of the welded parts. Multiple run welds shall be carried out with each run closely following the previous run, so that sufficient time is allowed for slag removal. Welds shall on completion present an even, smooth and regular finish free from defects. The weld metal shall be solid throughout with complete fusion between weld metal and parent metal and between successive runs throughout the joints. Caulking shall not be used to correct defects. Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint and other foreign materials. Surfaces need not be cleared of Zinc Silicate primer if present prior to welding. Upon completion of each welding pass, the weld shall be cleaned of spatter, slag and flux deposits. The weld must show a good clean contour and on a cut specimen good fusion with the parent metal. After welding is complete, adjacent surfaces shall be thoroughly cleared of all spatter and deposits. All structural welds shall be continuous around all mating faces and edges of the members being connected. If not detailed on the drawings welds shall be sized to develop the full strength of the smaller of the two members being joined and not less than 6 mm. All welds shall develop the strength and ductility specified for the steel being welded. Welds forming connections between steel of different grades shall develop at least the same unit strength as the specified for the higher strength steel. Automatic and semi-automatic welding processes may be employed provided they are approved by the Engineer and conform to the requirements of these specifications. All equipment for automatic and semi-automatic welding shall be subject to approval by the Consultant.

Pre-heating will be required where any section thickness exceeds 30mm. Requirements for, and method of pre-heating shall be submitted to the Consultant for approval. Upon completion of steel fabrication and before any surface treatment is applied, the Vendor shall allow inspection of the steel work by the Consultant who may reject the steel work if it fails to meet the requirements of this Specification.

#### **10 B.9 STEEL PLATES & PROTECTION ANGLES**

Steel plate and protection angles required for the protection of concrete work shall be erected true to line and grade within the tolerances specified below. The edges of exposed faces may have a vertical or horizontal distortion from a straight line not greater than 3 mm per meter of length, provided, that distortion for any single piece shall not exceed 1 mm and provided, that when the warp is greater than 1.6 mm an extra anchor hole shall be drilled near the proper corner and the piece drawn into position thereby. All bolts head on the exposed face shall be countersunk and fitted or ground so that the heads are flushed with the finished surface. Joints between abutting sections shall be square and flush and the butting ends shall be sawed or otherwise made smooth and regular.

#### **10B.10 SURFACE TREATMENT**

Following the completion of fabrication all steel shall be cleaned and protective coated in accordance with the procedures specified in the Surface Treatments. Protective coatings damaged during the Contract shall be rectified as specified in the Surface Treatment.

#### **10B.11 MISCELLANEOUS**

**Marking:** The steel work shall be temporarily shop erected complete or as arranged with the Project Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop assembled with a sufficient number of parallel drifts to bring and keep the parts in place.

**Packing:** Prior to transportation of the steelwork all projecting plates or bars, and all ends of members at joints shall be stiffened. All straight bars and plates shall be bundled, all screwed ends and machined surfaces shall be suitably packed. All rivets bolts, nuts, washers and small loose parts shall be packed separately in case so as to prevent damage or distortion during transit.

**Inspection and Testing:** The Project Engineer shall have free access at all reasonable time to those parts of the Vendors works which are concerned with the fabrication of the steel work. He shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with the provisions of the Specification. Unless specified otherwise, inspection shall be made at the place of manufacture prior to dispatch and shall be conducted so as not to interfere unnecessarily with the operation of the work. The Vendor shall guarantee compliance with the provisions of the Specification, if required to do so by the Engineer. Should any structure or part of a structure be found not to comply with any of the provisions of the Specification, it shall be liable to rejection. No structure or part of the structure, once rejected shall be resubmitted for test, except in cases where the Consultant considers the defects as rectifiable. Defects, which may appear during fabrication, shall be made good by the Vendor with the consent of, and according to the procedure laid down, by the Consultant. The Vendor shall supply all gauges and templates necessary to satisfy the Consultant. The Consultant may, at his discretion, check the test results obtained at the Vendor's works by independent tests at the Government Test House or elsewhere. Should the material tested be found to be unsatisfactory, the costs of such tests shall be borne by the Vendor, and if satisfactory, the costs shall be borne by the Employer.

#### **10B.12 ERECTION**

**Plant and Equipment:** The suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the Consultant. Details of the proposed equipment shall be submitted for approval 6 weeks prior to erection commencing.

**Storing and Handling:** All structural steel should be so stored and handled at the site that the members are not subject to excessive stresses and damage. **Setting out:** The positioning and leveling of all steel work with accuracy shall be in accordance with the approved Drawings, Specifications and to the satisfaction of the Consultant.

**Security During Erection:** During erection, the steel work shall be securely bolted or otherwise fastened and, where necessary, temporarily bracing provided for all load to be carried by the structure during erection including those due to erection equipment and its operation. No permanent bolting or welding should be done until proper alignment has been obtained.

**Field Connections:** All field assembly and welding shall be executed in accordance with the requirements for shop fabrication, excepting such as manifestly apply to shop conditions only. Where the steel has been delivered painted, the paint shall be removed before field welding, for a distance of at least 50 mm on either side of the joints.

**Painting after erection:** Prior to the painting of steel, which is delivered unpainted, commences, all surfaces to be painted shall be dry and thoroughly cleaned from all loose scale and rust. The specified protective treatment shall be completed after erection. All bolt heads and site welds shall be cleaned.

Where the steel has been surface treated in the workshop, the coating shall be completed on site so as to be continuous over any welds and site rivets or bolts. Bolts, which have been galvanized or similarly treated, are exempted from this requirement. Surfaces, which will be inaccessible after site assembly, shall receive the full-specified protective treatment before assembly.

### **10B.13 TRANSPORT, HANDLING & STORAGE**

Steel shall be handled and transported with care, and in such a manner that parts will not suffer strain, distortion or abrasion. The Engineer shall reject distorted or damaged steelwork. All steel shall be stored above the ground and supported in timber packers. Lifting and handling of all steel, whether painted or not shall be done with synthetic webbing flat slings or bagged chains. All slings shall comply with the local work place, health and safety acts. Under no circumstances shall unprotected chains be used for lifting steel. Paintwork damaged during transport and erection shall be rectified as specified in the Surface Treatment Section of the Specification. Where large portal frames are being used, the flexibility of the frames requires that care be taken when accepting delivery, stacking, lifting and erecting. It is expected that a foreman competent and familiar with all aspects of lifting a large portal frame be appointed to the site. Beams and trusses shall be lifted such that bending occurs about the axis for which the member was designed.

### **10B.13 GROUTING**

Unless otherwise stated on the Drawings a space of not less than 25mm shall be provided between undersides of column base plates and between all beam and roof truss bearings, and concrete pads, footings etc. After steel work has been wedged up to line and level fixed in position, the space between steelwork and concrete shall be grouted with high strength super fluid micro-concrete. The grout shall be rammed to penetrate into the space between steel work and concrete and protected from damage until it sets.

## **11. REPAIR OF R.C. STRUCTURAL MEMBERS**

**11.a.** All distressed R.C. members shall be exposed of existing plaster and loose and disintegrated concrete for the investigation of corrosion activity in Rebars by chisel and light weight hammer (prefer vibro-hammer). Proper scaffolding and shoring shall be provided. In case of carbonated concrete, the concrete shall be removed for a depth 10 mm more than the carbonation depth.

(Note: A spray of 0.2% solution of phenolphthalein will be used as ph indicator of concrete. The change of color of concrete to pink indicates that the concrete is in the good health, where no change in color takes place; it is suggestive of carbonation-affected concrete.)

**11.b.** The test will be conducted by drilling a hole on the concrete surface to different depths up to cover concrete thickness, removing dust by air blowing, spraying phenolphthalein with physician's injection syringe and needle on such freshly drilled/broken concrete and observing the color change. The depth of carbonation will be estimated based on the change in color profile.

**11.c.** Rust passivatory coat shall be applied and rebars shall be cleaned with rotary wire brush and rust remover.

**11.d.** Wherever the rebar is reduced by more than 20% of original, extra main rebar shall be provided by tying a suitable dia. Bar to existing rebar with a lap of 12 to 40 times the dia. Of such bar depending on location and type of structural member. In case development length of 12 to 40 times is not available, a hole will be drilled in the hard & healthy concrete and new rebar shall be anchored therein using Epoxy mortar. G.I. weld wire mesh of 100 mm. X 100 mm. (10 gauge) shall to be clamped on all sides of RC members. The mesh shall be clamped onto concrete surface by means of concrete nails and binding wire. Anti-corrosive coating on steel and GI weld mesh shall be applied before next operation.

**11.e.** A bonding coat of Polymer Latex (SBR) over the exposed steel/mesh/ concrete shall be applied in 1:1 ratio of cement to Polymer Latex prior to application of new polymer based mortar/modified mortar / micro-concrete / modified concrete / ordinary concrete as directed in step (i).

OR (as specified)

An Epoxy bonding coat shall be applied between the old and new concrete subjected to high stresses, prior to repairs to be done with Polymer Modified Mortar after the coat becomes sticky (leaving finger prints when touched).

**11.f.** Repair of Damaged Portions: Repair with Micro-silica and Fibre blended repair mortar of following specifications.

*F.1. (Polymer Modified Mortar, PMM)*

- Cement (OPC) ..... 500 kg.
- Quartz Sand well graded 2.36 mm. Downgraded ..... 1500 kg.
- Polymer Latex..... 100 kg.
- PP fibre .....1 pack of 125 gms. Per 50kg bag of cement.
- Water .....150 to 170 litres
- Curing .....with spray water 3 days & drying for next 5 days.
- Thickness of Application.... In one application 15 mm. Thickness shall be built. Subsequent layer shall be built with one bond coat of Polymer modified cement slurry as per 1(g).
- Application Method..... Hand packing shall be used and finished surface shall be obtained with trowel. Surface shall be roughened by binding wire.

*F.2. (Ordinary Concrete)*

- Cement
- River sand / Equivalent Sand
- Coarse aggregate
- Water
- Polymer dose
- Super Plasticizer .....As designed
- Application..... Shuttering shall be placed around the concrete
- Method element after placing the required Rebars/wire mesh. Mixture shall be poured into the shuttering.
- Curing..... After casting the exposed surface shall be immediately covered with polythene sheet with simultaneous sprinkling of water. After 10 hrs. The regular curing by ponding or wrapping the wet Hessian cloth for 14 days.

*F.3. Micro-concrete (Pre-packed)*

- Micro-concrete
- Coarse aggregate
- Water
- Application Method..... same as f.2
- Curing..... same as f.2



*F.4. Polymer Fibre Reinforced Thixotropic Ready to Use Mortar*

Mixing and placing of Proprietary Polymer Fibre Reinforced Thixotropic Mortar shall be as per Manufactures' instruction.

- Water
  - Application Method
  - Curing
- } As per Manufacturer Instructions

**12. CEMENT GROUTING**

Cement grouting may be required to some RC member for general strengthening. Grout slurry shall be prepared by following proportion :

- Cement (OPC) .....50 kg.
- Polymer Latex (Optional & as per Consultant's instruction) ..... 5 kg.
- Grouting Additive.....200-250 gms.
- W/C .....0.50 to 0.60
- Method..... Drill holes at 12" c/c in grid pattern. Fix 10 mm. Dia. Perforated plastic pipes (nipples). Holes shall be 5" to 8" deep. Gaps between nipples and hole shall be filled with polymer mortar. After hardening of Polymer Modified Mortar use compressed air to clean the dirt from cracks. Injection of grout material shall be carried out at 2 to 3 kg/cm<sup>2</sup> pressure.

Injection of grout material shall be taken up first lower level nipple till the material spill out from next higher level nipple. Once the injection is completed the nipples shall be removed after 24 hours and drilled holes shall be plugged with Polymer Modified Mortar.

**13. REPAIR OF HONEYCOMBED AREAS AND STITCHING OF CRACKS**

When RC members have honey combing inside after removal of loose concrete material it is advised to inject low viscosity epoxy injection resin in the honey combed area. Also same technique could be adopted in case of cracks (2 to 3 mm. Wide) in these elements.

Drilling holes in concrete and fixing one way injection packers using with ready to use polymer based quick stopper plug (sealer).

"A hole shall be drilled into the honey combed area and along the cracks. Compressed air shall be used to clean the hole, cracks and honey combed portion to remove dust and dirt. One way injection packers shall be fixed into the holes. Spacing of holes shall be 12" to 18" depending upon the deficiency / crack pattern. Surface of crack shall be sealed with epoxy sealant to ensure that injection material does not leak from cracks. Also the honey combed areas shall be sealed in the similar manner. Injection packers shall be secured in fixed position with help of epoxy sealant. This preparation shall be left for 24 hours for drying and hardening."

Injection of epoxy resin shall be completed in two stages using Very Low Viscosity Injection Resin and Low Viscosity Resin with 24 hrs operation interval. Very Low Viscosity Injection Resin shall be injected to fill very fine cracks and micro-cracks and also to strengthen the injected portion. Low Viscosity Resin shall be injected to finally fill the micro-cracks and hone combs. Both operations shall be used in

combination. Injection pressure shall be 2 kg/cm<sup>2</sup> for Very Low Viscosity Resin and 2.5 to 3.0 kg/cm<sup>2</sup> for Low Viscosity Resin. Machine operated compressor shall be used with small air flow. In case no material could be injected from one Injection packers due to path blocked, maintain the pressure for 10 min. And continue the operation from next Injection packers. Having completed the injection process the Injection packers shall be flush cut after 24 hours.”

#### **14. PLASTER ON EXTERNAL SURFACE**

Step 1 – Hack the concrete area ( in case of brickwork) rake the brick joints).

Step 2 - Soak the concrete / brickwork by water and allow the surface to be saturated dry.

Step 3 - Apply the 1<sup>st</sup> coat of CM mortar plaster 15 to 20mm thick in the following mix design.

Cement (fly ash blended)	....	1 Part
Screened Sand	....	3 Parts
Polypropylene Fibre	....	As per manufacturer’s recommendation
Plasticizer	....	100 ml. Per 50 kg. Cement
Water	....	18 litres ± 3 litres per 50 kg cement

Step 4- Finish the surface without applying excess pressure by trowel. Dry cement shall not be used for any reason.

Step 5- Put the wire rubbed hacking to receive the next coat.

Step 6- Follow steps (4) above. Cure the surface for minimum 3 days by moist curing.

Step 7- Apply the 2<sup>nd</sup> coat of CM mortar plaster 10 to 15 mm thick in the following mix proportion.

Cement (fly ash blended)	....	1 Part
Screened Sand	....	3 Parts
Polypropylene Fibre	....	As per manufacturer’s recommendation
Plasticizer	....	100 ml. Per 50 kg. Cement
Water	....	18 litres ± 3 litres per 50 kg cement

Step 10 - Spray the cement + screened sand 1:1 slurry to have the projected sand particle on the finished surface. (Dubba Punch) / or obtain the sand grained finish using sponge. Sponge shall be floated from one end to other end to have even and uniform surface. Water used for sponging shall be admixed with non-shrink additive.

Step 11 - 1<sup>st</sup> three days kantan shall not be rolled up to act as wind barrier. Curing is to be done for 14 days.

#### **15. BUILDING THE SECTION BY GUNITING**

##### **15.a Material :**

Ordinary Portland cement as per IS: 8112 – 1976 : 43grade (In case 43grade is not available the Vendor may use 53 grade cement confirming to IS:12269:1987 or fly ash blended cement for specific work only

with prior permission from consultant) and at a moisture content between 3 to 6% lying within the grading limit as given in table.

<b>I. S Sieve Designation</b>	<b>% Passing the Sieve</b>
4.75 mm.	95 - 100
2.36 mm.	65 - 90
1.18 $\mu$ m	45 - 75
6.00 $\mu$ m	30 - 50
300 $\mu$ m	10 - 22
150 $\mu$ m	2 - 8

Ratio : 100 parts of cement and 300 parts of sand by weight mixed with 35-50 parts of water and 2 parts by weight quick setting compound (accelerator).

Process : Dry mix guniting.

Required properties : Density - 20 KN/m<sup>3</sup>

Strength - 25 N/mm<sup>2</sup>. (minimum)

#### **15.b Procedure:**

1. The defective concrete shall be cut out to the full depth till sound concrete surface is reached or upto the clear cover to the main rebars whichever is greater. The cut-off portion perimeter shall be tapered to avoid the feather edge.
2. Study of NDT report regarding USP velocity, approx. Ave. Range of comp. Strength, carbonation depth, half cell potential meter test etc.
3. All R.C. members shall be exposed of existing plaster and loose and disintegrated concrete for the investigation of corrosion activity in Rebars by chisel and light weight hammer (prefer vibro-hammer). Proper scaffolding and shoring shall be provided. In case of carbonated concrete, the concrete shall be removed for a depth 10 mm. More than the carbonation depth.
4. The test will be conducted by drilling a hole on the concrete surface to different depths up to cover concrete thickness, removing dust by air blowing, spraying phenolphthalein with physician's injection syringe and needle on such freshly drilled/broken concrete and observing the color change. The depth of carbonation will be estimated based on the change in color profile.
5. Rust passivatory coat shall be applied and rebars shall be cleaned with rotary wire brush and rust remover.
6. Wherever the rebar is reduced by more than 20% of original, extra main rebar shall be provided by tack welding a suitable dia. Bar to existing rebar with a lap of 12 to 40 times the dia. Of such bar depending on location and type of structural member. In case development length of 12 to 40 times is not available, a hole will be drilled in

the hard & healthy concrete and new rebar shall be anchored therein using Epoxy mortar. G.I. weld wire mesh of 100 mm. X 100 mm. (10 gauge) shall to be clamped on all sides of RC members. The mesh shall be clamped onto concrete surface by means of concrete nails and binding wire. Anti-corrosive coating on steel and GI weld mesh shall be applied before next operation.

7. A bonding coat of Polymer Latex (SBR) over the exposed steel/mesh/ concrete shall be applied in 1:1 ratio of cement to Polymer Latex prior to application of new polymer based mortar/modified mortar / micro-concrete / modified concrete / ordinary concrete as directed in step (i).

OR (as specified)

An Epoxy bonding coat shall be applied between the old and new concrete subjected to high stresses, prior to repairs to be done with Polymer Modified Mortar after the coat becomes sticky (leaving finger prints when touched).

8. Repair of Damaged Portions: Repair with appropriate material as directed and specified above.
9. The cement and sand shall be batched comprising 100 parts by weight of cement and 300 parts by weight of sand, mixed thoroughly and conveyed through a hose pipe with help of compressed air.
10. A separate line shall carry the 35-50 parts water and 2 parts of accelerator under pressure.
11. The cement, sand and water shall be passed through and be intimately mixed in a special manifold.
12. Keeping the guniting nozzle (gun) 60 cm. To 150 cm. Away from the surface at right angle to the surface the mix shall be projected at high velocity. Near rebars the nozzle shall be kept closer at a slight angle and mix shall be of little higher w/c ratio so that rebars are encapsulated.
13. Thickness of application : 25 mm. To 40 mm. Of gunite shall be deposited in one operation. For successive layer of deposit the previous layer shall be allowed to set but not become hard and dry.
14. Gunite : material deposit shall be moisten for at least seven days.
15. Rebound : The gunite mix shall be wet enough to reduce the rebound. Sand shall have preferably moisture content between 3 to 6%. Fineness modulus of sand shall be between 2.8 to 3.2 (neither too course nor too fine). Rebound material shall never be re-used.

## **16. SURFACE PROTECTION**

It is desired to protect the repaired concrete elements and also the concrete elements which are in good condition and are likely to get damaged over a period of time under the aggressive weather conditions. For this it is recommended, subject to approval, to apply the flexible, elastomeric anti-carbonation coating of desired Dry Film Thickness in selected shade / colour of approved brand as specified in bill of quantities as per the literature of manufacturer including the complete operation for its effective end results.

## **17. MECHANICAL & CHEMICAL ANCHORAGES**

All anchor system shall be of HILTI and fixing shall be as per standard procedure laid by manufacturer.

## **18. FIBRE WRAPPING & PRECURED LAMINATES: FRP COMPOSITE SYSTEM**

### **A. Material:**

The fibre fabric should essentially be a uni-directional fabric comprising of high strength continuous fibres oriented with E-glass fibres in the primary direction. The fibre reinforcement fabric should be woven and bounded such that there should be no disturbance of the main and secondary direction fibres upon tailor cutting, saturation and handling prior to and during the wrapping operation. The fibre reinforcement fabric should be made available in the rolls of minimum 300mm width and a continuous length of minimum 30 meters.

### **B. Resin:**

Appropriate formulated two component epoxy resin compatible to fibre fabric to serve the purposes of surface priming and saturation should be used.

### **C. FRP Shear Anchors System:**

In case aspect ratio is high or the dimension of structural element is large then for effective load transfer and confinement FRP composite system should include an anchoring system. The anchoring system should be of the same composite material. The diameter of the anchor should be between 12 mm. To 15 mm. And should have a minimum embedded length of 75 mm. To 150 mm. From the wrap surface. The FRP anchor should be pre-cured before insertion. The tail of anchor should be well spread over the wrapped surface.

### **E. Properties of FRP composite:**

Evaluation of FRP composite systems shall be based on the specifications and details provided by the manufacturers. The evaluation shall be on the basis of characteristics of fibre fabric, properties and characteristics of epoxy primer and saturant resins and properties and characteristics of cured composite laminate. During the work progress the data submitted shall be validated by test reports. Tests shall be carried out at Indian Institute of Technology or Sardar Patel College of Engineering. Test will include a).Ultimate tensile strength, b). Ultimate strain and c). Tensile Modulus. Vendor will submit the drawings containing the details of the number of layers of FRP composite system, joint and end details, FRP anchor details, locations of the composite to be placed, orientation of the fibres and all other information required for the proper installation of the FRP composite system.

### **F. FRP Composite System Installer Competency Criteria:**

The Vendor shall provide complete details of the installation process, quality control procedures and other relevant details pertaining to the FRP composite system.

The Vendor should have undergone training and he should be certified as trained applicator by the system manufacturer. The traing cerication should include surface preparation, material handling, batching and mixing of epoxy resin, manual and mechanical saturation, installation, curing and preparation of specimen for testing.

## **G. Method Statement:**

### **I. Non metallic composite fiber wrapping**

- a) Mortar Treatment: Application of average 10 to 20 mm thick Polymer Modified Mortar over the uneven RCC element surface by using Polymer Modified Cement bonding coat.
- b) Curing of subsurface: Mortar should be cured properly, maintaining moisture level in substrata less than 4 to 6%.
- c) Surface Preparation: The surface to be repaired is ground to smooth out the irregularities and sharp corners. Rounding of column / beam edges shall be done by grinding.
- d) Application of Primer: In order to improve adhesion and prevent the surface from drawing resin from the wrap, a low viscosity epoxy primer is applied with a roller until the substrate is locally saturated.
- e) Application of Putty: An adhesive, high viscosity putty is applied when necessary to the surface to fill in pin holes, offsets or voids.
- f) Application of Saturant: Apply Saturant coat to primed surface and FRP sheet using a medium nap roller. (Mechanized wetting of fiber sheet: Cut the fabric to required size. Mix the saturant and fill the same in tub area of the wet lay up saturation machine. Place the fiber on metallic rods and pass through the rollers of machine and saturant tub ensuring complete wetting (65% fiber volume fraction) of fibers. Remove the fiber on rod and place the new fiber sheet.)
- g) Application of Composite Wraps: Fabric will be carefully laid onto the surface and smoothed out to remove air bubbles and ensure that the fibers are straight and there are no wrinkles.
- h) Sand Sprinkling: Sand should be sprinkled on the final coat of wrap.

### **II. Non metallic pre-cured carbon fiber laminates**

- a) Mortar Treatment: Application of average 10 to 20 mm thick Polymer Modified Mortar over the uneven RCC element surface by using Polymer Modified Cement bonding coat.
- b) Curing of subsurface: Mortar should be cured properly, maintaining moisture level in substrata less than 4 to 6%.
- c) Surface preparation: Grind concrete substrate, cleaning it with wire brush removing oil, laitance if present, etc. Complete.
- d) Profiling: Apply compatible primer on prepared substrate, Fill the holes and uneven surface with thixotropic putty etc. Complete
- e) Application of plate: Mark the application area on structural element, cut the plate to require size, apply compatible structural adhesive on plate in parabolic manner by adhesive laminating machine (gluing machine), paste the laminate on desire area by using tamping roller to avoid any air voids etc. Complete.
- f) Sand pasting: Apply second coat of saturant after min. 12 hrs, rectify air voids if any paste the river sand on it to make surface rough to take any further finishes.

### **APPROVED BRANDS OF CONSTRUCTION / REPAIR CHEMICALS AND OTHER MATERIALS**

The materials used must be approved by the Consultant in writing. The following materials are approved for use.

<b><i>SN</i></b>	<b><i>MATERIALS</i></b>	<b><i>APPROVED BRAND / MAKE</i></b>
1	Rust Remover	Dr. Fixit Rust Remover, Feovert : Krishna Conchem
2	SBR Latex Polymer	Dr. Fixit Pidicrete URP, Monobond – SBR : Krishna Conchem
3	Acrylic Based Polymer	Dr. Fixit Pidicrete MPB, Monobond : Krishna Conchem
4	Anti-corrosive Protective Coat on Rebars	Dr. Fixit Epoxy Zinc Primer
5	Epoxy Bonding Agent	Krishna Conchem, Dr.Fixit Bonding Agent (Two Part Epoxy based)
6	Proprietary Polymer Fibre Reinforced Thixotropic Mortar	Dr. Fixit Polymer Mortar HB
7	Migratory Corrosion Inhibitor	Ferrogard – 903 of Sika, EPCO-KP-100 : Krishna Conchem
8	Anodic Protection	Galvashield XP (FOSROC)
9	Silicon Water Repellant Coating	Waker 290 of Wacker-Chemie
10	Sand for Plaster	River sand with silt content not more than 5% by volume ( In case silt content is more than 5% the sand, same has to be washed)
11	Sand for Polymer Mortar	Quartz sand / Washed river sand or blend of two at specified proportion..
12	Micro-concrete	Dr. Fixit Micro-concrete / Fosroc- Rederoc-RG
13	Low Viscosity Epoxy	Dr. Fixit Epoxy Injection Grout (Two part epoxy based injection)
14	Low viscosity high molecular weight thermosett polymer	Monopol : Krishna Conchem
15	Grouting additive	Dr. Fixit Pidicrete AM
16	Polypropylene Fibre	Nina Conc. System
17	Cement	43 grade OPC / Fly ash blended (Ambuja)
18	Heavy Duty Flexible Protective Membrane	New Coat of Dr. Fixit (Pidilite Ind.)

<b>SN</b>	<b>MATERIALS</b>	<b>APPROVED BRAND / MAKE</b>
19	Super-plasticizer	Supercon-100 : Krishna Conchem / Dr. Fixit Pidicrete CF111
20	Cement Based Paint	Snowcem Plus, Nitcocem
21	Acrylic Paint (100%)	Apex, ICI or as approved
22	Protective Coating System	Dryvit of NINA Conc. System
23	Anchor Fastener	Range of Hilti Products
24	Glass fibre	S&P G-Sheet 90/10 (980 gsm)
25	Carbon wrap	S&P C-Sheet 240 (430 gsm)
26	Primer	S&P Resin 20 Primer I
27	Saturant coat	S&P Resin Epoxy 55/50 (I)
28	Carbon Shear Anchors (Single)	S&P -ECFA/1
29	Carbon Shear Anchors (Double)	S&P -ECFA/2
30	Glass Fibre Shear Anchors (Single)	S&P -ECGA/1
31	Carbon Non Pre-stressed Laminates	S&P CFK Laminates
32	Mechanical Pre-stressing Anchor System	S&P Pre-stressing Anchor System

Equivalent material brand of other leading brands like Fosroc/BASF/SIKA/PIDILITE/KRISHNA CONCHEM can also be used after approval from the consultant.

Materials specified in SN 24 to 32 shall be handled under the guidance of S&P Clever Reinforcement and as per provisions of relevant codes ACI 440.1R-03 & ACI 440.2R-02.



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**SECTION: 3**

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**EQUIPMENTS**

Following equipments shall be required at the site.

- |     |   |     |                                    |
|-----|---|-----|------------------------------------|
| 1.  | Mixing trays for mortar   | 2.  | Water sprayer for curing           |
| 3.  | Spring weighing balance   | 4.  | Sand measuring box (FARMA)         |
| 5.  | Graduated measuring cylinders   | 6.  | Polymer mortar mixer               |
| 7.  | Measuring tapes   | 8.  | Caulking gun for crack filling     |
| 9.  | Water storage tank (10,000 liter cap.)  | 10. | Grouting gun (Epoxy & cement)      |
| 11. | Curing water pump   | 12. | Compressor for grouting            |
| 13. | Hammer drill  | 14. | Two legged H- Framed scaffolding   |
| 15. | Wet fibre lay up machine  | 16. | Pre-stressing assembly and machine |
| 17. | Compressor for guniting   | 18. | Guniting gun with all accessories  |
| 19. | Laminate gluing machine   | 20. | Stamping roller & brush            |
| 21. | Any other special equipment / machine / apparatus as and when required shall be mobilized by the Vendor as per instruction of consultant / owner. |     |                                    |