



Light Gauge Framed Steel Structure

User should check the validity of the Certificate by contacting Member Secretary, BMBA at BMTPC or the Holder of this Certificate.

Name and Address of Certificate Holder:

M/s JB Fabinfra Pvt. Ltd
907, Bhikaji Cama Bhavan
Bhikaji Cama Place,
New Delhi-110066
Tel: 0995822857

Performance Appraisal
Certificate No.

PAC No **1014-S/2014**
Issue No. **01**
Date of Issue: **16.10.2014**



bmtpc

Building Materials & Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation
Government of India
Core 5A, First Floor, India Habitat Centre,
Lodhi Road, New Delhi – 110 003

Tel: +91-11-2463 8096, 2463 8097; Fax: +91-11-2464 2849

E-mail: bmtpc@del2.vsnl.net.in Web Site: <http://www.bmtpc.org>

PERFORMANCE APPRAISAL CERTIFICATE


FOR

LIGHT GAUGE FRAMED STEEL STRUCTURE

ISSUED TO

M/S JB FABINFRA PVT. LTD.

STATUS OF PAC 1014- S/2014

S. No	Issue No.	Date of Issue	Date of renewal	Amendment		Valid up to (Date)	Remarks	Signature of authorized signatory
				No.	Date			
1.	2.	3.	4.	5.	6.	7.	8.	9.
1	01	16-10-2014	16-10-2016	--	--	15-10-2016	--	

Dr. Shailosh Kr. Agarwal
Chairman, TAC
& Member Secretary, BMBA
Building Materials and Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation, (Govt. of India)
Core 5A, 1st Floor, India Habitat Centre, Lodhi Road,
New Delhi-110 003

PAC No.1014-S/2014

Issue No. 01

Date of issue: 16-10-2014

CONTENTS

PART 1 CERTIFICATION	3
1.1 Certificate Holder	3
1.2 Description of System.....	3
1.3 Assessment	5
1.4 Uses of the System and its Limitations	5
1.5 Conditions of Certification	6
1.6 Certification	7
PART 2 CERTIFICATE HOLDER’S TECHNICAL SPECIFICATION	7
2.1 General	7
2.2 Specifications of the System	7
2.3 Inspection & Testing	9
2.4 Machinery Involved.....	9
2.5 Construction Process.....	10
2.6 Design Considerations.....	10
2.7 Unloading & Storage And Marking & identification.....	10
2.8 Erection & Fixing Process.....	12
2.9 Good Practices for Installation & Maintenance	17
2.10 Maintenance requirements	17
2.11 Skills/ Training needed for installation	17
2.12 Guarantees/ Warranties provided by the PAC holder	17
2.13 Service provided by the PAC holder to the customer	17
2.14 Manuals.....	18
2.15 Responsibility.....	18
PART 3 BASIS OF ASSESSMENT AND BRIEF DESCRIPTION OF ASSESSMENT PROCEDURE	18
3.1 Assessment	18
PART 4 STANDARD CONDITIONS	20
PART 5 LIST OF STANDARDS AND CODES USED IN ASSESSMENT	22
CERTIFICATION	23
PART 6 ABBREVIATIONS	24
PERFORMANCE APPRAISAL CERTIFICATION SCHEME – A BRIEF	25
ANNEX A	26
ANNEX B	27
ANNEX C	28
ANNEX D	34
ANNEX E	48

PART 1 CERTIFICATION

1.1 Certificate Holder: **M/S JB Fabinfra Pvt. Ltd.**
907, Bhikaji Cama Bhawan
Bhikaji Cama Place
New Delhi-110066
Phone No. 09958222857

1.2 Description Of System

1.2.1 *Name of the System* – Light Gauge Framed Steel Structure

1.2.2 *Brief Description*

Light Gauge Framed Steel Structure (LGFSS) is based on factory made galvanized light gauge steel components produced by the cold forming method assembled as panels at site forming structural steel framework of a building and varying wall and floor construction as detailed in this Certificate. The panels are assembled on site with screws and bolts to form the internal and separating walls and inner leaf of the external walls of a building and floors & ceiling. The building is completed by the installation of an external layer of insulation material and outer leaf of CP Board or dry mix shotcrete.

The system can incorporate all types of architectural features like coving, boxes, cantilevers, projections, infill walls, mezzanine floors etc. This system can also incorporate all types of services viz. electrical, gas and plumbing etc. The design and engineering of the structures is executed by following the norms & guidelines stipulated in relevant Indian Standards.

Typical section showing various components of Light Gauge Framed Steel structure is illustrated in Fig. 1.

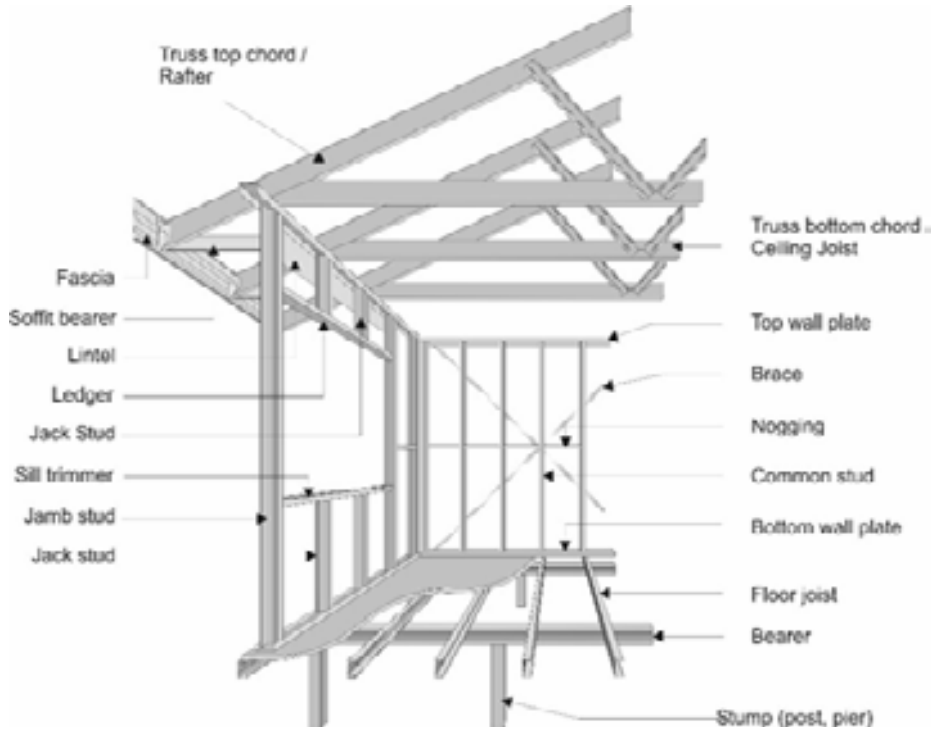


Fig. 1

1.2.3

Profiles and Sizes of Framing Components

The wall and floor panels are assembled from C section studs on a 610 mm grid aligning on centerlines and U section perimeter track of galvanized steel of specified grade, thickness and size, conforming to ASTM A 653/A, 653/M: 2013, IS277:1992 with minimum coating of Z 275 as per the details given below in Tables 1 and 2.

Table 1: Stud Profiles


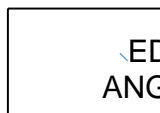


Shape	Width (Web) (mm)	Flange Height (mm)
 <p>STUD Thickness of 0.84, 1.2, 1.6 & 2mm in required cut size with service slots, as per design & requirement</p>  <p>EDGE ANGLE</p>	92.2	41.4
	92.2	50.8
	92.2	63.5
	101.6	41.4
	101.6	50.8
	101.6	63.5
	152.4	41.4
	152.4	50.8
	152.4	63.5
	203.2	41.4
	203.2	50.8
	203.2	63.5

Table 2: Track Profiles

Shape	Width (Web) (mm)	Flange Height (mm)
 <p>TRACK Thickness of 0.84, 1.2, 1.6 & 2mm in required cut size with services slots, as per design & requirement</p>  <p>ANGLE</p>	96.8	63.5
	106.2	63.5
	157.0	63.5
	207.8	63.5
	258.6	63.5
	309.4	63.5

1.3 Assessment

1.3.1 *Scope of Assessment*

1.3.1.1 Scope of assessment included conformance of manufactured steel sections to the specified requirements for use as:

- i) Multistoreyed residential Apartments
- ii) Low rise residential buildings

1.3.2 *Basis of Assessment*

1.3.2.1 Assessment of the suitability of the sections manufactured at M/s JB Fabinfra, Raigarh as framed structure is based on

- (i) Inspection of the factory
- (ii) Inspection of the test equipment used, test procedures followed and testing personnel involved in the laboratory of the factory
- (iii) Design details of G+3 two bed room flat considering wind load, seismic load etc. complete duly vetted by IIT Madras
- (iv) Assessment of quality assurance procedures implemented in the factory
- (v) Inspection of different stages of 12 blocks of Staff Quarters at Prasadha, Raigarh and Construction of 2nd floor extension of Girls hostel of GP Jindal Institute of Technology, Raigarh.

1.4 Use of The LGSS And Limitations

1.4.1 The system shall be used as framed steel structure.

1.4.2 *Limitation of Use*

- 1.4.2.1** LGSS may be used only upto G+3 level without any composition
- 1.4.2.2** LGSS may be used in G+3 and above with composition of hot rolled structures
- 1.4.2.3** LGSS shall not be used for buildings with vibrations
- 1.4.2.4** Advisable span for LGSS buildings shall be up to 6.5m.

1.4.3 *Durability*

The Certificate Holder shall provide necessary structural warranty ensuring durability of the system to the user, on demand. The windows, doors and internal fittings used on specified projects are outside the scope of this Certificate and their durability must be assessed independently.

1.5 **Conditions of Certification**

1.5.1 *Technical Conditions*

- 1.5.1.1** The raw materials and the finished sections shall conform to the requirements of the prescribed specifications.
- 1.5.1.2** The building to be constructed using Light Gauge Steel Structure shall be designed by competent structural engineer in accordance with the specifications following relevant codal requirements, manufactured as per the details worked out in design and constructed by trained persons only with technical support or supervision by qualified engineers and builders, based on structural designs and seismic evaluation & wind forces as per the details given in the Construction Manual and this PAC.
- 1.5.1.3** The structural engineers and building designers associated with such type of construction should be thoroughly familiar with the various structural aspects. It is also recommended that Architects and Construction Engineers who undertake such building design and construction gain familiarity with the properties and materials, characteristics of Light Gauge Steel System and its applications.

1.5.2 *Quality Assurance*

The Certificate Holder shall implement & maintain a quality assurance system in accordance with Scheme of Quality Assurance (SQA) given in Annex A attached with this Certificate. Process Flow (Standard Operating Procedure) for Light Gauge Steel Structure is also given in Annex B.

1.5.3 *Handling of User Complaints*

- 1.5.3.1** The Certificate holder shall provide quick redressal to consumer/user complaints proved reasonable & genuine and within the conditions of warranty provided by it to customer/purchaser
- 1.5.3.2** The Certificate holder shall implement the procedure included in the SQA. As part of PACS Certification he shall maintain data on such complaints

with a view to assess the complaint satisfaction and suitable preventive measures taken.

1.6 Certification

1.6.1 On the basis of assessment given in Part 3 of this Certificate & subject to the conditions of certification, use & limitations set out in this Certificate and if selected, installed & maintained as set out in Part 1 & 2 of this Certificate, the sections covered by this Certificate are fit for use set out in the Scope of Assessment.

PART 2 CERTIFICATE HOLDER'S TECHNICAL SPECIFICATION

2.1 General

2.1.1 The PAC holder shall manufacture these sections in accordance with the requirements specified in the relevant Standards. In addition it shall follow the Company standards specifying requirements of various materials used in the manufacture of these sections (see Part 5)

2.2 Specifications for the System

2.2.1 *Specification*

The manufacturer shall only use the raw materials supplied with the relevant documents as laid down in the prescribed Quality Assurance Plan. The raw materials shall be subject to agreed controls and tests by the manufacturer before acceptance.

2.2.2 *Technical Specifications*

2.2.2.1 *Raw materials*

1. *Stud & track profiles* shall be manufactured from pre-galvanized high tensile steel conforming to IS 277:1992, ASTM A 653/A 653M-2013 Grade 350 having Yield stress of min.350 MPa & Tensile stress of min. 380 MPa and coating of min. Z 275 or equivalent as per the Performance requirement, Dimensions and Permissible tolerances shall to ASTM C:955-07. See Fig 2 and table 3

- (i) Track shall be formed in a U-shaped configuration, having a depth compatible with that of the studs of the same nominal size.
- (ii) Min. height of track flanges shall be 19 mm.
- (iii) Bracing and bridging shall have configuration and steel thickness to provide secondary support for the studs in accordance with the relevant specifications for the Design of Cold-formed Steel Structural Members.
- (iv) Members shall be manufactured within the tolerance limits as shown in Fig.2 and Table 1 below
- (v) The width of the board to which the sheathing board is attached shall not be less than 32 mm

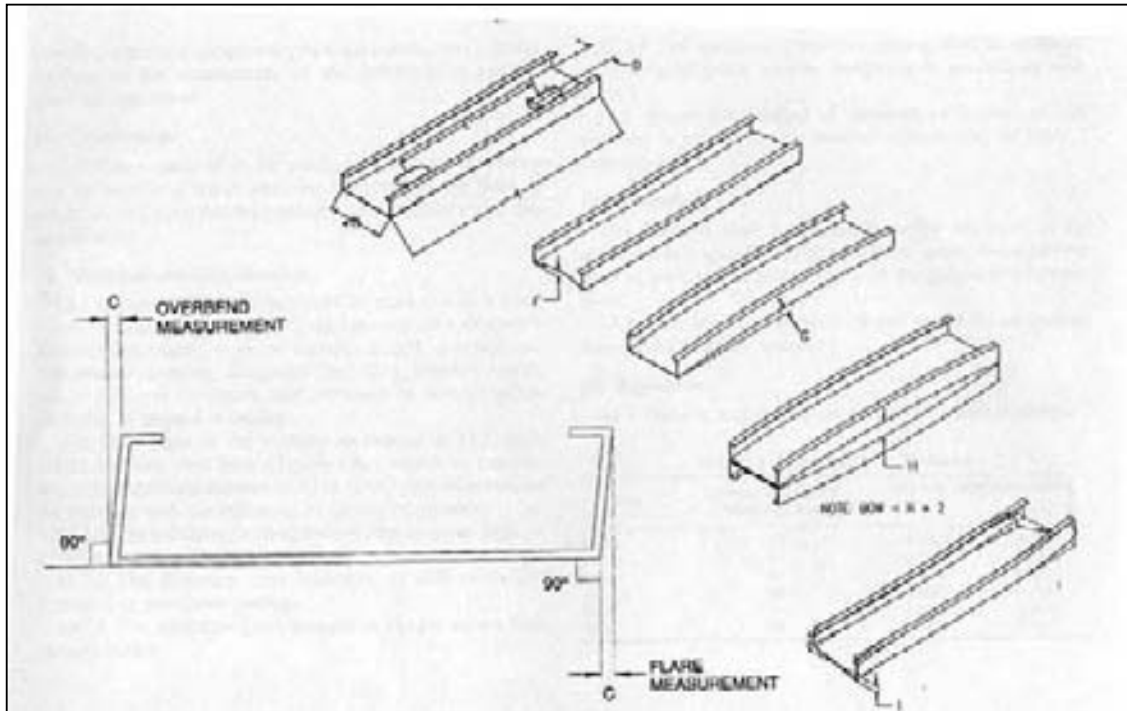


Fig. 2 Manufacturing Tolerances

Table 3 Manufacturing Tolerances

Dimension	Item	Structural Stud (mm)	Structural Track (mm)
A	Length	+ 2.38 -2.38	+ 12.7 - 6.35
B	Web width	+ 0.79 - 0.79	+0.79 -3.18
C	Flare overbend	+1.59 -1.59	+0 -2.38
D	Hole centre width	+1.59 -1.59	NA
E	Hole centre length	+6.35 -6.35	NA
F	Crown	+1.59 -1.59	+1.59 -1.59
G	Camber	0.79 12.7 max	0.79 12.7 max
H	Bow	0.79 12.7 max	0.79 12.7 max
I	Twist	0.79 12.7 max	0.79 12.7 max

2.2.2.2 MS plate shall conform to IS 2062:1999, E250

2.2.2.3 Other components

(a) Heavy duty CP Board shall conform to IS 14862:2000

(b) Gypsum board shall conform to IS 2095 (Part-1):2011

(c) Guniting/shotcreting

(d) shall conform to IS 9012:1978

(e) Screws as per the details given below shall be used:

(i) Panel Assembly – Low profile screws

(ii) LGS-LGS Wall panel to roof cassette – 12-14x15mm

(iii) LGS to concrete – Tapcon screw 14-12x60mm Hex head

(iv) Wire mesh = EPS board – SDS Hexhead with Ceresin without washer

(v) HRS-LGS – Hex head

(vi) CP board 6mm – WT 8 CSK Phillips

(vii) Gypsum board – Flat head self-driven type

(viii) Deck sheet/Wire mesh – SDS WT, CSK, Flat head

2.2.2.4 Wire mesh – made of 4mm dia wire of UTS 480 MPa of spacing 150x150 mm or 1.4mm dia of spacing 40x40mm

2.2.2.5 Rockwool slab having density 100 kg/m³ shall conform to IS 8183:1993

2.2.2.6 Rockwool roll with Aluminium foil having density 36 kg/m³ shall conform to IS 8183:1993

2.3 Inspections & Testing

Inspections & testing shall be done at appropriate stages manufacturing process. The inspected sections shall be stored & packed to ensure that no damage occurs during transportation. As part of quality assurance, regular in process inspections shall be carried out by the trained personnel of the PAC holder.

Detailed Guidelines for Inspection of Cold-formed Steel Structural Framing in Low Rise Buildings are given in Annex C.

2.4 Design Consideration

2.4.1 The system is intended for use where Architectural drawings are available and satisfy the various requirements. The Architect and Engineer designer team of the concerned developer/ owner (client) is responsible for the drawings and overall building design to comply with the various regulatory requirements applicable to the area. However, design of any structure shall be done based on the details given in Annex D.

2.4.2 All installation using light gauge steel structure panels shall be designed by qualified structural engineer, based on the data supplied by the Certificate holder.

2.4.3 The design engineer shall liaise with the engineer of the developer for

- design of the foundation.
- 2.4.4** The design assumptions, detailed calculations, references to necessary and detailed design drawings shall be made available on demand, if required. The structural design calculations should clearly demonstrate structural integrity and stability including connection details. Design calculations should have proper sketches annotated in English.
- 2.4.5** Foundation shall be specifically designed in accordance with provision given in IS 1904:1986. All foundations should be designed by structural engineer with appropriate reference.
- 2.4.6** In addition, any other requirement regarding safety against earthquake need to be ensured by the designer as per prevailing codal requirements.
- 2.5** **Machinery Involved**
(i) Four Pinnacle Roll forming machines having capacity upto 3000 m/hr and capability of 25 m/min manufactured in USA
(ii) One Vertical Saw machine Felder Kappa V60 having capacity upto 20 m/s and capability of 1140 m³/hr
- 2.6** **Construction Process**
Construction phases of steel buildings resemble the phases of conventional reinforced concrete buildings. The building is designed and details of sections are worked out. Then the steel frame construction starts. The production takes place in the factory as floor, wall and roof etc. components of the building are manufactured as galvanized steel profiles in appropriate sizes. These profiles are sent to the construction site without loss, either as profiles or as panelized parts, considering the distance of the construction site and transportation conditions. Profiles are assembled by expert assembling teams at the construction site in line with the architectural plan. Only special studs are used during the assembly, no welding is done. When the assembly is done, the frame is filled with insulation materials (fiberglass, rock wool etc.). Walls are covered with standard boards or similar materials.
- 2.7** **Unloading & Storage and Marking & Identification**
2.7.1 *Unloading and Storage*
The panels for each floor shall be unloaded and stacked so that they are in the necessary sequence for erection. Panels shall be protected from high winds and sharp impact. Panels shall be usually set starting at one corner of the building and proceeding to clockwise fashion. At the time of unloading:
- 2.7.1.1** Before starting erection, it should be made sure that a complete set of erection drawings marked "Good for Construction (GFC)" are available in the register, which shows all the drawings in the set along with the

latest revision number and date. All the panels should check with the Dispatch Packing List.

2.7.1.2

If the panel has been damaged through transportation, it should be noted by the engineer in charge.

As the material is unloaded, it can be stored conveniently around the site.

- a) On receipt of material, it should be examined for damage. If a small amount of moisture is present, the member should be dried before restacking or storage. Damp material should never be restacked until thoroughly dry.
- b) The stud/joist/panel must be properly packaged and stored, otherwise, white rust may develop at minute cracks at the cut edges. When galvanized stud/joist/panel become wet from rain, natural condensation, or other causes, white rust may result. This may occur either in transit or in storage at the jobsite.
- c) Roofing and siding sheets should be erected as soon as possible after their arrival at the jobsite. If temporary storage is absolutely necessary, they should be stored indoors. Where indoor storage is not possible, entry of moisture into the bundle and consequent storage stain should be prevented.
- d) Steel bundles shall be stored level.
- e) Steel members shall be protected from weather.
- f) Do not open bundles until time of installation. Care shall be taken when handling bundles and individual components to prevent injury to handlers or damage by forklift or crane.
- g) Twisting of steel members, or applying loads to the members when flat, may damage them.
- h) Damaged steel members shall not be used.
- i) Care should be exercised when handling flat steel joist members. Beginning with the unloading process, and throughout all phases of construction, care must be taken to avoid lateral and torsional bending (twisting) of members, which may cause damage to the steel joist members.

2.7.2

Marking and Identification

2.7.2.1

Groups of like members shall be marked with a label or a tag attached thereto. Marking shall include the manufacturer's identification (name, logo etc.), length, quantity and manufacturer's member designator including depth, flange size and min. steel thickness.

2.7.2.2

In addition to the marking reference, individual members shall have a legible label, stencil or embossment at a max. distance of 2.44m on centre on the member with the following minimum information:

- (i) The min. steel thickness in mm, exclusive of protective coatings
- (ii) The min. yield strength in N/m²

- (iii) Where colour coding of members or bundles of like members is employed, the standard colour coding shall be used.

2.8 Erection & Fixing Process

2.8.1 Foundation

Foundations to light steel framing are essentially the same as for any other form of construction, although the dead loads applied by the light steel frame will be much lower than in concrete or masonry construction. The foundation line should be matched with GFC drawings.

All forms of frame construction require an accurate 'starting point'.

Therefore, the foundations or ground beams must be finished accurately in order to be acceptable for 'hand-over' to the frame erector. For accurate erection of the frame, the following tolerances are provided while in wide the engineering practice (SCI P301)

Length of wall frame +/- 10 mm in 10 m.

Line of wall frame +/- 5 mm from outer face of plate.

Level of base of wall frame +/- 5 mm over complete wall line.

- a) All tracks should completely rest on foundation to concrete.
- b) Before doing any fabrication or erection, the engineering department will usually submit fabrication and erection drawings to the architect and obtain approval. After approval, careful site measurements should be taken that any variations from the original plans can be allowed for.
- c) The level should be maintained for foundation if there any level difference erection can be done with insert plate and finally it should be grouted at the site.

2.8.2 Wall Panels

- All load bearing studs, including king and jack studs, shall be seated in the tracks with a maximum of 0.32 mm between the end of the stud and the web of the track.
- Wall bridging shall use the same pattern of blocked bay at the end of each run with additional intermediate blocked bays at 3.6 m on centre for lengths of walls greater than 3.6 m. Wall bridging is not necessary if appropriate sheathing is placed on both flanges of the stud prior to loading the wall.
- Adequate temporary wall bracing shall be provided until permanent bracing has been installed. Temporary construction bracing may also remain in place after permanent bracing is installed.
- A sill sealer, or equivalent, shall be provided between the underside of the wall when fastened directly to concrete.

- During erection, support may be provided in sufficient number to prevent distortion and damage to frame work due to wind or erection forces. These cables may also be used to plumb and align the work.
- All erection work must be level and to dimensions and elevations as indicated by plans, using leveling instruments and plumb bob.
- Report any discrepancies in plumbing or leveling to engineer in charge.
- Make certain that, equipment of adequate capacity are available.
- All the wall lines should be marked in the site.
- Starting at any convenient external corner stand and plumb a wall frame panel in its exact position.
- Stand and plumb the adjoining frame to make a self-supporting corner.
- Clamp the frames together and check again both the frames are in their exact locations and standing vertical.
- Connect the frames using the manufacturers recommended method.
- Proceed with the erection of the frames around the house, standing internal and external frames as they occur.
- Provide adequate temporary bracing during wall frame erection. The line of top plates in a run of walling should be checked with a string.
- *As-built tolerances for light steel framed structures*
Light steel framing is very accurate and dimensional variations are largely due to the inaccuracy of the other components, particularly the foundations. Light steel framing may be used with all foundation types but care must be taken to ensure that target line and level tolerances are achieved, in order to assemble the wall panels accurately.
- *Head of Stud Wall*
Overall Height
Plumb of stud wall:
Maximum deviation of +/-15mm in overall height of wall (3 storey) or +/- 10mm in overall height of wall (2 storey) and +/- 5mm in storey height (approx. 2.5m)
- *Base of stud wall*
Verticality of frame (relative to base) Temporary bracing

Wall frames are unstable until floor members are fixed in position. As with any type of building, it is unsafe practice to leave a partially erected structure in an unstable state. Therefore, temporary side supports or bracing may be required, particularly when the structure is left overnight in a partially erected condition.

The requirements of every individual case should be separately considered but it may be appropriate to use a scaffold 'cage' for

extra restraint. The addition of other loads, such as stacking of plasterboard on suspended floors, is not acceptable until the framework has been completed and fully braced. These loads should be checked by the designer.

2.8.3

Floor Panels

- Follow in-line-framing layout when require
- Use of string line, plumb bob, level, or transit is encouraged to ensure that the foundation is relatively “true” before beginning installation because tolerances are very critical in achieving an acceptable floor
- Track members shall not be used individually for any load carrying applications without an approved design.
- Bearing surfaces for joists shall be uniform and level.
- Adequate temporary joist bracing shall be provided until permanent bracing has been installed. Temporary construction bracing may also remain in place after permanent bracing is installed.
- All anchors, hangers, tie-downs, bearing ledgers, etc., that are part of the supporting structure shall be properly placed and attached. No steel joist shall ever be installed on anchors or ties that have temporary connections to the supporting structure.
- Web stiffeners shall be installed at all concentrated load locations and are often required at bearing points (i.e., where joists bear on bearing walls or beams) unless designed otherwise.
- Web stiffeners are permitted to be installed on either face of the joist web.
- Floor joists shall not be loaded before bracing or sheathing is installed. Heavy construction loads, such as stacks of plywood, gypsum board, bricks, etc., shall not be placed on floor joists before they are properly braced or without appropriately distributing the load so the capacity of the floor system is not exceeded.
- Walking across unbraced floor systems should be avoided. This may cause an unexpected fall.
- Sub-flooring should be checked for squeaks. Correct as necessary.
- Allow a small gap on either end of the floor joist to keep the floor joist away from the rim joist so that the potential problem of the floor joist rubbing against the rim joist and causing squeaks in the floor is eliminated.

2.8.4

Roof Panels

The truss system is the most common roof system. The truss spacing is determined by the type of roof cladding (i. e. tile or steel sheeting), the strength and rigidity of the battens and safety guidelines for safe installation of cladding. It is possible to increase this spacing if a ‘work method statement’ is developed to show it is safe to install battens and cladding on trusses spaced further apart.

Truss chords typically use one of following sections:

- Floor or roof trusses shall be engineered by a design professional.
- Dimensions and proper bearing locations, as shown on truss design drawing, shall always be verified before starting installation of the truss.
- Temporary construction bracing shall remain in place as long as necessary for the safe and acceptable completion of the roof or floor and may also remain in place after permanent bracing is installed.
- Trusses are laterally unstable until bracing is properly installed; necessary caution shall be employed during the installation process. Overloading of roof trusses before permanent bracing and/or sheathing is installed is not permitted.
- Heavy construction loads, such as stacks of plywood, gypsum board, bricks, HVAC units, etc., shall never be placed on trusses before they are properly braced. Trusses are not typically designed for dynamic loads (moving loads). Sleepers for mechanical equipment shall be located at panel points or over main supporting members, or on trusses that have been designed to carry such loads.
- Any corrections that involve cutting, drilling, or relocation of any truss member or component shall not be made without notifying the truss manufacturer of the need for and extent of the modifications. All major corrections, cutting, or drilling of truss members without the approval of a qualified design professional shall be prohibited.
- Trusses shall not be placed over loose lintels, shelf angles, headers, beams, or other supporting structures not securely attached to the building.
- Trusses that do not meet interior load bearing walls shall be shimmed for adequate bearing.
- Trusses shall not be pulled down to any interior partition.

Table 4 Minimum Allowable Fastener Capacity for Steel to Steel Connections^{1,2} [Safety factor = 3.0]

Screw Size	Minimum Shank Diameter	Minimum Head Diameter	Minimum Capacity (N)			
			Shear Capacity		Pullout Capacity	
			1.10mm	0.84mm	1.10mm	0.84mm
No. 8	0.738	1.449	1098	738	423	324
No. 10	0.855	1.728	1183	796.5	490	378

1 Values represent the smaller thickness of two pieces of steel being connected.

2. Screw capacities given are calculated in accordance with CCFSS Technical Bulletin [25].

2.8.5

Decking Sheet

Thickness and profile of decking sheet shall be verified with the erection

drawings. These are normally used as temporary supports for the concrete till hardens. Decking sheet has to be screwed to the joist with maximum spacing of 600 mm c/c for uniform action of concrete and joist. All the joints of decking sheets longitudinal direction requires a minimum lap of 100 mm.

2.8.6 *Finishing of Wall*

Walling materials such as CP board, Gypsum board, Guniting/shotcreting & PPGI sheet etc. when used for completing the wall internally & externally shall conform to the relevant Indian Standards as applicable wall. Details of fixing of wall panels using these materials as shown in Figs. 11 to 17 of Annex E may be referred for guidance.

Walling materials used in the system shall be such that the completed wall provides fire resistant property as per requirements given in National Building Code 2005.

2.8.7 *Cladding with GI Sheets*

Thickness and profile of sheet shall be verified with the erection drawings. These are normally used as roof/ wall cladding and design to resist wind load. Sheet has to be screwed to the joist/ purlin with maximum spacing of 300 mm c/c. All the joints of sheets longitudinal direction requires a minimum lap of 150 mm in order to make leak proof. Sealant tape/ sealant paste shall be used at joints to avoid any type of leakage

Structural drawings (Fig. 5 to 27) showing Erection & Fixing details of LGS Structure are appended at Annex E.

The erection procedure for a light gauge steel frame used in housing is illustrated in Fig. 3

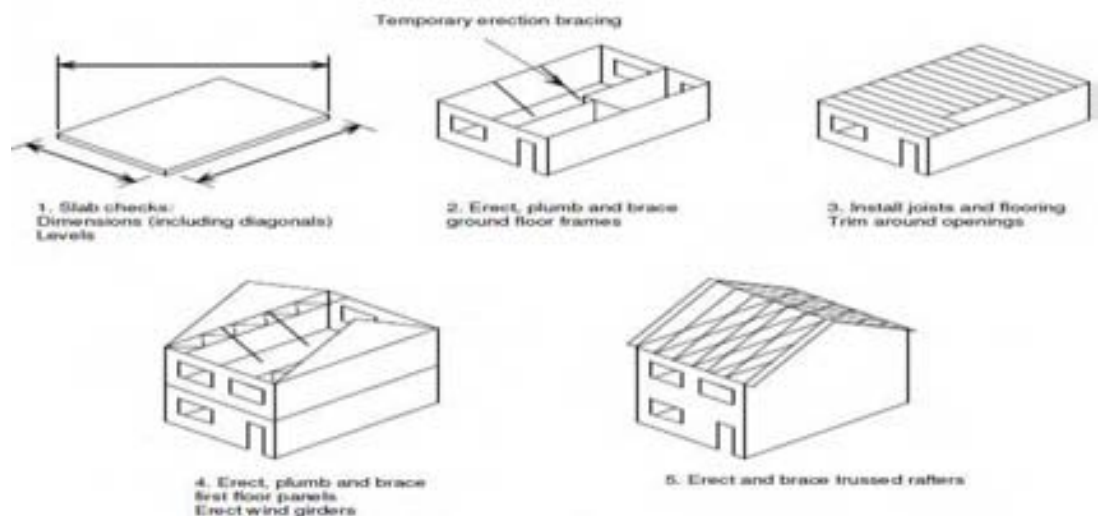


Fig. 3

- 2.8.8** *M & E Services*
Pre-punched service holes in the web of the steel frame allows electrical, gas and plumbing services to be installed within the wall framing system. Plastic grommets and silicone seals shall be used to fasten and protect wiring and pipes from corrosion and damage arising from vibrations.
- 2.8.9** *Electrical and Plumbing Services*
Electrical and plumbing services are outside the scope of this Certificate; however, in designing and installing these services, precautions must be taken to avoid the possible risk of long term damage to the structure or the services by e.g. the ingress of water, water vapour or condensation from water service pipes.
Electrical cables running within the insulation layer in the separating floor construction should be protected with cartridge fuses or min circuit breakers.
Where it is necessary for fittings, services or ducts to penetrate a wall or floor construction, the detailing must ensure that the relevant fire resistance, acoustic performance and water & vapour resistance is not impaired, particularly in relation to the fire integrity requirements
- 2.9** **Good Practices for Installation & Maintenance**
Good practice as per requirement including Do's & Don'ts of working with LGSS System of the manufacturer shall be followed for erection and maintenance of these sections.
- 2.10** **Maintenance Requirements**
It is assumed that no special maintenance is required during intended working life. Should repairs prove necessary, it shall ably be carried out by the trained persons using appropriate products and materials. The structures shall be regularly cleaned and painted.
- 2.11** **Skilled /Training Needed for Installation**
Workers shall be trained/ oriented on handling of sections and its erection and support system etc. with all required safety measures taken including heavy hats, protective shoes etc.
- 2.12** **Guarantees/Warranties Provided by the PAC Holder**
PAC holder shall provide necessary guarantees/ warranties of the system to the client. A brochure giving relevant details shall be made available to the client.
- 2.13** **Services Provided by the PAC Holder To The Customer**
In-house testing of sections at regular intervals as per the QCA requirement shall be ensured by the PAC holder

2.14 **Manuals**

A site Erection Manual and a Manual for Health & Safety shall be provided for each project incorporating the Light Gauge Steel Framed Structure.

2.15 **Responsibility**

- Specific design using Light Gauge Steel Structural System is the responsibility of the designer with the instructions, supervision and guidance of the PAC holder.
- Quality of installation of the system on site is the responsibility of the trade persons engaged by the agency
- Quality of maintenance of the building is the responsibility of the building owner.
- Providing necessary facilities and space for movement of cranes and vehicles is the responsibility of the building developer.

PART 3 BASIS OF ASSESSMENT AND BRIEF DESCRIPTION OF ASSESSMENT PROCEDURE

3.1 **Assessment**

3.1.1 *Factory Inspection*

The factory at Raigarh was inspected by the technical team of the Council. The raw materials and finished products were found to be as per specifications. The firm has got necessary manufacturing and test facilities to produce the required components as per design and specifications. It operates a Quality Assurance system in the factory to ensure that the product conforms to the specified requirements. Persons involved in testing were found to be well conversant with testing procedures required for the quality control of the system. Inspection of different stages of 12 blocks of Staff Quarters at Prasadha, Raigarh and Construction of 2nd floor extension of Girls hostel of GP Jindal Institute of Technology, Raigarh.

3.1.2 *Design Procedure*

The agency follows a well-defined design procedure based on relevant Indian Standards and British Standard BS 5950-05 as given in Annex D.

3.1.3 *Independent Evaluation of Design by IIT Madras*

IIT Madras carried out independent evaluation of loads and design of the LGSS G+3 system as per IS 801:1975 & British code BS 5950(Part 5):1998 for design and IS 875:1987 and IS1893: 2002 for loads. All the connection details were checked by it. Later a visit was made by IITM to the site at Punjipatra for an onsite evaluation of the construction. Based on the independent analysis and design carried out by the IIT Madras on the G Type G+3 residential flats using LGSS at Punjipatra, Raigarh and

also based on the site visit, it is certified by the IIT Madras that the designs submitted by M/s JB Fabinfra is structurally adequate and safe as far as the strength of stiffness requirements.

3.1.4 *Inspection of Projects at Prasada, Raigarh*

Inspection of 12 blocks of Staff Quarters and 2nd Floor extension of Girls Hostel of Jindal Institute of Technology, Raigarh was carried out by the technical team of the Council. The method of construction was found to be in accordance with the details provided by the Certificate holder and as detailed in this PAC. The arrangement of execution and fixing of services were found to be satisfactory. The overall construction of houses recently built and occupied were found to be satisfactory

3.1.5 *Execution of Projects*

The firm has executed the projects using the LGS system as per the details given below:

S. No.	Name & address of the customer	Area (Sq m) of the Project	Month/ Year of completion
1.	JSPL Prasada Housing Project (G+3), Raigarh (CG)	6000(approx.)	Oct., 2012
2.	JSPL Guest House (2 nd Floor extension), Raipur (CG)	460 (approx.)	Nov., 2012
3.	JRPL Field Hostel, Sonipat	200 (approx.)	Nov., 2012
4.	OPJIT Girls Hostel Extension, Raigarh	550 (approx.)	Jan., 2013
5.	JSPL Technical Block, Raipur	550 (approx.)	Apr., 2013

PART 4 STANDARD CONDITIONS

This certificate holder shall satisfy the following conditions:

- 4.1** The certificate holder shall continue to have the product reviewed by BMBA.
- 4.2** The product shall be continued to be manufactured according to and in compliance with the manufacturing specifications and quality assurance measures which applied at the time of issue or revalidation of this certificate. The Scheme of Quality Assurance separately approved shall be followed.
- 4.3** The quality of the product shall be maintained by the certificate holder.
- 4.4** The product user should install, use and maintain the product in accordance with the provisions in this Certificate.
- 4.5** This certificate does not cover uses of the product outside the scope of this appraisal.
- 4.6** The product is appraised against performance provisions contained in the standards listed in Part-V. Provisions of any subsequent revisions or provisions introduced after the date of the certificate do not apply.
- 4.7** Where reference is made in this Certificate to any Act of Parliament of India, Rules and Regulations made there under, statutes, specifications, codes of practice, standards etc. of the Bureau of Indian Standards or any other national standards body and the International Organization for Standardization (ISO), manufacturer's company standards, instruction/manual etc., it shall be construed as reference to such publications in the form in which they were in force on the date of grant of this Certificate (and indicated in Part V to this Certificate)
- 4.8** The certificate holder agrees to inform BMBA of their distributors / licensees whenever appointed by him and agrees to provide to BMBA a six monthly updated list thereof.
- 4.9** The certificate holder agrees to provide to BMBA feedback on the complaints received, the redressal provided, and the time taken to provide redressal on complaint to complaint basis as soon as redressal is provided. BMBA agrees to provide the certificate holder the user feedback received by it, if any.
- 4.10** If at any time during the validity period, PACH is unable to fulfill the conditions in his PAC, he should on his own initiative suspend using the PAC and notify Chairman, TAC the date from which he has suspended its use, the reason for suspension and the period by which he will be able to resume. He shall not resume without the prior permission of BMBA. He shall also inform, simultaneously, his agents, licensees, distributors, institutional, government, public sector buyers, other buyers and all those whom he has informed about his holding the PAC. He shall also inform all those who buy his product(s) during the period of suspension. He shall provide to BMBA at the earliest the list of who have been so informed by him.

- 4.11 In granting this Certificate, BMBA takes no position as to:
- The presence or absence of patent or similar rights relating to the product;
 - The legal right of the Certificate holder to market, install or maintain the product;
 - The nature of individual installations of the product, including methods of workmanship.
- 4.12 BMTPC and the Board of Agreement of BMTPC (BMBA) take no position relating to the holder of the Performance Appraisal Certificate (PACH) and the users of the Performance Appraisal Certificate (PAC) respecting the patent rights / copy rights asserted relating to the product / system / design / method of installation etc. covered by this PAC. Considerations relating to patent / copy rights are beyond the scope of the Performance Appraisal Certification Scheme (PACS) under which this PAC has been issued. PACH and users of this PAC are expressly advised that determination of the Claim / validity of any such patent rights / copy rights and the risk of infringement of such rights are entirely the responsibility of PACH on the one hand and that of the users on the other.
- 4.13 It should be noted that any recommendations relating to the safe use of the product which are contained or referred to in this Certificate are the minimum standards required to be met with when the product is installed, used and maintained. They do not purport in any way to restate or cover all the requirements of related Acts such as the Factory Act, or of any other statutory or Common Law duties of care, or of any duty of care which exist at the date of this Certificate or in the future, nor is conformity with the provisions of this Certificate to be taken as satisfying the requirements of related Acts.
- 4.14 In granting this Certificate, BMTPC and BMBA does not accept responsibility to any person or body for any loss or damage, including personal injury, arising as a direct or indirect result of the use of this product.
- 4.15 The certificate holder indemnifies BMBA, its officers and officials involved in this assessment against any consequences of actions taken in good faith including contents of this certificate. The responsibility fully rests with the certificate holder and user of the product.
- 4.16 The responsibility for conformity to conditions specified in this PAC lies with the manufacturer who is granted this PAC. The Board (BMBA) will only consider requests for modification or withdrawal of the PAC.
- 4.17 The PAC holder shall not use this certificate for legal defense in cases against him or for legal claims he may make from others.

Dr. Shailesh Kr. Agarwal
Chairman, TAC

Chairman TAC & BMBA

Building Materials and Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation, (Govt. of India)
Constitutional Body, Government of India
New Delhi-110 002

for and on behalf of

Member Secretary, BMBA

Place: New Delhi

Date of issue 16-10-14

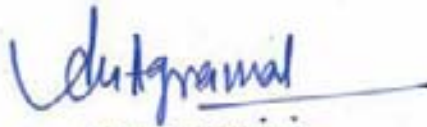
PART 5 LIST OF STANDARDS & CODES USED IN ASSESSMENT

- 5.1** These Standards are referred for carrying out particular tests only and do not specify the requirement for the whole product as such.
- 5.1.1** IS 277:1992 – Specifications for Galvanized Steel Sheets (Plain & corrugated)
- 5.1.2** IS 801:1975 – Code of practice for use of Cold Formed Light gauge Steel structural members in General building construction
- 5.1.3** IS 456:2000 –Code of practice for Plain & Reinforced concrete (fourth revision)
- 5.1.4** IS 875 (Parts1 to 5):1987 – Code of Practice for Design Loads (other than earthquake) for buildings & structures
- 5.1.5** IS1893:2002 – Criteria for Earthquake Resistant Design of Structures
- 5.1.6** IS 1904: 1986 – Code of Practice for design and construction of foundations in soils: General requirements.
- 5.1.7** IS 2062:2011– Specifications for hot rolled medium & high tensile structural steel
- 5.1.8** IS 2095 (Part1):2011 –Specifications for Gypsum plaster boards -- plain
- 5.1.9** IS 8183:1993 – Code of Practice for Bonded Mineral Wool
- 5.1.10** IS 9012:1978 – Recommended practice for shotcreting
- 5.1.11** IS14862:2000 – Code of Practice for Fiber Cement Flat Sheets
- 5.1.12** BS 5950 (Part 5):1998 –Code of practice for design of cold formed thin gauge sections
- 5.1.13** AS/NZS 4600:2005 – Design of Cold Formed Steel Structures
- 5.1.14** ASTM C 955:2007 – Standard Specifications for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks) and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases
- 5.1.15** ASTM A307: Standard specification for Carbon steel Bolts & studs
- 5.1.16** ASTM A 568 – Standard specifications for thickness tolerances of cold rolled steel sheets & coils
- 5.1.17** ASTM A 653(9) – Standard specifications for steel sheet, zinc coated or zinc-iron-alloy coated
- 5.1.18** ASTM C1513 – Standard specifications for steel tapping screws for cold formed steel framing connections
- 5.2** **Company Standards of the PAC holder** – The branded design & specifications of the raw materials and finished product are as submitted by the manufacturer. The PAC holder has to make available the company standards to the consumers according to which testing have been done.

CERTIFICATION

In the opinion of Building Materials & Technology Promotion Council's Board of Agreement (BMBA), **Light Gauge Framed Steel Structure** bearing the mark manufactured by M/s JB Fabinfra Pvt. Ltd. is satisfactory if used as set out above in the text of the Certificate. This Certificate **PAC No.1014-S/2014** is awarded to **M/s JB Fabinfra Pvt. Ltd.**

The period of validity of this Certificate is as shown on Page 1 of this PAC. This Certificate consists of pages 1 to 70.



Dr. Shailesh Kr. Agarwal
Chairman, TAC
& Member Secretary, BMBA
Building Materials and Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation, (Govt. of India)
Core 5A, 1st Floor, India Habitat Centre, Lodhi Road,
New Delhi-110 003



On behalf of BMTPC Board of Agreement, Chairman, Technical Assessment Committee (TAC) of (BMBA) Under Ministry of Housing and Urban Poverty Alleviation, Government of India

Place: New Delhi, India

Date: 16-10-14

Abbreviations

BMBA	Board of Agreement of BMTPC
BMTPC	Building Materials and Technology Promotion Council
CPWD	Central Public Works Department
ED	Executive Director of BMTPC
IO	Inspecting Officer
MS	Member Secretary of BBA
PAC	Performance Appraisal Certificate
PACH	PAC Holder
PACS	Performance Appraisal Certification Scheme
SQA	Scheme of Quality Assurance
TAC	Technical Assessment Committee (of BMBA)

Performance Appraisal Certification Scheme –A Brief

Building Materials & Technology Promotion Council (BMTPC) was set up by the Government of India as a body under the Ministry of Housing & Urban Poverty Alleviation to serve as an apex body to provide inter-disciplinary platform to promote development and use of innovative building materials and technologies laying special emphasis on sustainable growth, environmental friendliness and protection, use of industrial, agricultural, mining and mineral wastes, cost saving, energy saving etc. without diminishing needs of safety, durability and comfort to the occupants of buildings using newly developed materials and technologies.

During the years government, public and private sector organizations independently or under the aegis of BMTPC have developed several new materials and technologies. With liberalization of the economy several such materials and technologies are being imported.

However, benefits of such developments have not been realized in full measure as understandably the ultimate users are reluctant to put them to full use for want of information and data to enable them to make informed choice.

In order to help the user in this regard and derive the envisaged social and economic benefits the Ministry of Housing & Urban Poverty Alleviation has instituted a scheme called Performance Appraisal Certification Scheme (PACS) under which a Performance Appraisal Certificate (PAC) is issued covering new materials and technologies. PAC provides after due investigation, tests and assessments, amongst other things information to the user to make informed choice.

To make the PACS transparent and authentic it is administered through a Technical Assessment Committee (T AC) and the BMTPC Board of Agreement (BMBA) in which scientific, technological, academic, professional organizations and industry interests are represented.

The Government of India has vested the authority for the operation of the Scheme with BMTPC through Gazette Notification No. 1-16011/5/99 H-II in the Gazette of India No. 49 dated 4th December, 1999.

Builders and construction agencies in the Government, public and private sectors can help serve the economic, development and environmental causes for which the people and Government stand committed by giving preference to materials and technologies which have earned Performance Appraisal Certificates.

Further information on PACS can be obtained from the website: www.bmtpc.org

ANNEX A
(Clause 1.5.2)

QUALITY ASSURANCE PLAN FOR LIGHT GAUGE FRAMED STEEL STRUCTURE

S.No	Process/ Operation	Parameters to check	Acceptance Norms	Frequency of testing	
				Level (i)	Level (ii)
A-1 Raw Materials					
A-1.1	G P Coil	Dimensions & Properties	ASTM A568, ASTM A653 S50, Z275 & E350	MTC – 100%	Dimension - 100%
A-1.2	Screws	During receipt & issue for fabrication	ASTM C1513	MTC – 100%	Dimension - 100%
		Visual		Visual– 100%	Visual - 100%
A-1.3	Anchor Bolts	During receipt & issue for fabrication	HILTI /BTC	MTC – 100%	Dimension - 100%
		Visual		Visual– 100%	Visual - 100%
A-1.4	Roof Sheets /Cladding	Erection		MTC – 100%	Dimension - 100%
A-1.5	Corrugated Sheets	Erection	IS 277:1992	MTC – 100%	Dimension - 100%
A-1.6	Weld mesh	Erection	PO/ Supplier Standards	MTC – 100%	Dimension - 100%
A-1.7	Insulation	Erection	PO/ Supplier Standards	MTC – 100%	Dimension - 100%
A-1.8	Cement Fiber Board	Erection	PO/ Supplier Standards	MTC – 100%	Dimension - 100%
A-1.9	Gypsum Board	Erection	PO/ Supplier Standards	MTC – 100%	Dimension - 100%
A1.10	Floor Tiles	Erection	PO/ Supplier Standards	MTC – 100%	Dimension - 100%
A-2 Process					
A-2.1	Roll Framing	Dimensions	ASTM C955:07	Dimension 100%	Dimension - 100%
		Visual		Visual - 100%	Visual - 100%
A-2.2	Packing	Visual	As per panel wise drawing details	Visual - 100%	Visual - 100%
A-2.3	Dispatch	Visual		Visual - 100%	Visual - 100%
A-2.4	Assembly	Dimensions		Dimension 100%	Dimension - 100%
		Visual		Visual - 100%	Visual - 100%

Category of Quality Level Checks:

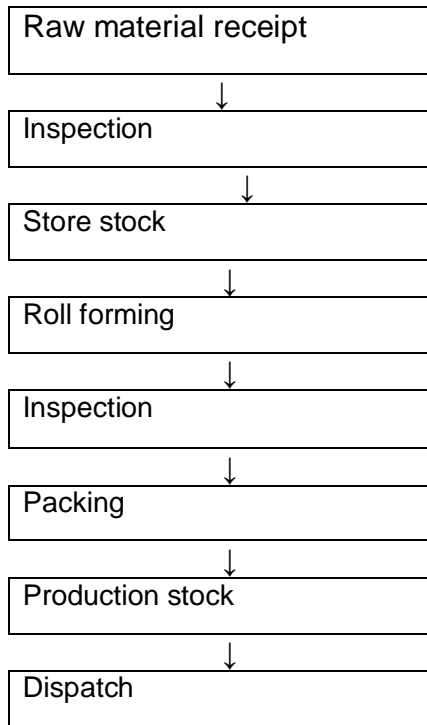
Level (i) Manufacturer’s Test Certificate as per tests conducted at its premises or other laboratories

Level (ii) Laboratories established at site

Level (iii) Independent laboratory

ANNEX B
(Clause 1.5.2)

PROCESS LAYOUT FOR *LIGHT GAUGE FRAMED STEEL STRUCTURE*



ANNEX C
(Clause 2.3.1)

GUIDELINES FOR INSPECTION OF COLD-FORMED STEEL STRUCTURAL FRAMING IN LOW RISE BUILDINGS

C-1 Materials

C-1.1 Steel Verification:

- (i) Cold-formed steel structural members shall match with the specified size, type, mechanical properties and spacing.
- (ii) Each member should bear a legible sticker, stamp, etc. spaced at a max. of 2.44m c/c indicating the steel designation, thickness, min. yield strength, name of manufacturer etc.
- (iii) Member sizes i.e. length of webs, flanges and material thickness should be the same as specified in the approved design.
- (iv) The min. metallic coating weight requirements of structural members should be CP60 unless another coating weight is specified.

C-1.2 Member Condition: The framing members shall not be damaged. Damaged members shall be replaced or repaired in accordance with approved design.

C-1.3 Web Holes: The factory punch outs or field penetrations shall conform with the approved design. Web holes should not be spaced closer than 60mm or located closer than 25 cm from a bearing condition.

C-1.4 Field Nuts and Notches: There shall be no field cuts or notches through the flanges or lips of any structural members.

C-2 Connections

C-2.1 Screw Connections:

- (i) The screws installed shall comply with the approved design. The screws shall satisfy shear and pull out requirements, diameter and point style in relation to combined thickness of all connected steel frame members.
- (ii) Steel-to-steel and structural sheathing-to-steel shall be inspected to ensure that they extend through the steel connection to a min. penetration of three exposed threads through the last material joined.
- (iii) The screws shall penetrate individual components in the connection without causing permanent separation between the components.
- (iv) Missing screw heads, if any, shall be replaced. For screw fasteners in steel-to-steel connections to be fully effective, the min. C to C spacing and edge distance should be three times the normal dia except when the edge is parallel to the direction of applied force. The min. edge distance of screw fasteners should be 1.5 times the normal dia.

Self-drilling screws shall be checked for pull out strength as per the calculated value at the component as well as system level.

C-2.2 *Pneumatically Driven Pins:*

- (i) Installed pins shall comply with the approved design.
- (ii) Ensure that pins are fully driven and have a min. penetration of 6mm through the last material joined.

C-2.3 *Welding:*

- (i) All welding shall be done as per approved design.
- (ii) Welded areas should be treated with the approved treatment to Retain the corrosion resistance of the welded area.

C-2.4 *Bolted Connections:* Bolts shall meet or exceed the requirements of ASTM A307 and should be installed with nuts and washers unless specified otherwise. C to C spacing of bolts should be min. of three bolt diameters.

C-2.5 *Low Velocity Fasteners:* Type of fastener, spacing and edge distance requirements shall be inspected for conformance to an approved design.

C-2.6 *Other Connections:* All other type of connections shall also be installed as per the approved design.

C-3 Foundations

C-3.1 *Bearing Surfaces:* Ensure that the foundation is level and free from defects. If the foundation is not level, provide a uniform bearing surface with a max. gap of 6mm between the bottom track or rim track and the foundation.

C-3.2 *Ground Contact:* Ensure that the framing is not in direct contact with the ground unless specified otherwise. Framing not in direct contact with the ground should be installed at a height above the ground in accordance with the applicable building code.

C-4 Floor, Roof and Ceiling Framing

C-4.1 *Plumpness:* Floor and ceiling joists and trusses should be installed in plumb and level except where specifically designed as sloping members.

C-4.2 *Bearing Width:* Floor and ceiling joists and trusses should be installed with full bearing over the width of the wall beneath having a min.38mm bearing.

C-4.3 *Joint Stiffeners and Compression Blocking:* The bearing stiffness and compression blocking shall conform to the approved design or standard.

C-4.4 *Joist and Rafter Bracing:* Joist and rafter bracing shall be installed as the approved design or standard. Bracing typically consist of gypsum board, structural-rated sheathing, steel strapping with blocking or X-bracing.

C-4.5 *Joist and Rafter Spacing:* No Joist or rafter spacing unless approved by the design professional. Joints lapped over an interior support are not considered spliced.

C-4.6 *Floor Cantilevers and Openings:* Framing at floor cantilevers and openings shall be installed as per the approved design or standard.

C-4.7 *Floor and Roof Trusses:* The floor and roof trusses shall be installed as per the approved design or standard.

C-5 Wall Framing

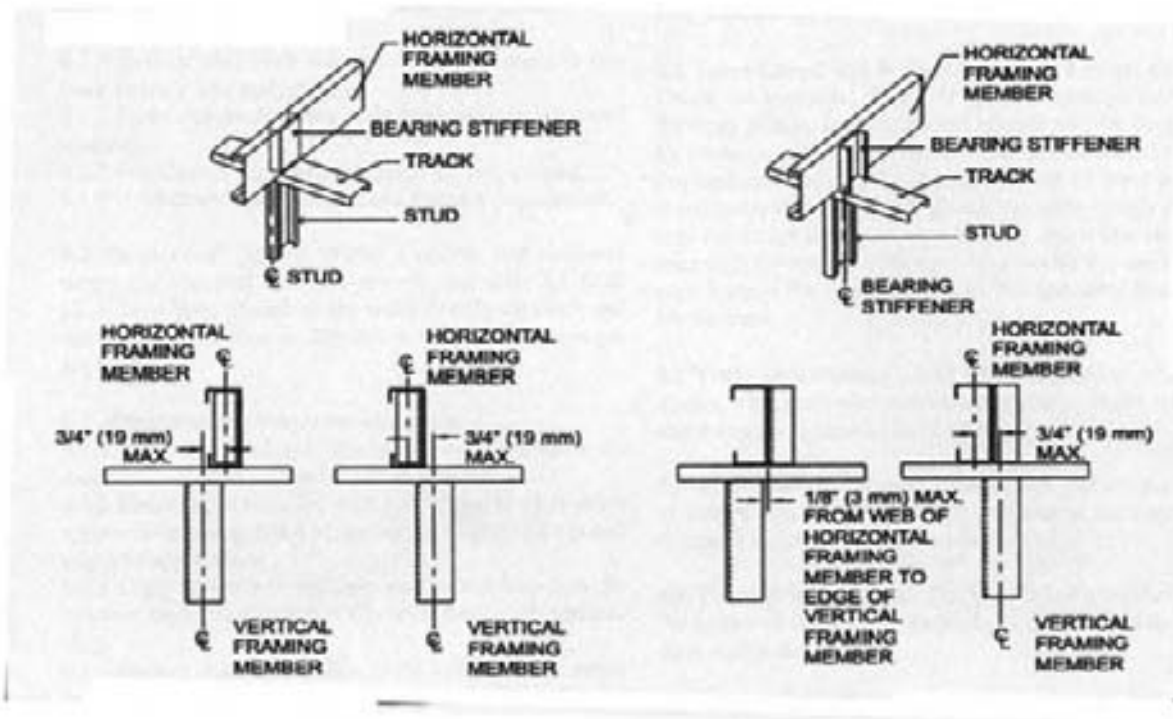
C-5.1 *Stud End Bearing:* Ensure that studs have square end cuts and are seated tight against the stud track. For axial load bearing applications, gaps between the ends of the stud the track web should not be greater than 3mm. For curtain wall applications, gaps between the ends of the stud the track web should not be greater than 6mm.

C-5.2 *Stud Alignment:*

(i) Identify whether the stud wall system indicated is either “in-line” or “wall top plate distributor” system and that loads are properly transferred as appropriate to the system end.

(ii) For “in-line” framing, where the roof trusses, rafter and floor joists are aligned over a bearing stud, the acceptable tolerance for alignment is as per Fig. 2 unless otherwise specified.

(iii) For “wall top plate distributor” system, the top track shall be properly framed as per the approved design or standard.



Alignment Framing

Fig. 4

C-5.3 Foundation Connection: Steel-framed walls should be anchored to the foundation or floors as per the approved design or standard.

C-5.4 Stud Bracing: Ensure that stud bracing shall be installed as per the approved design or standard. Bracing typically consist of gypsum board, structural-rated sheathing, steel strapping with blocking or a combination of gypsum board, structural rated sheathing, steel strapping with blocking.

C-5.6 Splicing: Studs and other structural members should not be spliced without an approved design. Track splices should be made continuous by means of splicing the track as per the approved design or standard.

C6 Shear Walls

C-6.1 Sheathed Shear Walls: The following shall conform to the approved design or standard:

- (i) Sheathes type panels shall be as per current building codes or other approved sheathing;
- (ii) Roof diaphragm boundary to block fastener size and spacing;
- (iii) Roof blocking to wall top track fastener size and spacing;
- (iv) Panel sheathing boundary and field fastener size and spacing;

- (v) Bottom wall track through floor diaphragm to rim track fastener size and spacing;
- (vi) Floor rim track to top wall track fastener size and spacing;
- (vii) Foundation track fastener type, size and spacing;
- (viii) Hold-down size, location and fastener requirement.

C-6.2 *“X-braced” Shear Walls:* It shall be confirmed that diagonal straps are installed taut and remain taut after all dead loads have been placed on the walls.

C-6.3 *Miscellaneous: The following shall be verified:*

- (i) Screws or pins shall be driven so that the head is not more than 1.5mm below surface of sheathing;
- (ii) Sheathing shall be installed with continuous strap or other blocking detail at horizontal intermediate panel edges, if applicable;
- (iii) Edge fasteners at multiple studs shall be driven into the member connected to the hold-down device;
- (iv) Bottom track connection, to the foundation or structure, shall meet all requirements carried out on the approved design or standard;
- (v) Blocking and/or shear transfer connections at the top of the walls shall meet all requirements carried out on the approved design or standard;
- (vi) Shear wall ends shall have boundary studs, min. two, per current code assemblies, or as required by the approved design or standard;
- (vii) Where hold-downs are indicated, all hold-downs shall be attached through the webs of two studs, unless there is a single boundary stud required by the approved design or standard;
- (viii) Where anchor bolts are used, nuts and washers shall be properly installed.

C-7 Built-up Beams and Headers

C-7.1 *Built-up Beam and Header Composition:* The built-up beams and headers shall be inspected to make sure they conform to the approved design or standard. The members used to make built-up beams and headers shall be inspected for punch-outs or other penetrations. Penetrations should be allowed only if shown on the approved design or standard, unless approved.

C-7.2 *Beam Stiffeners:* Beams require stiffeners at the ends and at the interior locations where point loads occur, unless specified otherwise.

C-8 Floor and Roof Trusses

C-8.1 *Truss Chord, Web Members and Panel Points:* Pre-engineered trusses may be designed by a specialized designer rather than the design

professional. The truss design drawings shall be checked for design loads and truss spacing to conform compliance with the approved design.

C-8.2 *Truss Orientation:* Orientation of installed trusses shall be checked with particular attention to parallel chord trusses and trusses with interior bearings.

C-8.3 *Truss-to-Wall Connection:* The connections of trusses to the top of the wall shall conform to the approved design or standard.

C-8.4 *Truss Bracing:* Truss bracing shall be as per the approved design or standard and the truss design drawings.

C-8.5 *Truss Anchorage:* The approved design shall be checked to determine if the truss hold-down connections are required. If the hold-down typically will attach to the truss and to the aligned stud below.

C-8.6 *Shear Connector Blocking at Exterior Bearing Walls:* The approved design or standard shall be checked to determine if a strap and intermediate blocking or continuous blocking are required for the transfer of shear from the roof to wall diaphragms.

ANNEX D
(Clause 2.4)

DESIGN PHILOSOPHY

D-1 DESIGN BASIS

D-1.1 Design of LGS is based on the below mentioned standards, codes and engineering practices.

D-1.1.1 *IS 875 (Part 1): 1987 Code of Practice for Design Load (Other than Earthquake) for Building and Structures-Part 1-Dead Loads Unit of Building Materials and Stored Materials*

D-1.1.2 *IS 875 (Part 2):1987 Code of Practice for Design Load (Other than Earthquake) for Building and Structures-Part 2-Imposed Loads*

D-1.1.3 *IS 875(Part 3):1987 Code of Practice for Design Load (Other than Earthquake) for Building and Structures-Part 3-Wind Loads*

D-1.1.4 *IS 1893 (Part 1):2002 Criteria for Earthquake Resistance Design of Structures-Part 1 General Provision and Buildings*

D-1.1.5 *IS 801:1975 Code of Practice for use of Cold-Formed Light Gauge Steel structural Members in general building construction*

D-1.1.6 *BS 5950 (Part 1):2000 Structural Use of Steelwork in Building – Part 1: Code of practice for design – Rolled and welded sections*

D-1.1.7 *BS 5950 (Part 5):1998 Structural Use of Steelwork in Building – Part 5: Code of Practice for design of cold formed thin gauge sections*

D-1.1.8 *BS 7916:1998 Selection and Application of Particleboard, Oriented Strand Board (OSB), Cement Bonded Particleboard and Wood Fibre Boards for Specific Purposes*

D-1.1.9 *BS 13163: 2001 Thermal Insulation Products for Buildings – Factory made products of expanded polystyrene (EPS) – Specification*

D-1.1.10 *SCI P202: Steelwork Design Guide to BS5950-1:2000 6th Edition (Blue Book)*

D-1.1.11 *SCI P212: Joints in Steel Construction: Simple Connections (2002 Green Book)*

D-1.1.12 *SCI P301: Building Design Using Cold Formed Steel Sections – Light Steel Framing in Residential Construction*

D-1.1.13 *Structural Engineers Pocket Book, Fiona Cobb, 2004*

D-1.1.14 *Hilti Fastening and Technology Manual, 2005*

D-2. LOAD CALCULATIONS

D-2.1 Dead Load

D-2.1.1 Normally, the weight of the wall varies from 0.45 kN/m² to 1.2 kN/m²

D-2.1.2 Weight of the floor varies from 2.5 kN/m² to 3 kN/m²

D-2.1.3 Load for Roof normally varies from 0.4 kN/m² to 0.75 kN/m² for GI Sheet and 2.4 kN/m² to 3 kN/m² for R.C.C Slab

D-2.1.4 Dead load is calculated based on the unit weight provided in *IS 875 (Part 1): 1987* for each work.

D-2.2 Live Load

Live load for different occupancies may be considered from *Table 1 of IS 875 (Part 2): 1987*

D-2.3 Wind Load

Wind loads apply on face of elevations of the buildings. The face loads are transferred from the cladding outer leaf by the wall ties to the stud sections which span vertically between horizontal floor diaphragms. The floor diaphragm spans horizontally between each of cross walls which may be internal load bearing or external walls. This produces a highly cross braced symmetrically arranged lateral load resistance system.

Each of the cross walls is cross braced with flat steel strap to transfer the shear forces in tension to each cassette floor and ultimately to the foundation level.

D-2.3.1 Wind Load Analysis

Wind load analysis is done as per *IS 875 (Part 3):1987*. The 90 degree case acts on the side elevation and 0 degree wind load case acts on the front or back elevation. Each elevation is to be analysed separately and the highest calculated load is to be applied throughout the entire structure.

Overturning (global stability) and holding down analysis is conducted for the widest cases. Comprehensive explanation of the global stability analysis follows.

Design wind pressure (N/m²) $P_z = 0.6 \times V_z^2$ {Refer 5.4 of *IS 875 (Part 3):1987*};

Design wind speed (m/s) $V_z = V_b \times K_1 \times K_2 \times K_3$ -- {Refer 5.3 of *IS 875 (Part 3):1987*};

Basic wind speed (m/s) V_b {Refer Fig. 1 of *IS 875 (Part 3):1987*};

Risk coefficient factor (K_1) {Refer Table 1, 5.3.1 of *IS 875 (Part 3):1987*};

Terrain, height and Structure factor (K_2) {Refer Table 2, 5.3.2 of *IS 875 (Part 3):1987*};

Topographic factor (K3)

{Refer 5.3.3.1 of IS 875 (Part 3):1987};

D-3 STABILITY

D-3.1 Bracing System Design

The in-plane stiffness of the cross wall construction layout is to be utilized to provide overall stability in both directions.

The flat strip bracing is designed to act in tension only, and each bracing set is to be designed based on the overall wind load defined under IS 875 (Part 3):1987, and the effective area supported in each area or zone. The load is chased down through the continuous bracing system from floor to floor. The bracing and its end connections are to be designed in accordance with the provisions set out in BS 5950-5:1998 for the cold formed components and connections.

In the design of the bracing system, no account is taken of the contribution to racking resistance from the lining boards. As a result the design of the bracing system is deemed very conservative.

D-3.2 Holding Down Requirements

A separate check is made on the holding down requirements of the framing system based on a more appropriate global design basis.

Horizontal loading transferred into the structure is resisted by a combination of the bracing system and the natural (and significant) in-plane racking resistance of the perpendicular walls, leading to a dissipation of the theoretical bracing forces calculated above.

This approach is only appropriate if the perpendicular Walls do not have any significant openings in them. The individual framing components are fully tied together to form inter-connecting panels, which together with the sheathing resistance of the lining boards, ensures that the whole framed structure acts as a single mass.

For holding down requirements, a check is made on the factor of safety against overturning for the overall building structure, calculated on the following basis:

$$\text{Overturning moment (OTM)} = \text{WL} * \text{B} * \text{H}^2 / 2$$

$$\text{Restoring moment (RM)} = 0.9 * \Sigma \text{DL} * \text{L} / 2$$

Where WL = Wind load {Refer 2.1.3.6 of BS 6399 (Part 2):1997, (kN/m²)}

B = Width of structure under consideration for overturning (m)

H = overall building height (m)

DL = Total dead load of structure under consideration (kN)

L = building length perpendicular to wind direction (m)

Minimum acceptable factor of safety against overturning is to be 2.5, i.e.

$$\text{FOS Against Overturning} = \text{RM}/\text{OTM} \geq 2.5$$

If the FOS is less than 2.5 then calculate the Hold Down Force, HD at each end of the Wall to achieve at least a FOS of 2.5 i.e.

$$\frac{(\text{RM} + (\text{HD} \times \text{L}))}{\text{OTM}} > 2.5$$

When designing Hold-down bolts at these points also consider the combined shear on the bolts to resist the Wind Shear. The Shear may be distributed between the total number of bolts from the panel to the slab.

A similar check is to be made against sliding, using the same principles.

Consider the building and calculate the minimum dead weight of the total structure and apply a coefficient of friction to this to add to the Sliding Resistance. The Shear resistance of the bolts required is then calculated in order to achieve the minimum Factor of safety of 2.5.

$$\text{FOS against Sliding} = \frac{V_{\text{resisting}}}{V_{\text{sliding}}} \geq 2.5$$

$$V_{\text{sliding}} = \text{WL} \times \text{H}$$

$$V_{\text{resisting}} = V_{\text{friction}} + V_{\text{bolts}}$$

$$V_{\text{friction}} = 0.9\text{DL} \times \mu$$

Where μ = coefficient of friction between steel and DPC, taken as 0.2

DL = Dead load of under consideration

Solving the Equation for V bolts then,

$$V_{\text{bolts}} \geq 2.5(V_{\text{sliding}}) - V_{\text{friction}}$$

Under the assumption that the structure acts as a whole, the shear force on the bolts to resist sliding can be distributed to all the necessary bolts in the portion of the structure under consideration.

Specific holding down/anchorage requirements are to be provided to ensure the required factor of safety is achieved for both Overturning and Sliding.

D-3.3 General Anchorage Provisions:

Irrespective of the above, minimum base fixity is to be provided based on the following:

- (a) All external perimeter walls and internal load bearing are secured to the sub-structure using suitable expanding bolts and/or self-tap screws, e.g. "Tapcon" at regular centres to suit site specific lateral loading on individual panels
- (b) External Walls to be fixed at a maximum of 1200 mm crs and the fixing type checked for face wind loads. Tapcon screws to be used where ever possible.
- (c) All bracing positions are to be further secured to the base using an expanding anchor type fixing through a 10 mm thick washer plate inside the base track at

the end of the brace. The washer plate is to be factory glued in position. Holding down straps can be considered in special cases if this suits the foundation type.

D-4 SEISMIC CONSIDERATIONS

Seismic loads apply on the each floor and roof level of the buildings. The horizontal loads are transferred from the floor cassette diaphragm to the walls tying or supporting the floors and roof. The stud sections in the walls which span vertically between horizontal floor diaphragms. The floor diaphragm spans horizontally between each of cross walls which can be internal load bearing, party or external walls. This produces a highly cross braced symmetrically arranged lateral load resistance system.

Each of the cross walls is cross braced with flat steel strap to transfer the shear forces in tension to each cassette floor and ultimately to the foundation level.

By inspection, the seismic loads are critical for overall stability.

Since facility of experimental investigation of the seismic performance is not available, analytical procedures should be adopted.

While designing, floor wise drift should be verified by the designer.

Damping coefficient for steel shall be taken as 2 for calculating seismic forces.

Total Design lateral Force or Seismic Base Shear V (kN) = $A_h \times W_{total}$

{Refer 7.5.3 of IS 1893:2002};

Design Horizontal Seismic Coefficient $A_h = (Z I S_a / 2 R_g)$

{Refer 6.4.2 of IS 1893:2002};

Zone Factor (Z)

{Refer Table 2, 6.4.2 of IS1893-2002};

Seismic Zone

{Refer Seismic Zone Map of IS1893:2002};

Seismic Intensity

{Refer Table 2, 6.4.2 of IS1893:2002};

Importance Factor (I)

{Refer Table 6, 6.4.2 of IS1893:2002};

Response Reduction Factor R

{Refer Table7, 6.4.2 of IS1893:2002};

Average response acceleration coefficient factor (S_a/g) {Refer 6.4.5 of IS1893:2002};

Total weight of building (W , total) (kN) {Refer 7.3 of IS1893:2002};

D-5 STUD DESIGN

Stud designs include the stud flexural buckling and torsional flexural buckling checks under axial compression load and local buckling and overall buckling checks under combined bending and compression loads. The bending is caused by wind pressure and/or connection eccentricity between a joist and a stud.

D-5.1 Maximum Slenderness {Refer 6.2.2 of BS 5950 (Part 5):1998};

The slenderness ratio should be taken as the effective length, L_E , divided by the radius of gyration about the relevant axis, r , except as given in 6.2.5 for back-to-back members.

The L_E effective length of a member in compression should be established in accordance with {Table 9 of BS 5950(Part 5):1998}

The maximum values of the slenderness ratio L_E/r should not exceed the following:

- (i) for members resisting loads other than wind loads: 180
- (ii) for members resisting self-weight and wind loads only: 250
- (iii) for any member acting normally as a tie but subject to reversal of stress resulting from the action of wind: 350

D-5.2 Single Symmetrical Section {Refer 6.2.4 of BS 5950 (Part 5):1998}

For sections symmetrical about a single axis and which are not subject to torsional flexural buckling, or which are braced against twisting, the effects of movement of the effective neutral axis should be taken into account in evaluation of the maximum load.

The buckling resistance, P'_c , may then be evaluated from:

$$P'_c = \frac{M_c P_c}{M_c + P_c e_s}$$

M_c is the moment capacity determined in accordance with {Fig. 5, 5.2.2 of BS 5950 (Part 5):1998}

$$M_c = \rho_0 \times Z$$

ρ_0 is the compressive Stress

Z is the section modules

The compressive stress, ρ_0 , in a stiffened element which results from bending in its plane, should not exceed the lesser of the following values:

$$\rho_0 = p_y \quad \text{or} \quad P_0 = \left\{ 1.13 - 0.0019 \frac{D_w}{t} \left(\frac{Y_s}{280} \right)^{1/2} \right\} P_y$$

D_w is the section depth or twice the depth of the compression zone, D_c whichever is the greater in mm

D_c is the depth of the compression zone of the web, taken as the distance from the neutral axis of the gross cross-section to the compression element in mm

Y_s is the material yield strength in N/mm²

t is the web thickness in mm;

p_y is the design strength in N/mm².

{Refer 3.3; Table 4, Grade 43/35 has a p_y of 350 N/mm²}

P_c is the buckling resistance under axial load {Refer 6.2.3 of BS 5950 (Part 5); 1998}

For sections symmetrical about both principal axes or closed cross-sections which are not subject to torsional flexural buckling, or are braced against twisting, the buckling resistance under axial load, P_c

$$P_c = \frac{P_E P_{CS}}{\Phi + \sqrt{\Phi^2 + P_E P_{CS}}}$$

Where

$$\Phi = \frac{P_{CS} + (1 + \eta) P_E}{2}$$

P_{CS} is the short strut capacity and is equal to

$A_{\text{eff}} \times p_y$

A_{eff} is the effective cross-sectional area {Refer 4.7.2 of BS 5950 (Part 5): 1998}

P_y is the design strength {3.3; Table 4, Grade 43/35 has a p_y of 350 N/mm²}

P_E is the minimum elastic flexural buckling load equal to $\frac{\pi^2 EI}{L_E^2}$

E is the modulus of elasticity

I is the second moment of area of the cross-section about the critical axis

L_E is the effective length of the member about the critical axis {Refer Table 9 of BS 5950 (Part 5): 1998}

η is the Perry coefficient

for $L_E/r \leq 20$, $\eta = 0$

for $L_E/r > 20$, $\eta = 0.002 (L_E/r - 20)$

r is the radius of gyration of the gross cross-section corresponding to P_E .

e_s is the distance between the geometric neutral axis of the gross cross-section and that of the effective cross-section as indicated in Figure 5

D-5.3 Torsional Flexural Buckling {Refer 6.3.2 of BS 5950 (Part 5):1998}

For members which have at least one axis of symmetry, taken as the x axis, and which are subject to torsional flexural buckling, design according to clause 6.2, and the values given in Table 10 used to provided that a factored slenderness ratio, $\alpha L_E/r$, is used in place of the actual slenderness ratio. Values of α for a number of cross-sectional shapes are given in Annex C of BS 5950

α Factor for member in compression obtained From Annexure C, Table C.1

$$\frac{L_E}{r_{\text{min}}} * \frac{t}{b}$$

L_E is the effective length of the member about the critical axis {Refer Table 9 of BS 5950 (Part 5); 1998}

r_{min} is the minimum radius of gyration of the gross cross-section

t is the thickness of section

b is the width of section

$$\frac{d}{b}$$

d is the depth of section

b is the width of section

Torsional Flexural Buckling resistance P_{ct} obtained from Table 10 of BS 5950

$$\frac{\alpha L_E}{r}$$

α Factor for member in compression obtained From Annexure C, Table C.1

r is the radius of gyration of the gross cross-section

L_E is the effective length of the member about the critical axis {Refer Table 9 of BS 5950(Part 5):1998}

$$Q = \left(\frac{Y_s}{280} \right)$$

Y_s is the Nominal Yield strength of steel (Refer 3.3; Table 4, Grade 43/35 has a p_y of 350 N/mm²)

Q Relative cross sectional area

$$Q = \left(\frac{A_{eff}}{A} \right)$$

A_{eff} Effective cross-sectional area

A Gross cross-sectional area

D-5.4 Combined Bending and Compression {Refer 6.4.1 of BS 5950 (Part 5):1998}

Compression members which are also subjected to bending should be checked for local capacity at the points of greatest bending moment and axial load (usually at the ends). These members should also be checked for overall buckling.

D-5.5 Local Capacity Check {Refer 6.4.2 of BS 5950 (Part 5):1998}

The member should satisfy the following relationship:

$$\frac{F_c}{P_{cs}} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} \leq 1$$

F_c is the applied axial load

P_{cs} is the short strut capacity defined in 6.2.3

M_x is the applied bending moment about the x axis

M_{cx} is the moment capacity in bending about the x axis in the absence of F_c and M_y , (5.2.2 and 5.6)

$$M_{cx} = p_0 \times Z_{xx}$$

p_0 is the compressive Stress

Z_{xx} is the section modulus

M_y is the applied bending moment about the y axis

M_{cy} is the moment capacity in bending about the y axis in the absence of F_c and M_x , (5.2.2 and 5.6)

$$M_{cy} = p_0 \times Z_{yy}$$

p_0 is the compressive Stress

Z_{yy} is the section modulus

D-5.6 Overall Buckling Check {Refer 6.4.3 of BS 5950(Part 5):1998}

D-5.6.1 For beams not subject to lateral buckling, the following relationship should be satisfied:

$$\frac{F_c}{p_c} + \frac{M_x}{C_{bx} M_{cx} \left(1 - \frac{F_c}{P_{Ex}} \right)} + \frac{M_y}{C_{by} M_{cy} \left(1 - \frac{F_c}{P_{Ey}} \right)} \leq 1$$

F_c is the applied axial load

P_c is the axial buckling resistance in the absence of moments, 6.2.3

M_x is the applied bending moment about the x axis

C_{bx} , C_{by} are C_b factors as defined in 5.6.2.1 with regard to moment variation about the x and y axes respectively

C_b is a coefficient which may be conservatively assumed to be unity, or can be calculated using

$$C_b = 1.75 - 1.05 \beta + 0.3\beta^2 \leq 2.3$$

β is the ratio of the smaller end moment to the larger end moment M in the unbraced length of a beam. β is taken as positive in the case of single curvature bending and negative in the case of double curvature bending as shown in Figure 3. When the bending moment at any point within the span is greater than M , C_b should be taken as unity.

M_{cx} is the moment capacity in bending about the x axis in the absence of F_c and M_y , (5.2.2 and 5.6)

$$M_{cx} = \rho_0 \times Z_{xx}$$

ρ_0 is the compressive Stress

Z_{xx} is the section modulus

M_{cy} is the moment capacity in bending about the y axis in the absence of F_c and M_x , (5.2.2 and 5.6)

$$M_{cy} = \rho_0 \times Z_{yy}$$

ρ_0 is the compressive Stress

Z_{yy} is the section modulus

P_{Ex} is the flexural buckling load in compression for bending about the x axis

P_{Ey} is the flexural buckling load in compression for bending about the y axis

D-5.6.2 For beams subject to lateral buckling the following relationship should be satisfied:

$$\frac{F_c}{P_c} + \frac{M_x}{M_b} + \frac{M_y}{C_{by} M_{cy} \left(1 - \frac{F_c}{P_{Ey}}\right)} \leq 1$$

F_c is the applied axial load

P_c is the axial buckling resistance in the absence of moments, 6.2.3

M_x is the applied bending moment about the x axis

P_{Ey} is the flexural buckling load in compression for bending about the y axis

C_{bx} , C_{by} are C_b factors as defined in 5.6.2.1 with regard to moment variation about the x and y axes respectively;

M_b is the lateral buckling resistance moment about the x (major) axis as defined in

D-5.6;

$$M_b = \frac{M_E M_y}{\phi_B + \sqrt{\phi_B^2 - M_E M_y}} \leq M_c$$

Where

$$\phi_B = \frac{M_y + (1+\eta)M_E}{2}$$

M_c is the moment capacity of the section determined in accordance with **5.2.2**
 M_y is the yield moment of the section, that is, the product of the design strength, p_y , and the elastic modulus of the gross cross-section with respect to the compression flange, Z_c

M_E is the elastic lateral buckling resistance moment determined in accordance with **D-5.6**.

The elastic lateral buckling resistance moment, M_E , for sections loaded effectively through the shear centre should be determined as follows:

a) for equal flange I-section and symmetrical channel section beams bent in the plane of the web

$$M_E = \frac{\pi^2 A E D}{2(L_E/r_y)^2} C_b \left\{ 1 + \frac{1}{20} \left(\frac{L_E t}{r_y D} \right)^2 \right\}^{\frac{1}{2}}$$

A is the cross-sectional area of the beam

E is the modulus of elasticity

D is the overall web depth

t is the material thickness

L_E is the effective length determined in accordance with **5.6.3**

for beams restrained against torsional rotation θ_1 , and rotation about the minor axis θ_2 , $L_E = 0.8L$

η is the Perry coefficient, such that

$$\frac{L_E}{r_y} < 40 C_b \quad \text{when } \eta = 0$$

$$\frac{L_E}{r_y} > 40 C_b \quad \eta = 0.002 \left(\frac{L_E}{r_y} - 40 C_b \right)$$

r_y is the radius of gyration of the section about the y axis

C_b is a coefficient which may be conservatively assumed to be unity, or can be calculated using

$$C_b = 1.75 - 1.05 \beta + 0.3\beta^2 \leq 2.3$$

β is the ratio of the smaller end moment to the larger end moment M in the unbraced length of a beam. β is taken as positive in the case of single curvature bending and negative in the case of double curvature bending as shown in Figure 3. When the bending moment at any point within the span is greater than M , C_b should be taken as unity.

D-6 JOIST DESIGN

D-6.1 Combined Bending and Crushing {Refer 5.5.1 of BS 5950 (Part 5):1998}

Flat webs of sections subject to a combination of bending and concentrated load or reaction should be designed to satisfy the following relationships at the limit state:

a) sections having single-thickness webs

$$1.2 \frac{F_w}{P_w} + \frac{M}{M_c} \leq 1.5$$

$$\frac{F_w}{P_w} \leq 1$$

$$\frac{M}{M_c} \leq 1$$

b) I-beams made from two channels connected back-to-back, or similar sections which provide a high degree of restraint against rotation of the web

$$1.1 \frac{F_w}{P_w} + \frac{M}{M_c} \leq 1.5$$

$$\frac{F_w}{P_w} \leq 1$$

$$\frac{M}{M_c} \leq 1$$

where

F_w is the concentrated web load or reaction

P_w is the concentrated load resistance determined in accordance with **5.3**

The resistance to local crushing of the webs of beams at support points or points of concentrated load should be evaluated using the equations given in Table 7 and

Table 8. For built-up I-beams, or similar sections, the distance between the connector and beam flange should be kept as small as practicable.

The equations in Table 7 and Table 8 apply to the following.

Beams with: $D/t \leq 200$

$$r/t \leq 6$$

In these relationships and the equations in Table 7 and Table 8 of BS 5950:

D is the overall web depth in mm;

t is the web thickness in mm;

r is the inside bend radius in mm;

N is the actual length of bearing in mm; for the case of two equal and opposite concentrated loads distributed over unequal bearing lengths, the smaller value of N should be taken;

P_w is the concentrated load resistance of a single web in (N);

c is the distance from the end of the beam to the load or the reaction in mm

C is a constant with the following values:

$$C1 = (1.22 \text{ } 2 \text{ } 0.22k)$$

$$C2 = (1.06 - 0.06r/t) \leq 1.0$$

$$C3 = (1.33 - 0.33k)$$

$$C4 = (1.15 - 0.15r/t) \leq 1.0 \text{ but not less than } 0.50$$

$$C5 = (1.49 - 0.53k) \geq 0.6$$

$$C6 = (0.88 + 0.12m)$$

$$C7 = 1 + D/t / 750 \text{ when } D/t < 150;$$

$$C7 = 1.20 \text{ when } D/t > 150$$

$$C8 = 1/k, \text{ when } D/t < 66.5;$$

$$C8 = (1.10 - D/t / 665)/k \text{ when } D/t > 66.5$$

$$C9 = (0.82 + 0.15m)$$

$$C10 = (0.98 - D/t / 865)/k$$

$$C11 = (0.64 + 0.31m)$$

$$C12 = 0.7 + 0.3 (\theta/90)^2$$

where

$k = p_y/228$ where p_y is the design strength in N/mm²;

$m = t/1.9$;

θ is the angle in degrees between plane of web and plane of bearing surface, where $45^\circ \leq \theta \leq 90^\circ$

M is the applied bending moment at the point of application of F_w

M_c is the moment capacity determined in accordance with

{Refer Fig. 5, 5.2.2 of BS 5950 (Part 5):1998};

$$M_c = p_0 \times Z$$

p_0 is the compressive Stress

Z is the section modulus

D-6.2 Combined Bending and Shear {Refer 5.5.2 of BS 5950 (Part 5):1998};

For beam webs subjected to both bending and shear stresses the member should be designed to satisfy the following relationship

$$\left(\frac{F_v}{P_v}\right)^2 + \left(\frac{M}{M_c}\right)^2 \leq 1.0$$

Where

F_v is the shear force

P_v is the shear capacity or shear buckling resistance determined in accordance with

D-5.4.3

and is equal to P_v or $q_{cr} D t$ whichever is the lesser

The maximum shear stress, calculated on the basis of an accepted method of elastic analysis, should not be greater than $0.7 p_y$, where p_y is the design strength.

$$P_v = 0.6 P_y$$

$$q_{cr} = \left(\frac{1000 t}{D}\right)^2$$

p_y is the design strength in N/mm²;

t is the web thickness in mm

D is the web depth in mm;

M is the value of the bending moment acting at the same section as F_v

M_c is the moment capacity determined in accordance with {Fig. 5, 5.2. 2 of BS 5950 (Part 5):1998}

The compressive stress, p_0 , in a stiffened element which results from bending in its plane, should not exceed the lesser of the following values:

$p_0 = p_y$ or

$$P_0 = \left\{ 1.13 - 0.0019 \frac{D_w}{t} \left(\frac{Y_s}{280} \right)^{1/2} \right\} P_y$$

D_w is the section depth or twice the depth of the compression zone, D_c whichever is the greater in mm

D_c is the depth of the compression zone of the web, taken as the distance from the neutral axis of the gross cross-section to the compression element in mm

Y_s is the material yield strength in N/mm²

t is the web thickness in mm;

p_y is the design strength in N/mm²

D-6.3 Deflection

D-6.3.1 {Refer 2.4.2 of BS 5950 (Part 5):1998}

The deflection under serviceability loads of a building or its members should not impair the strength or efficiency of the structure or its components or cause damage to the finishing. Table 3 gives recommended deflection limits for certain structural members.

D-6.3.2 (Refer 6.2.1 of SCIP301)

D-6.3.2.1 Static criteria

- (a) The maximum deflection for a single joist subject to dead and imposed loads is limited to the smaller of span/350, or 15 mm
- (b) The maximum deflection for a single joist subject only to imposed load is limited to span/450

D-6.3.2.2 Dynamic criteria

- (c) The natural frequency of the floor should be limited to 8 Hz for the uniformly distributed load case of dead plus 0.3 kN/m², which represents the nominal load on lightly loaded floor. This is achieved by limiting the deflection of a single joist to 5mm for this loading condition.
- (d) The deflection of the complete floor (ie series of joists plus the flooring Material) when subject to a 1 kN point load, should be limited to the values presented in Table 6.1 of BS 5950
- (e) For the floor subjected to imposed loads in excess of 1.5 kN/m², the governing criterion is most likely to be (a) (Span/350 or a maximum of 15mm)

(f) Deflection of uniformly distributed simply supported beam can be calculated by

$$\text{Deflection} = \left(\frac{5Wl^4}{383 EI} \right)$$

E - is the modulus of elasticity 205000 N/mm²

I - is the moment of inertia mm⁴

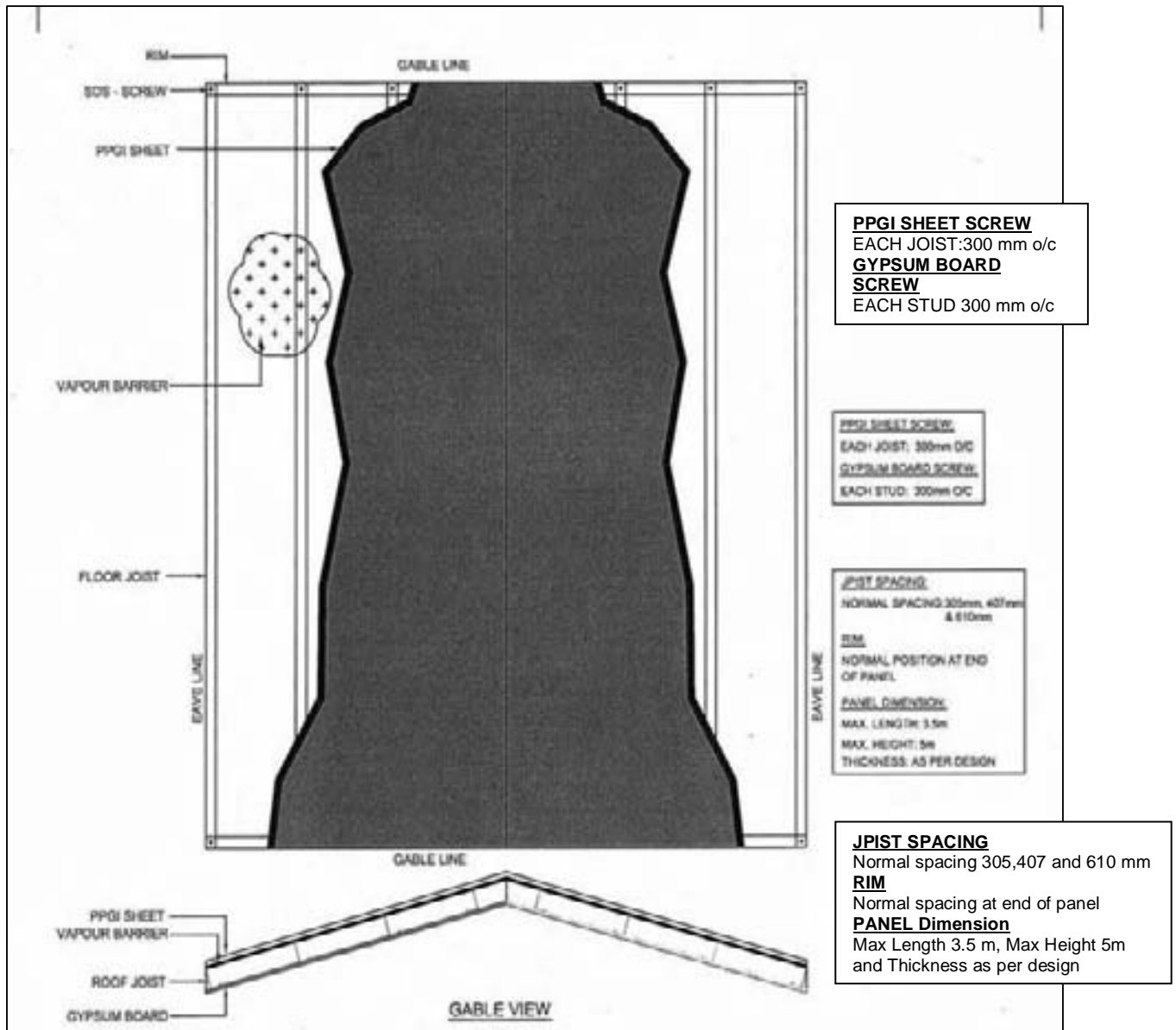
W - is the total uniform load

l - is the span length

ANNEX E

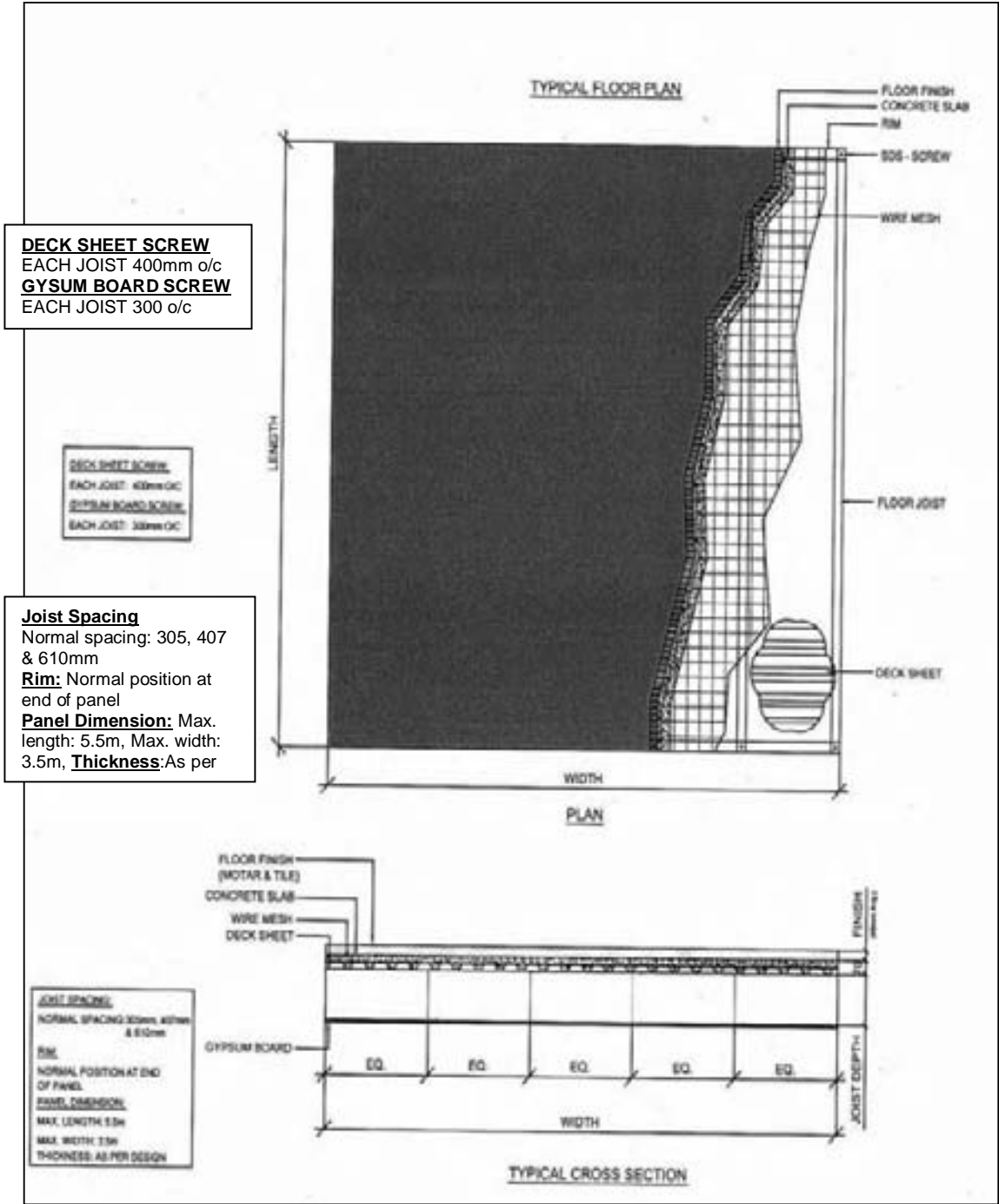
(Clause 2.8.6)

ERECTION & FIXING DRAWINGS



TYPICAL ROOF DETAIL
SLOPED ROOF (PPGI Sheet & Gypsum Board)

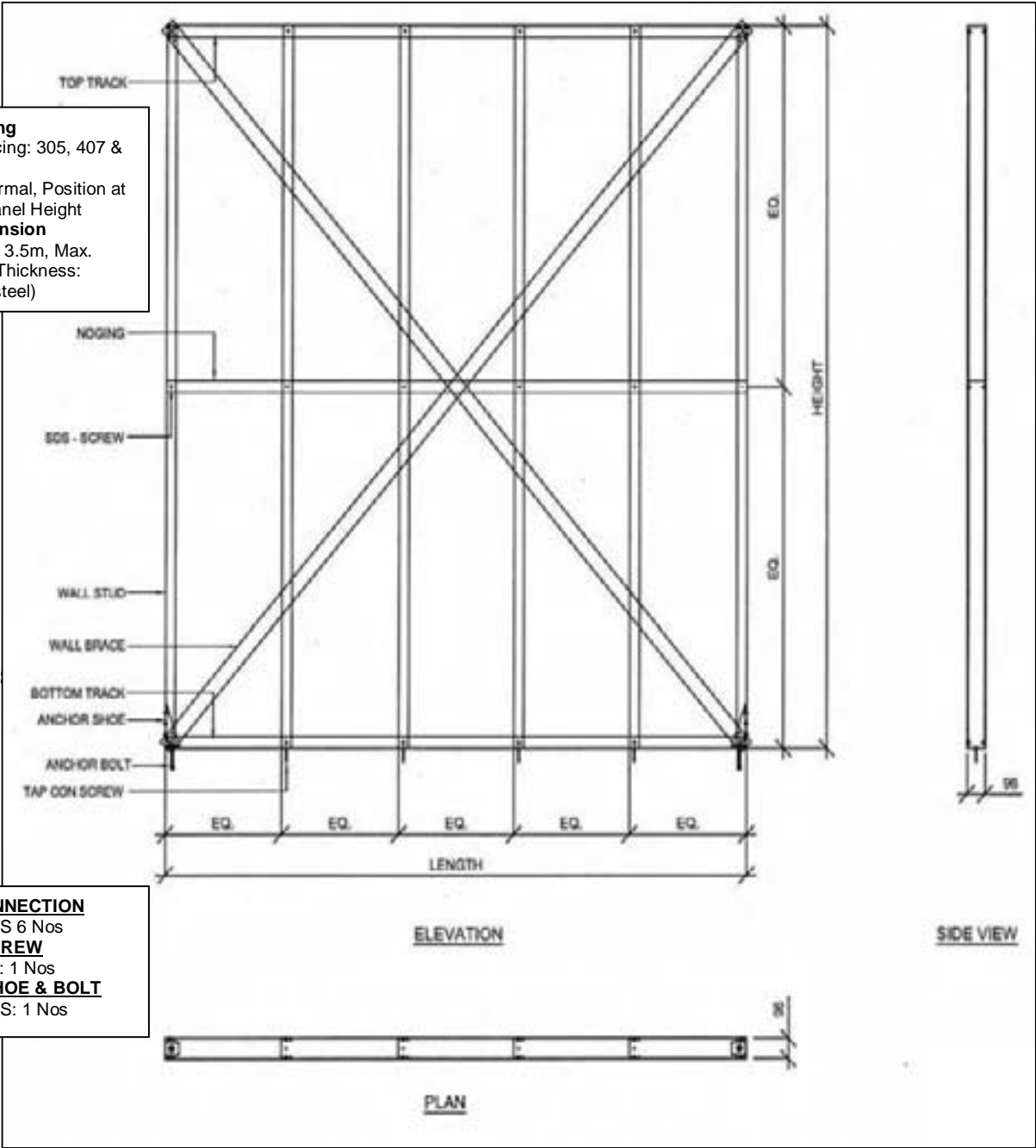
Fig. 5



**TYPICAL ROOF / FLOOR DETAIL
(Concrete Floor & Gypsum Ceiling)**

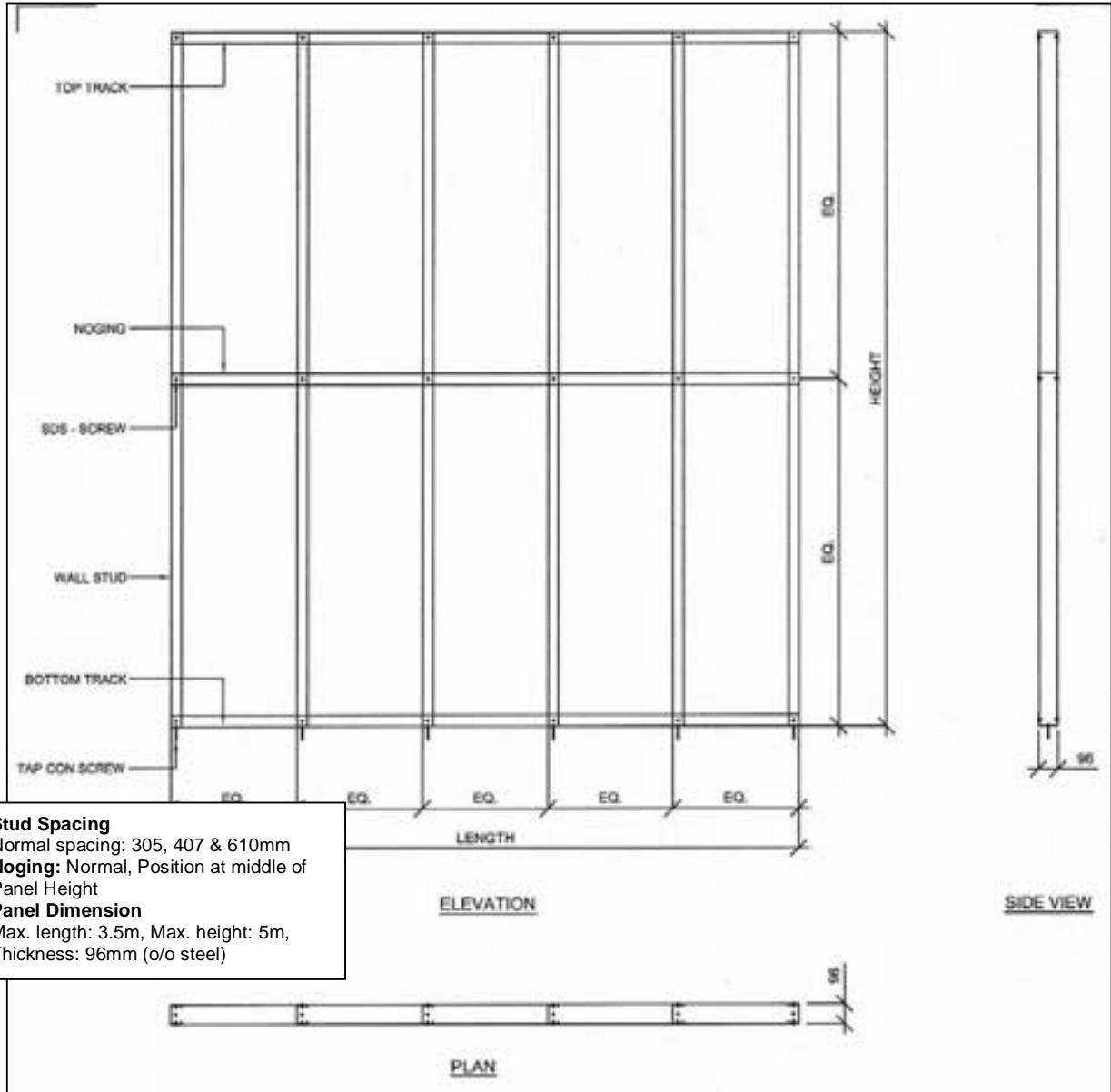
Fig. 6

Stud Spacing
 Normal spacing: 305, 407 & 610mm
Nogging: Normal, Position at middle of Panel Height
Panel Dimension
 Max. length: 3.5m, Max. height: 5m, Thickness: 96mm (o/o steel)



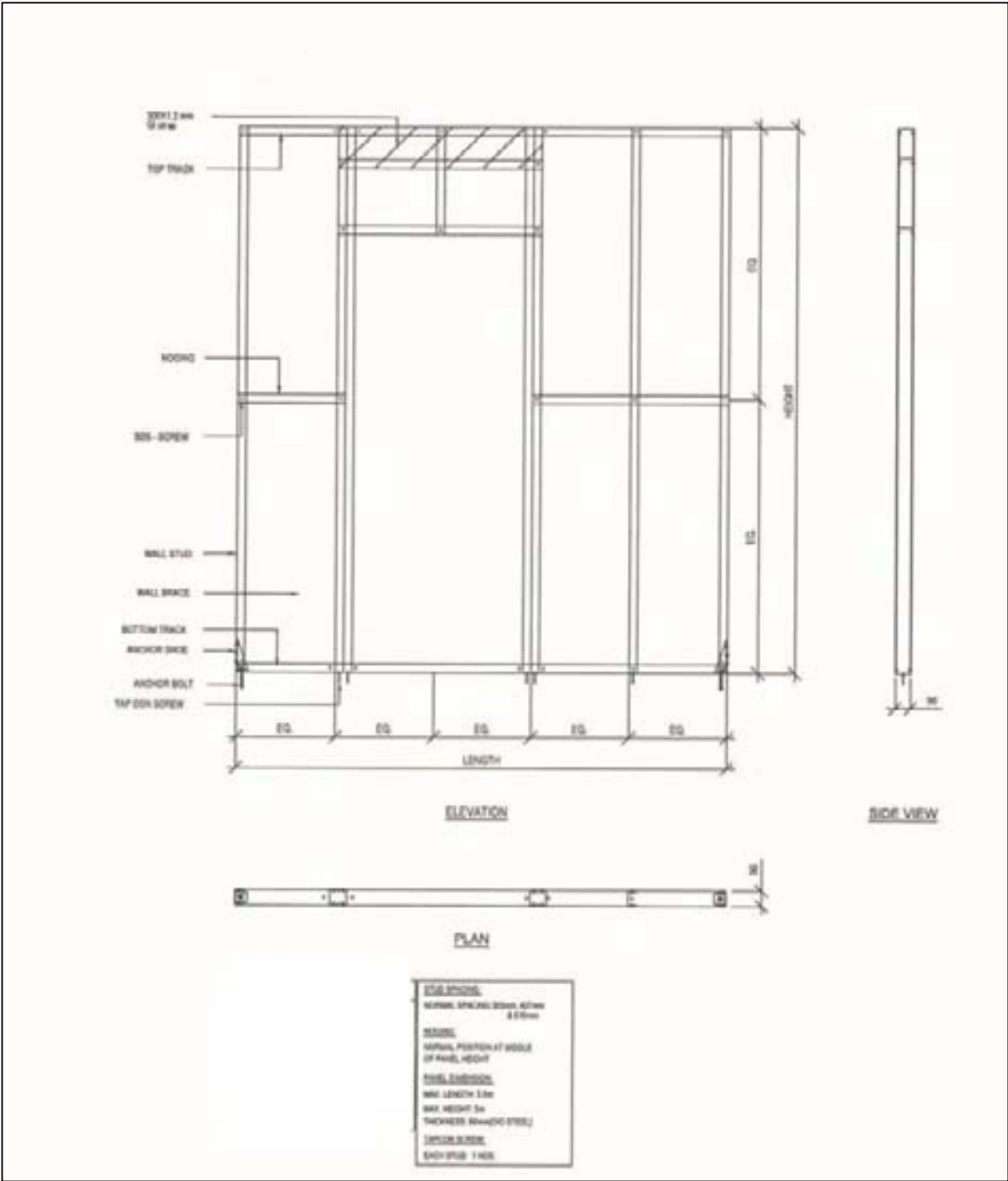
**TYPICAL WALL FRAME
 WALL FRAME (WITH BRACE)**

Fig. 7



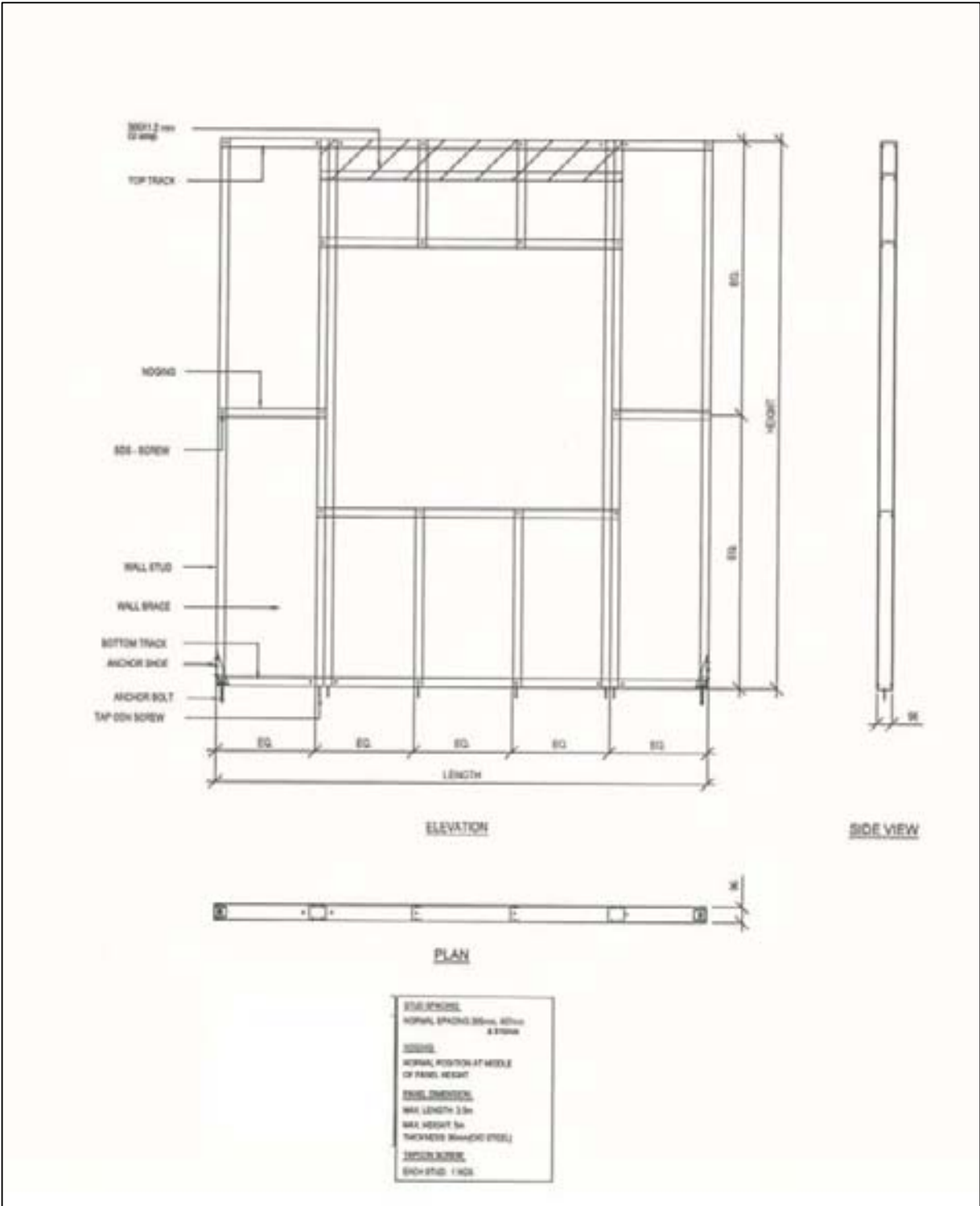
TYPICAL WALL FRAME
WALL FRAME (WITHOUT BRACE)

Fig. 8



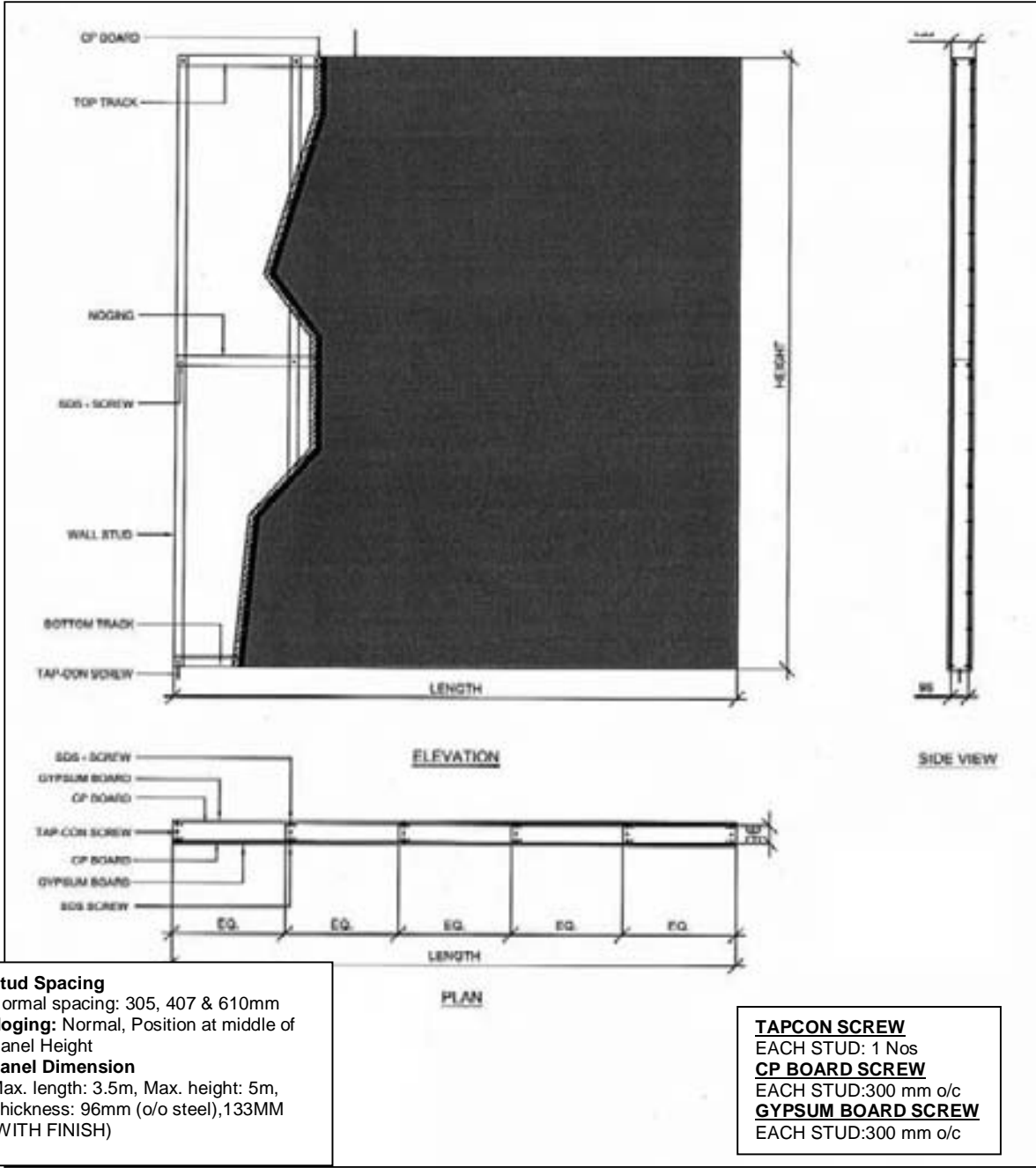
**TYPICAL WALL FRAME
(WITH DOOR)**

Fig. 9



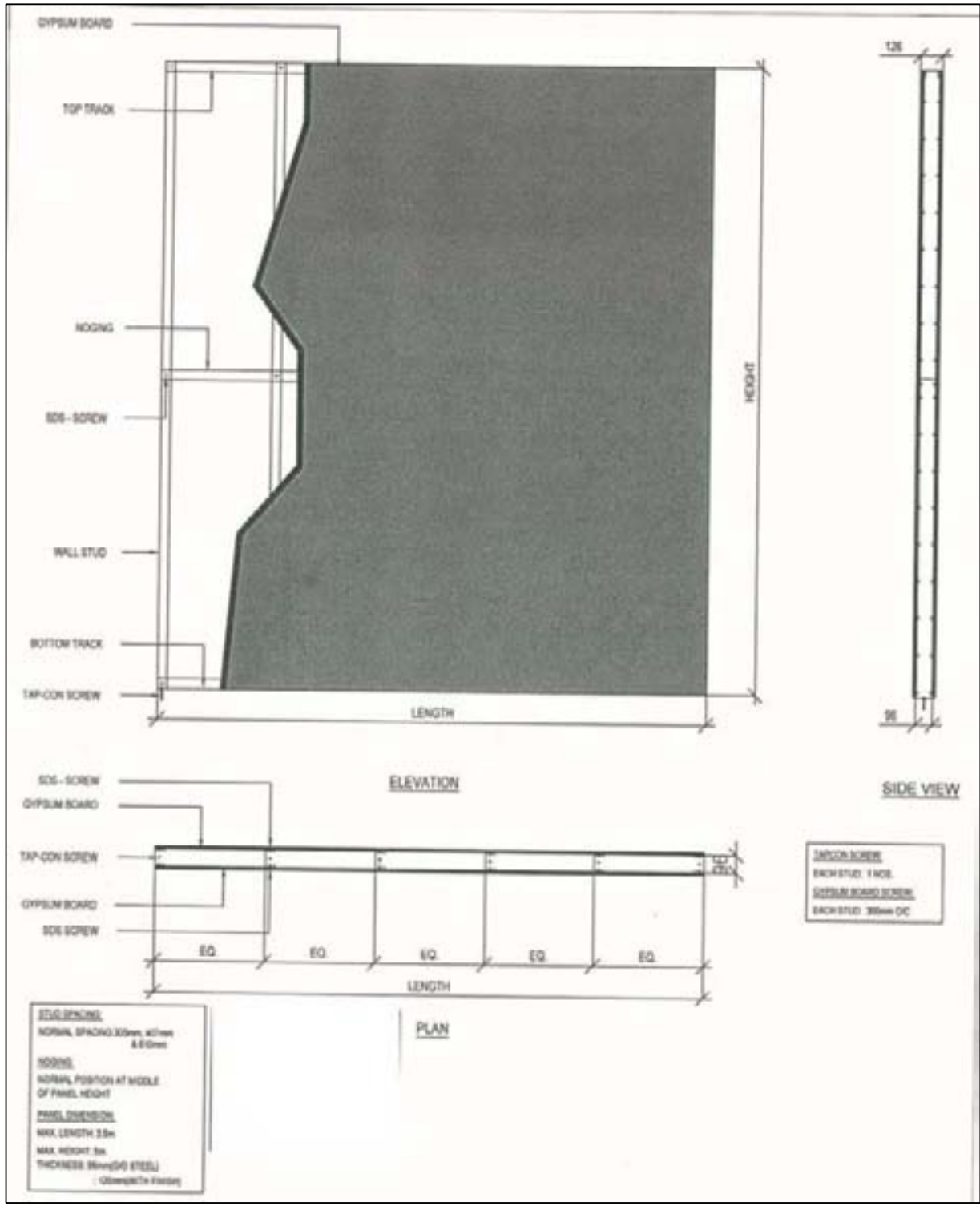
**TYPICAL WALL FRAME
(WITH WINDOW)**

Fig. 10

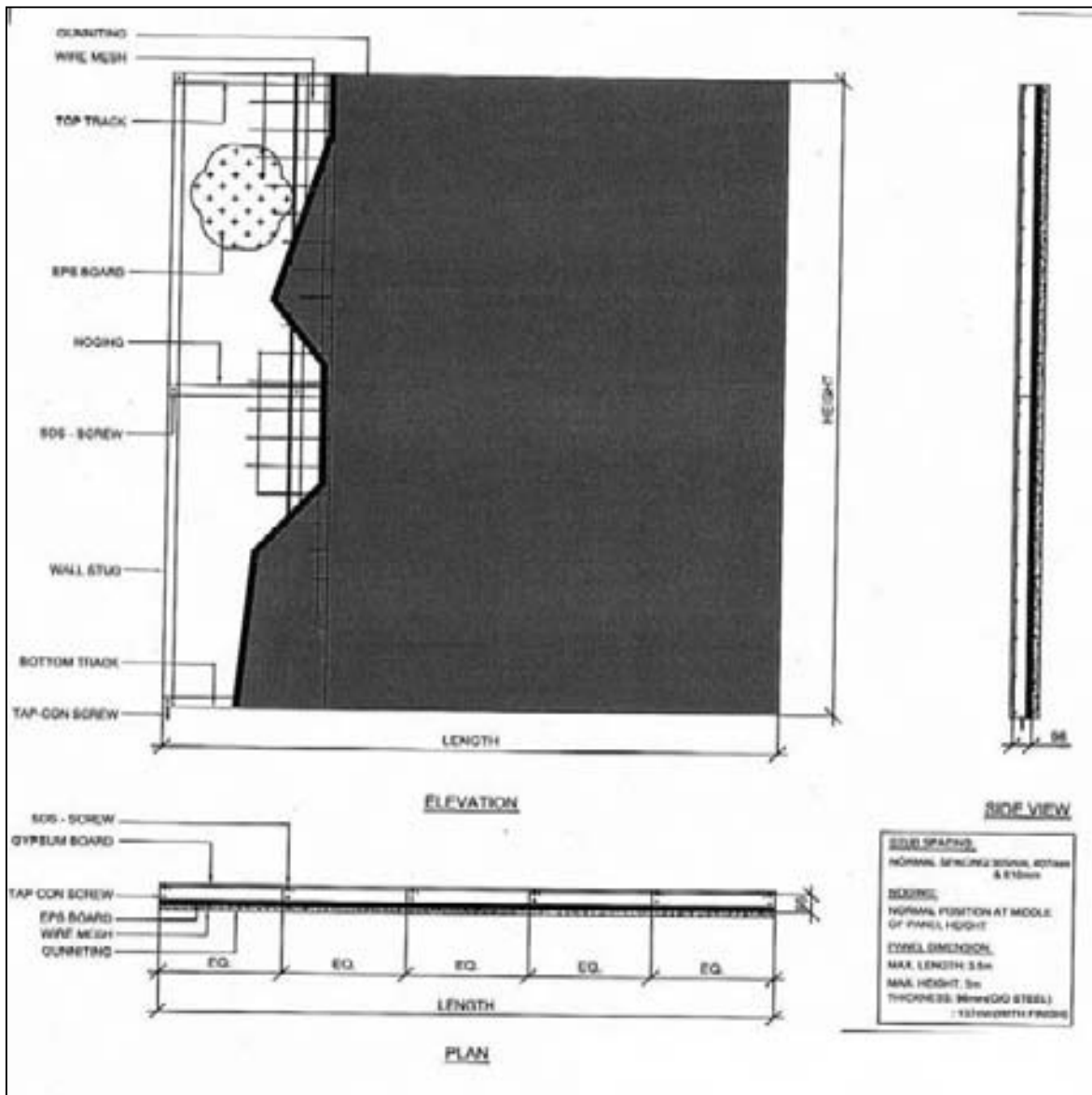


TYPICAL WALL PANEL
INTERNAL WALL PANEL
 (CP BOARD+GYPSUM BOARD IN BOTH SIDES)

Fig. 11



TYPICAL WALL PANEL
INTERNAL WALL PANEL
(BOTH SIDE GYPSUM BOARD) Fig. 12

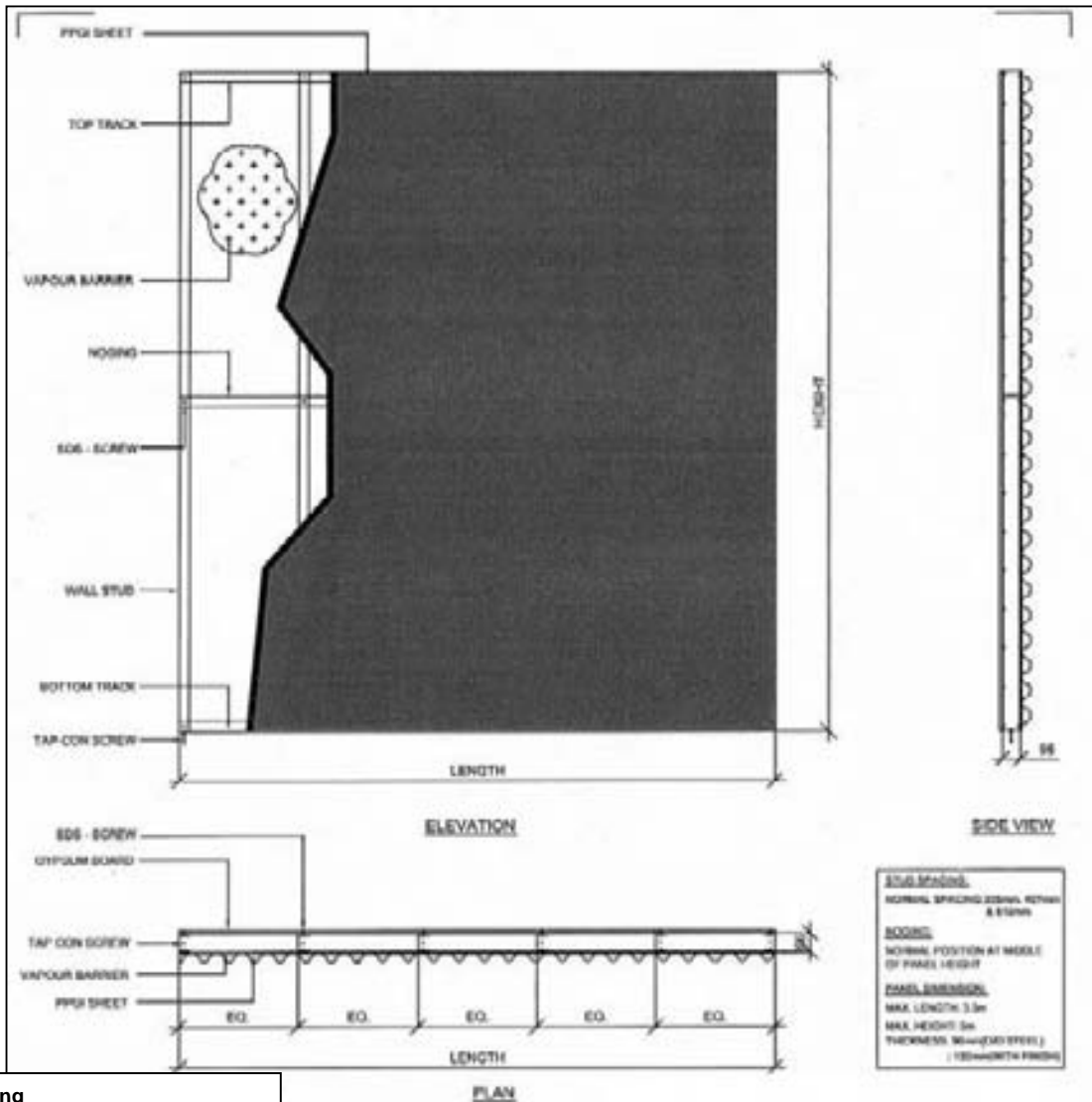


Stud Spacing
 Normal spacing: 305, 407 & 610mm
Nogging: Normal, Position at middle of Panel Height
Panel Dimension
 Max. length: 3.5m, Max. height: 5m, Thickness: 96mm (o/o steel), 137 MM (WITH FINISH)

TAPCON SCREW
 EACH STUD: 1 Nos
WIRE MESH SCREW
 EACH STUD: 600 mm o/c
GYPSUM BOARD SCREW
 EACH STUD: 300 mm o/c

**TYPICAL WALL PANEL
 EXTERNAL WALL PANEL
 (GUNNITING AND GYPSUM BOARD)**

Fig. 13

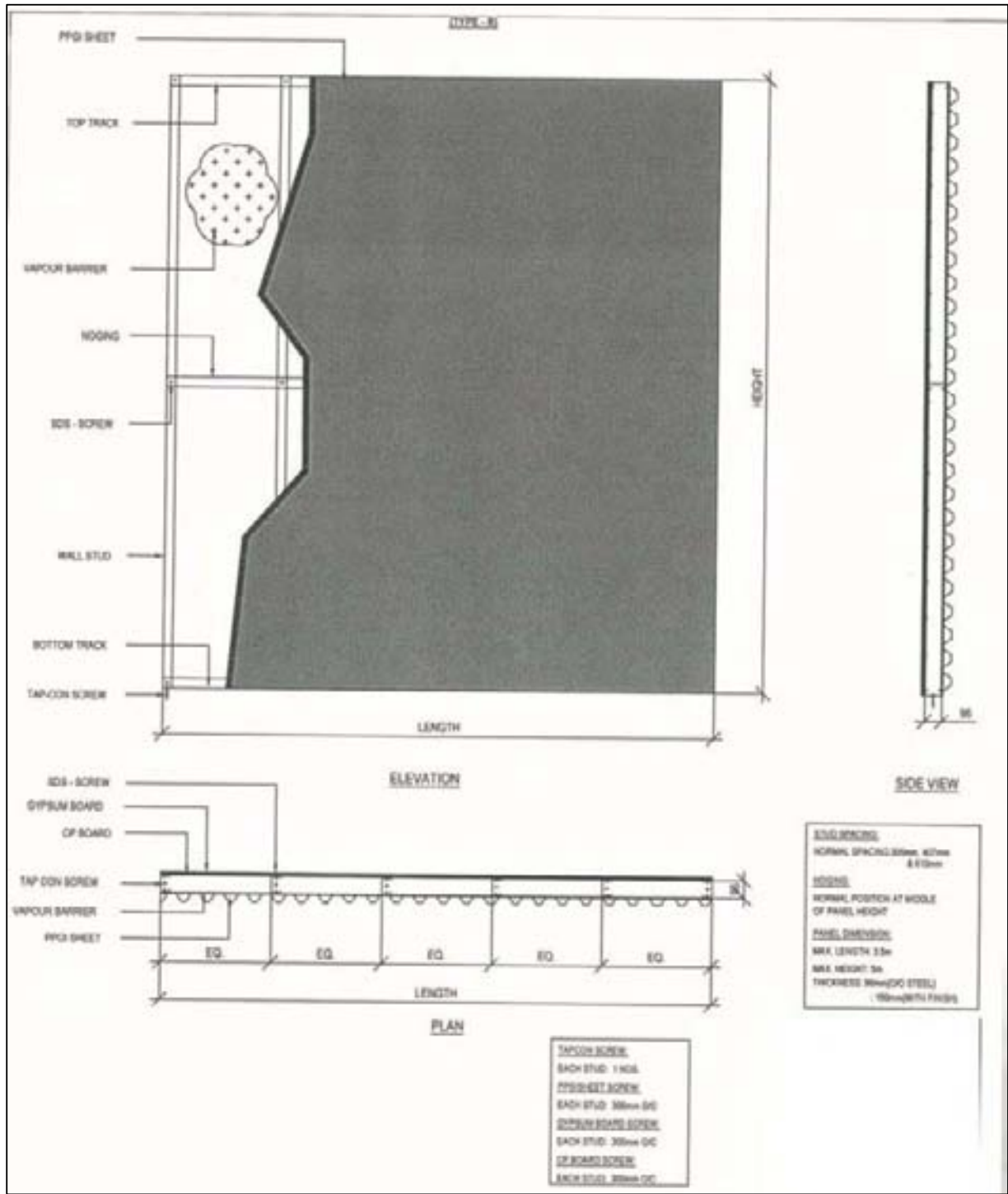


Stud Spacing
 Normal spacing: 305, 407 & 610mm
Nogging: Normal, Position at middle of Panel Height
Panel Dimension
 Max. length: 3.5m, Max. height: 5m,
 Thickness: 96mm (o/o steel), 150 MM (WITH FINISH)

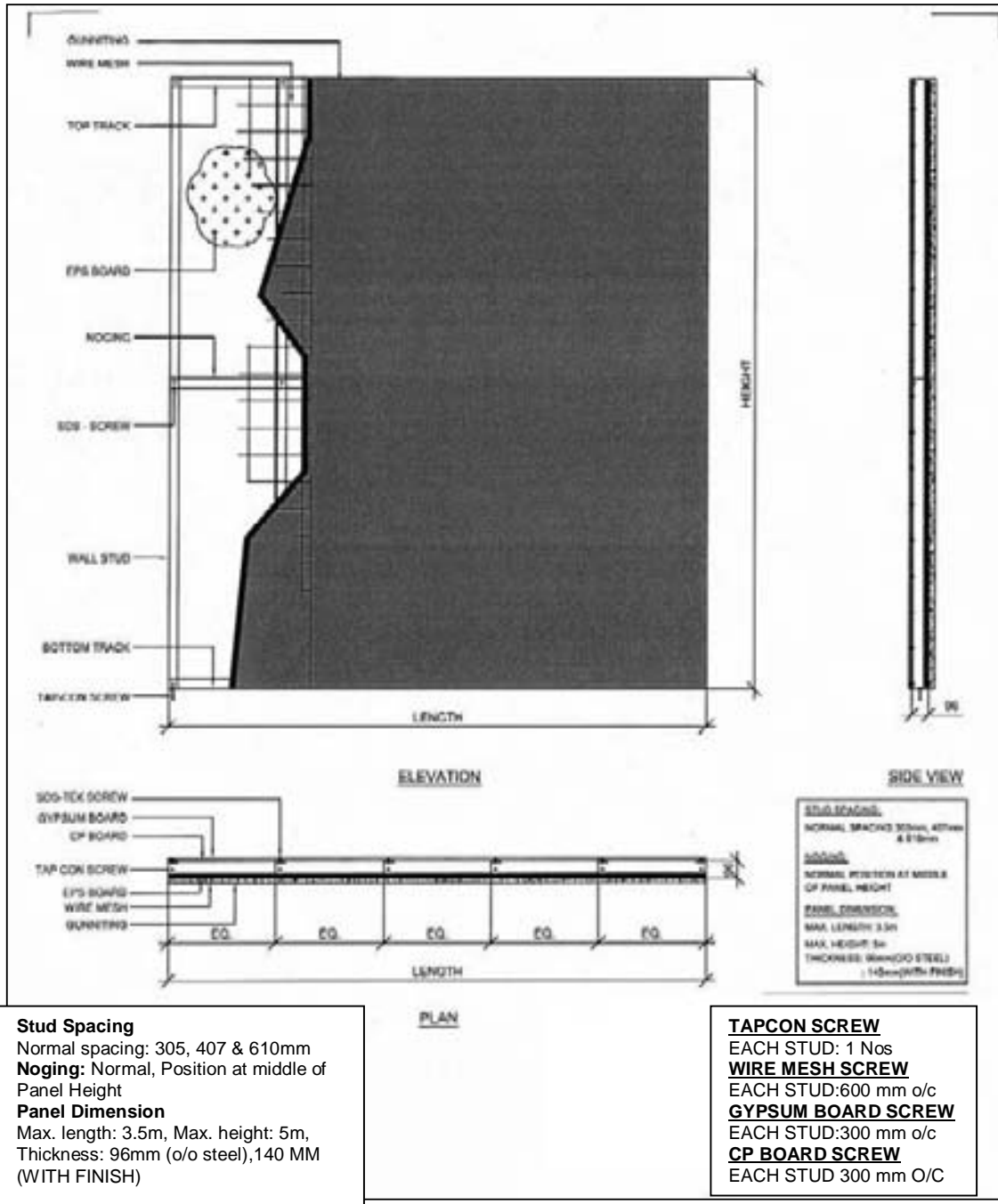
TAPCON SCREW
 EACH STUD: 1 Nos
PPGI SHEET SCREW
 EACH STUD: 300 mm o/c
GYPSUM BOARD SCREW
 EACH STUD: 300 mm o/c

TYPICAL WALL PANEL
EXTERNAL WALL PANEL
 (PPGI SHEET AND GYPSUM BOARD)

Fig. 14

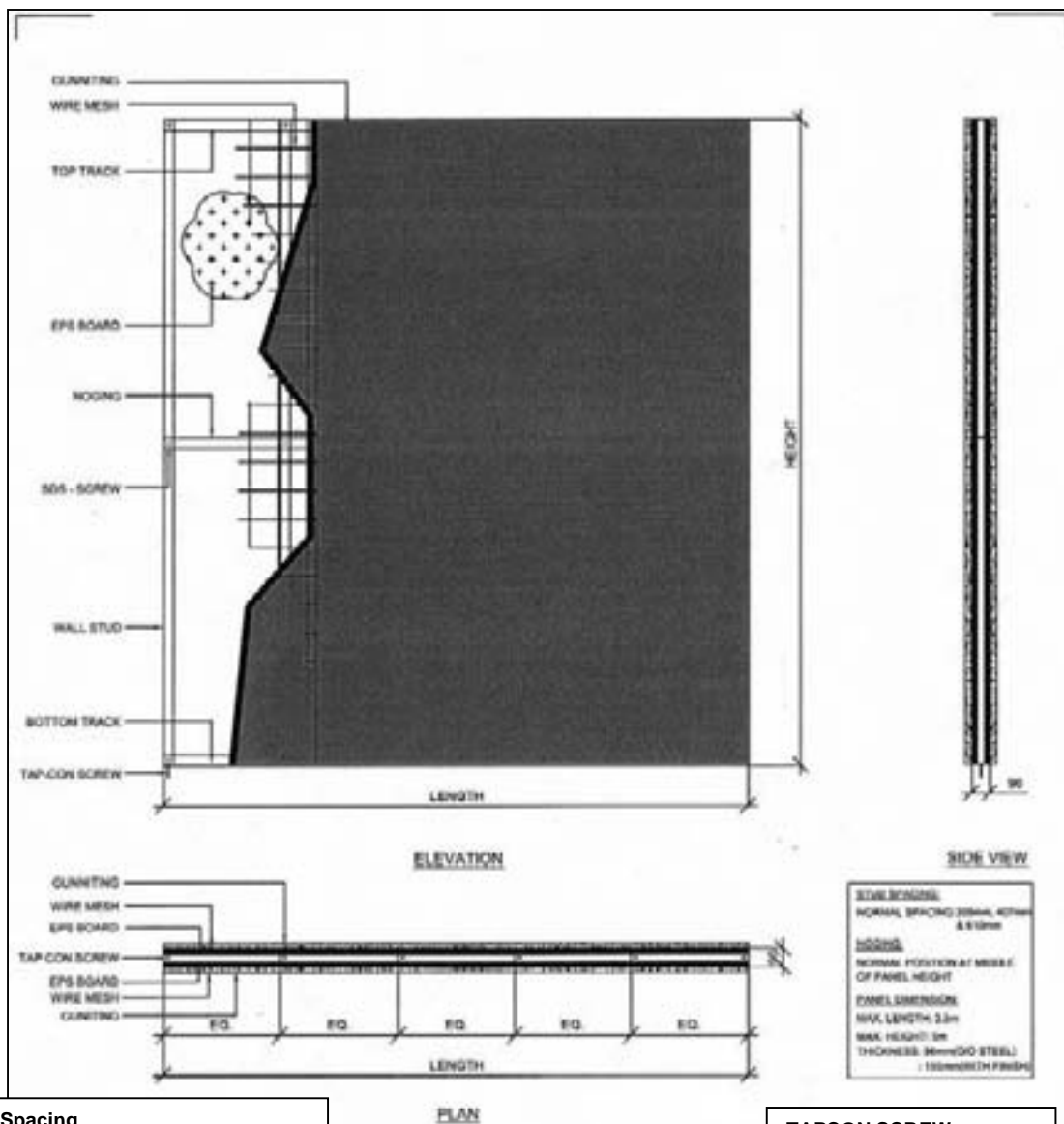


TYPICAL WALL PANEL
EXTERNAL WALL PANEL
 (PPGI SHEET & CP BOARD + GYPSUM BOARD) **Fig. 15**



TYPICAL WALL PANEL
EXTERNAL WALL PANEL
 (GUNNING, CP BOARD AND GYPSUM BOARD)

Fig.16

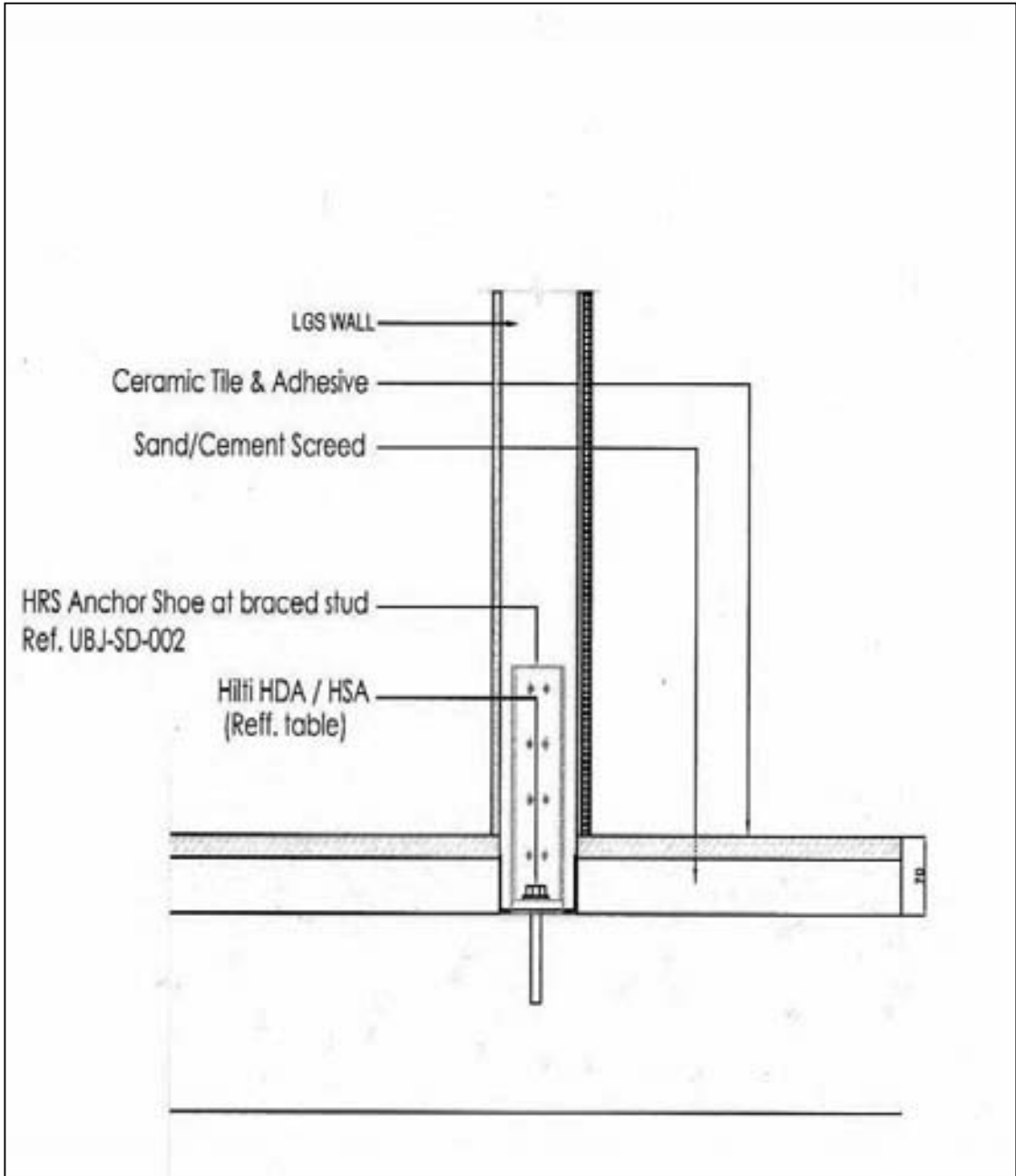


Stud Spacing
 Normal spacing: 305, 407 & 610mm
Noging: Normal, Position at middle of Panel Height
Panel Dimension
 Max. length: 3.5m, Max. height: 5m,
 Thickness: 96mm (o/o steel), 155 MM (WITH FINISH)

TAPCON SCREW
 EACH STUD: 1 Nos
WIRE MESH SCREW
 EACH STUD: 600 mm o/c

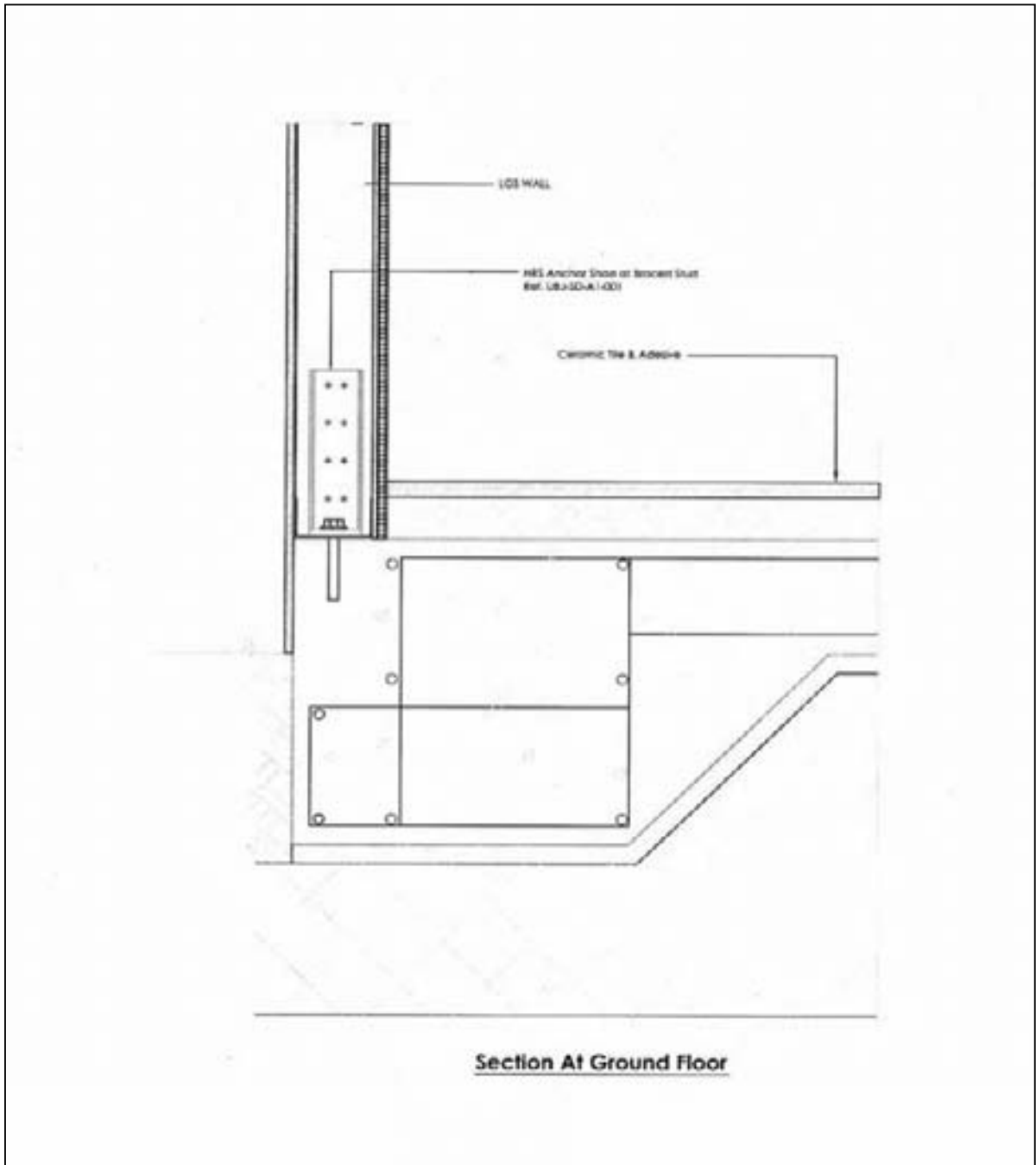
TYPICAL WALL PANEL
WET WALL PANEL
 (GUNNING BOTH SIDE)

Fig. 17



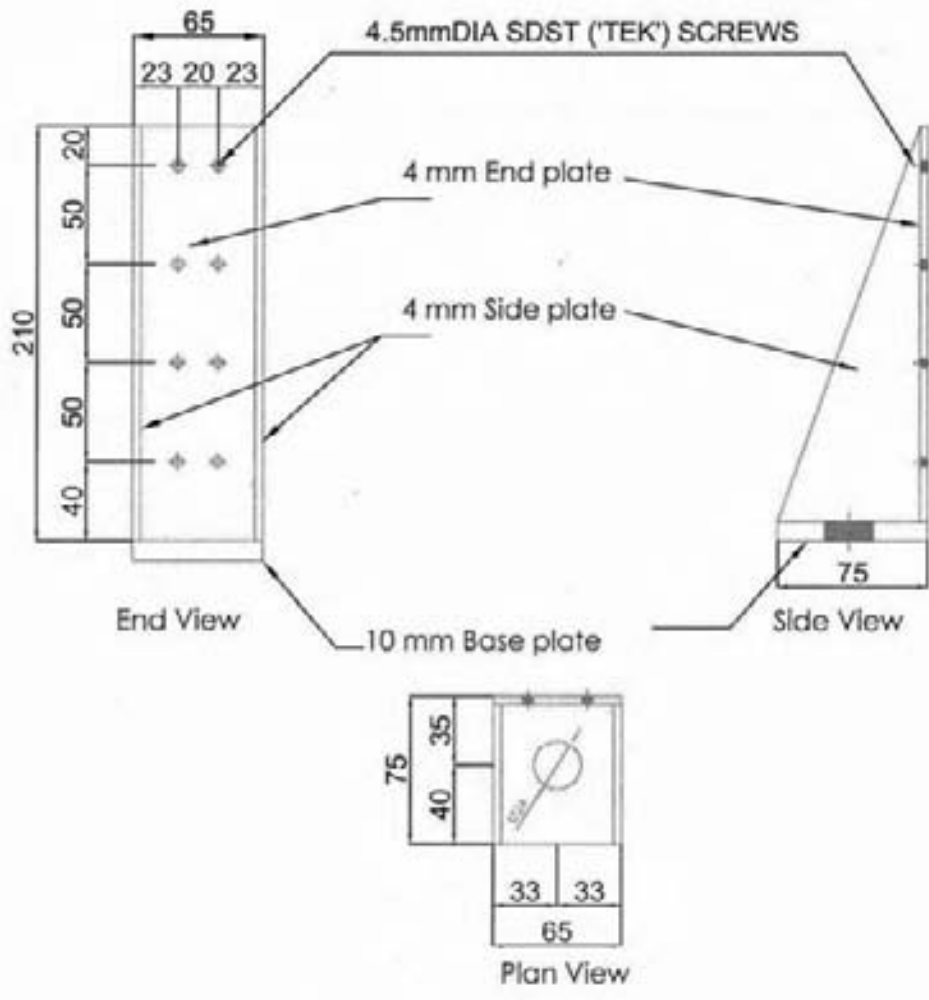
**TYPICAL ANCHORING
ANCHOR DETAIL AT INTERNAL WALL**

Fig. 18



**TYPICAL ANCHORING
ANCHOR DETAIL AT EXTERNAL WALL**

Fig. 19

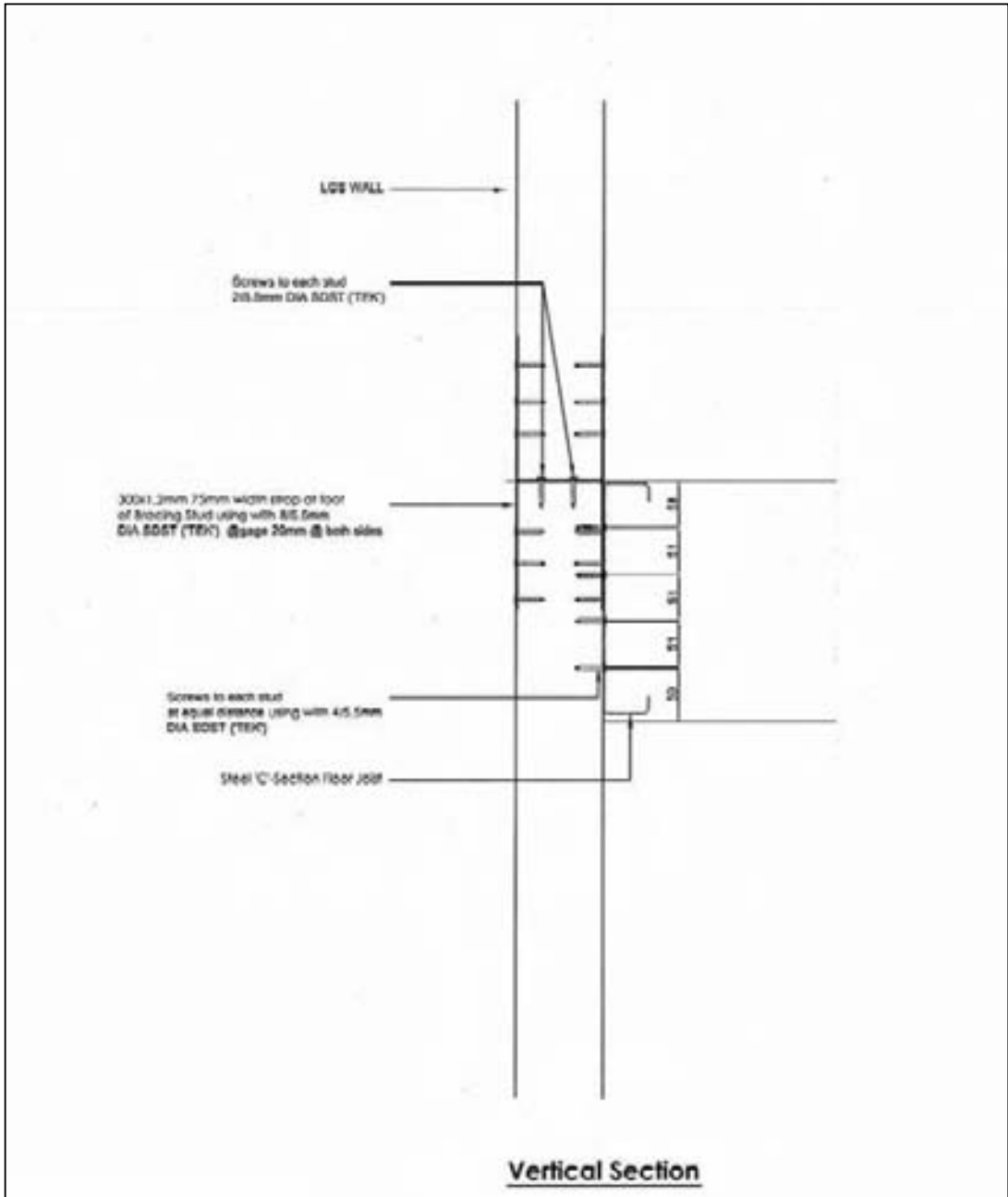


ANCHOR BOLT
AS PER SPECIFICATION

{ Hilti HDA-T M12. M12x125/30 Hef 125mm
Depth of Hole in Concrete to be 150mm
Drill Ø22 Trightenly Torque-80Nm.

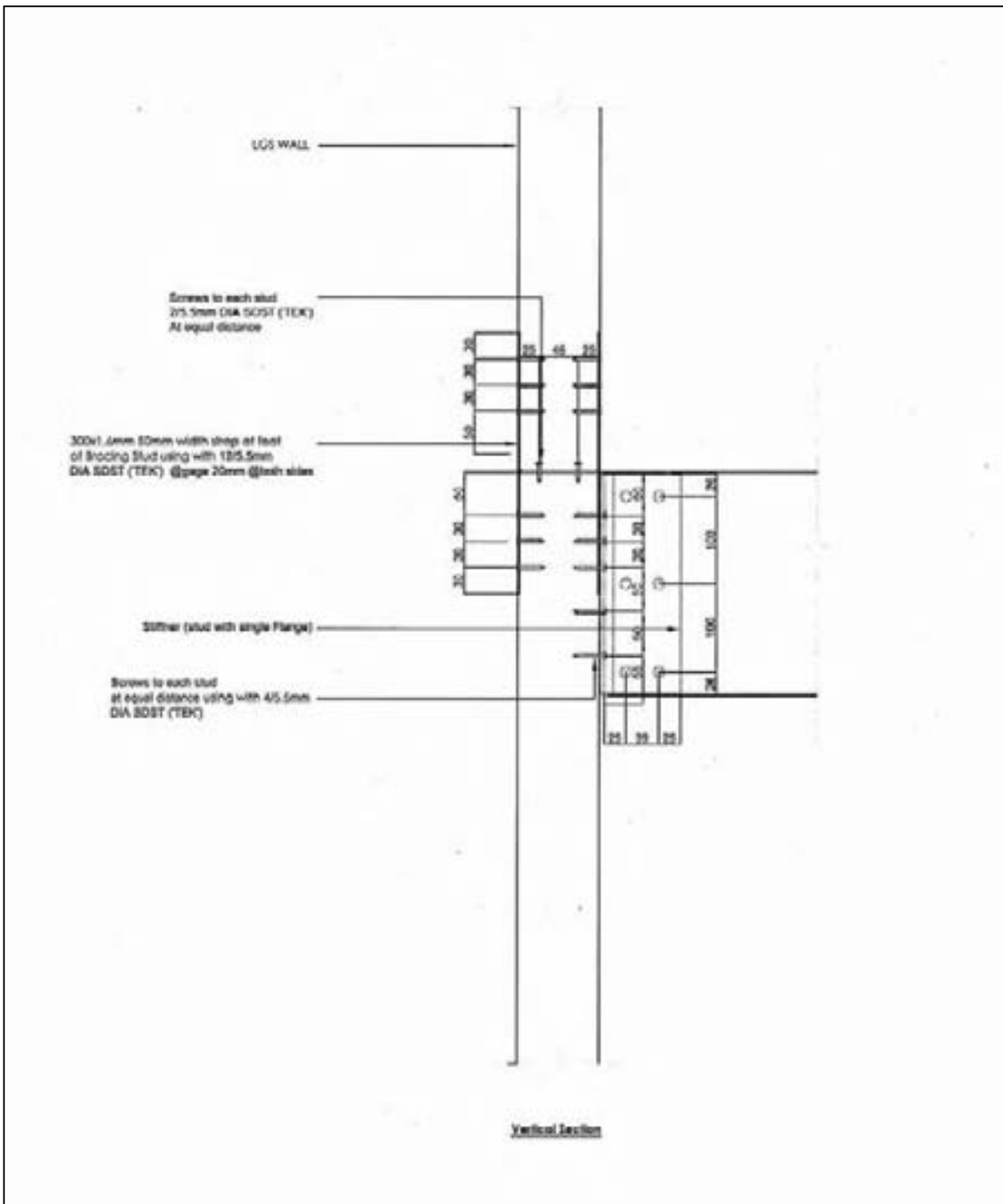
ANCHOR SHOE
HRS ANCHOR SHOE

Fig. 20



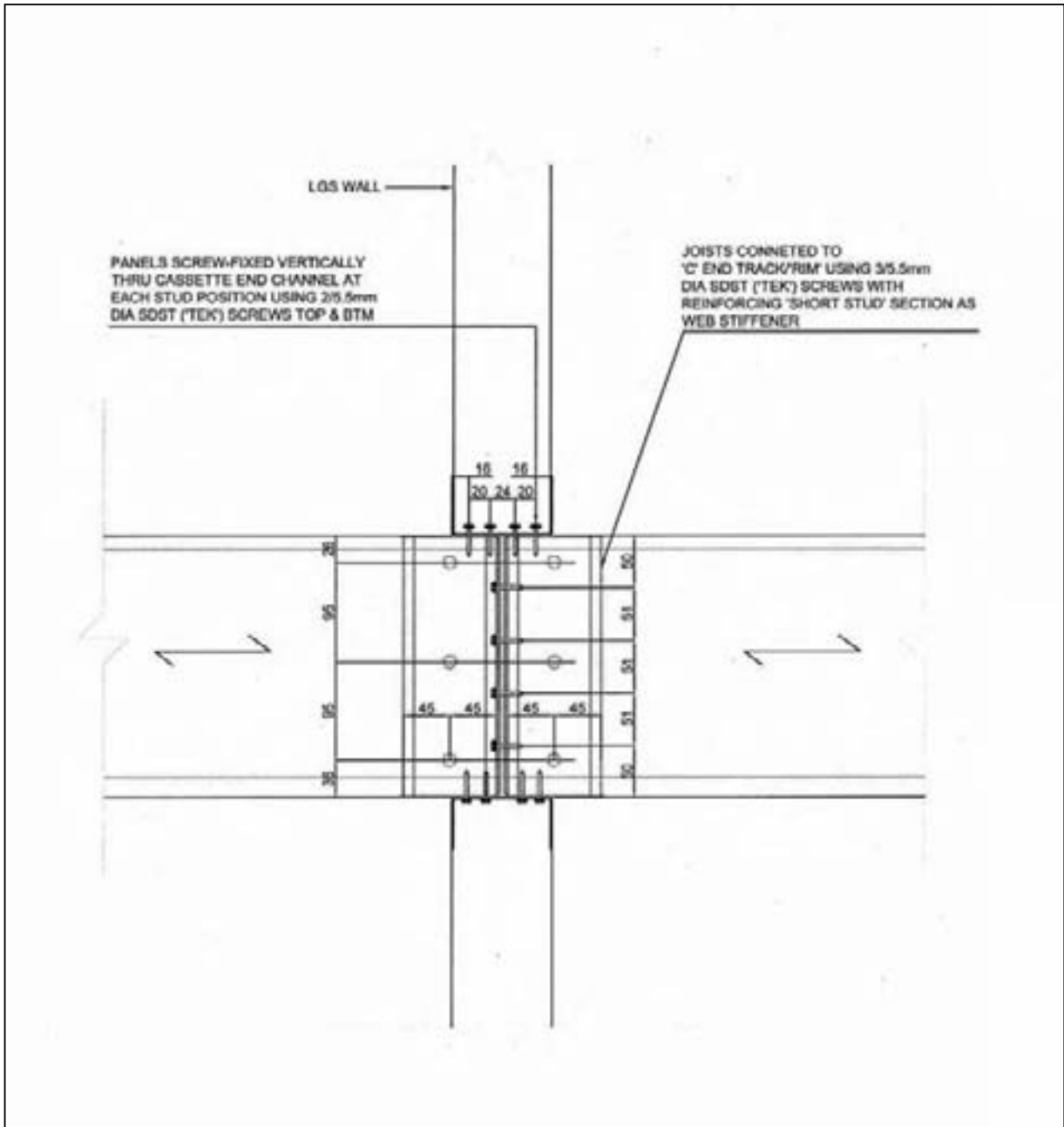
JOIST CONNECTION
JOIST PARALELL TO EXTERNAL WALL

Fig. 21

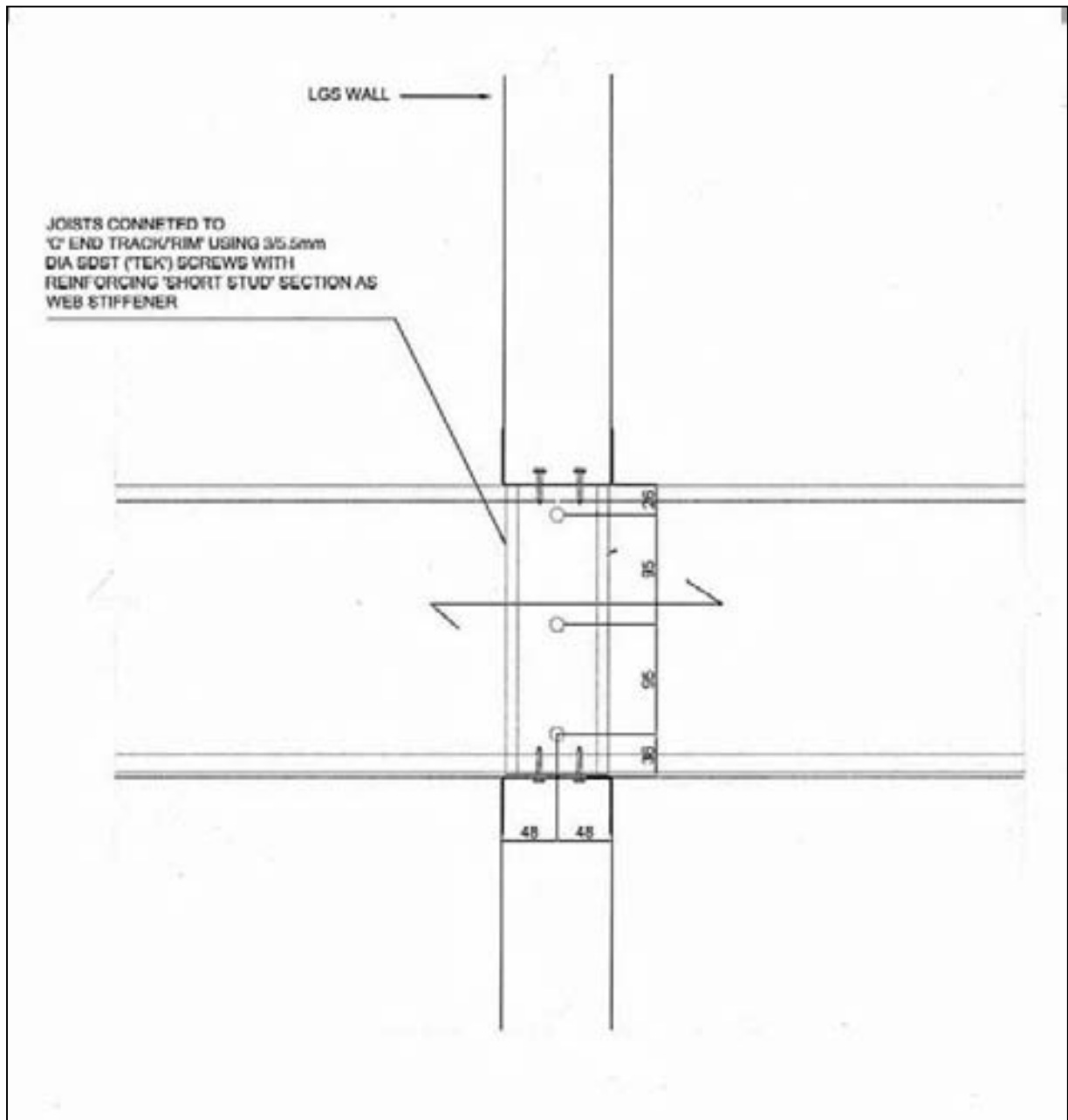


JOIST CONNECTION
JOIST PERPENDICULAR TO EXTERNAL WALL

Fig. 22



JOIST CONNECTION
INTERNAL LOAD BEARING WALL WITH TWO FLOOR CASSETTES
Fig. 23



**JOIST CONNECTION
INTERNAL LOAD BEARING WALL FLOOR CASSETTES**

Fig. 24

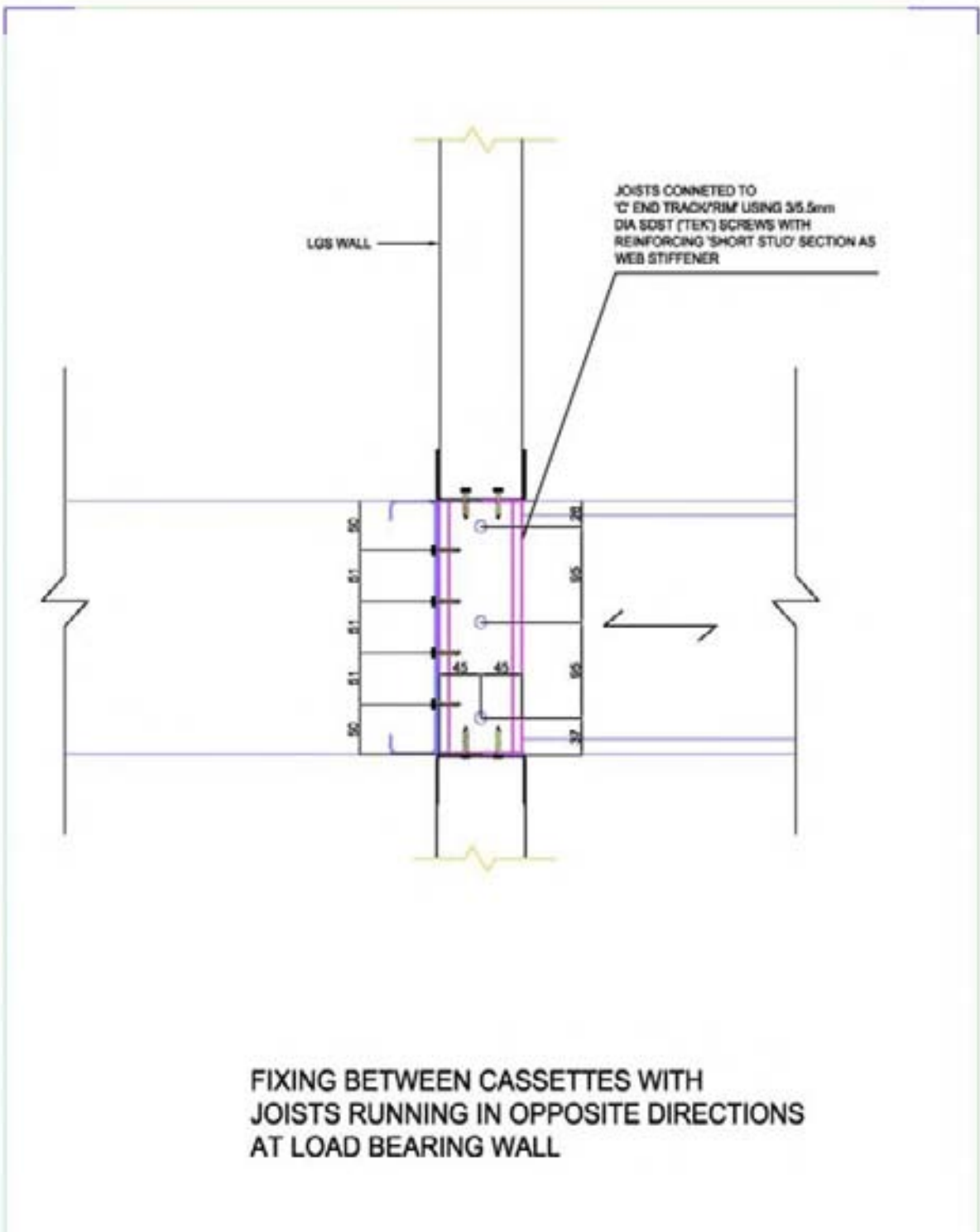
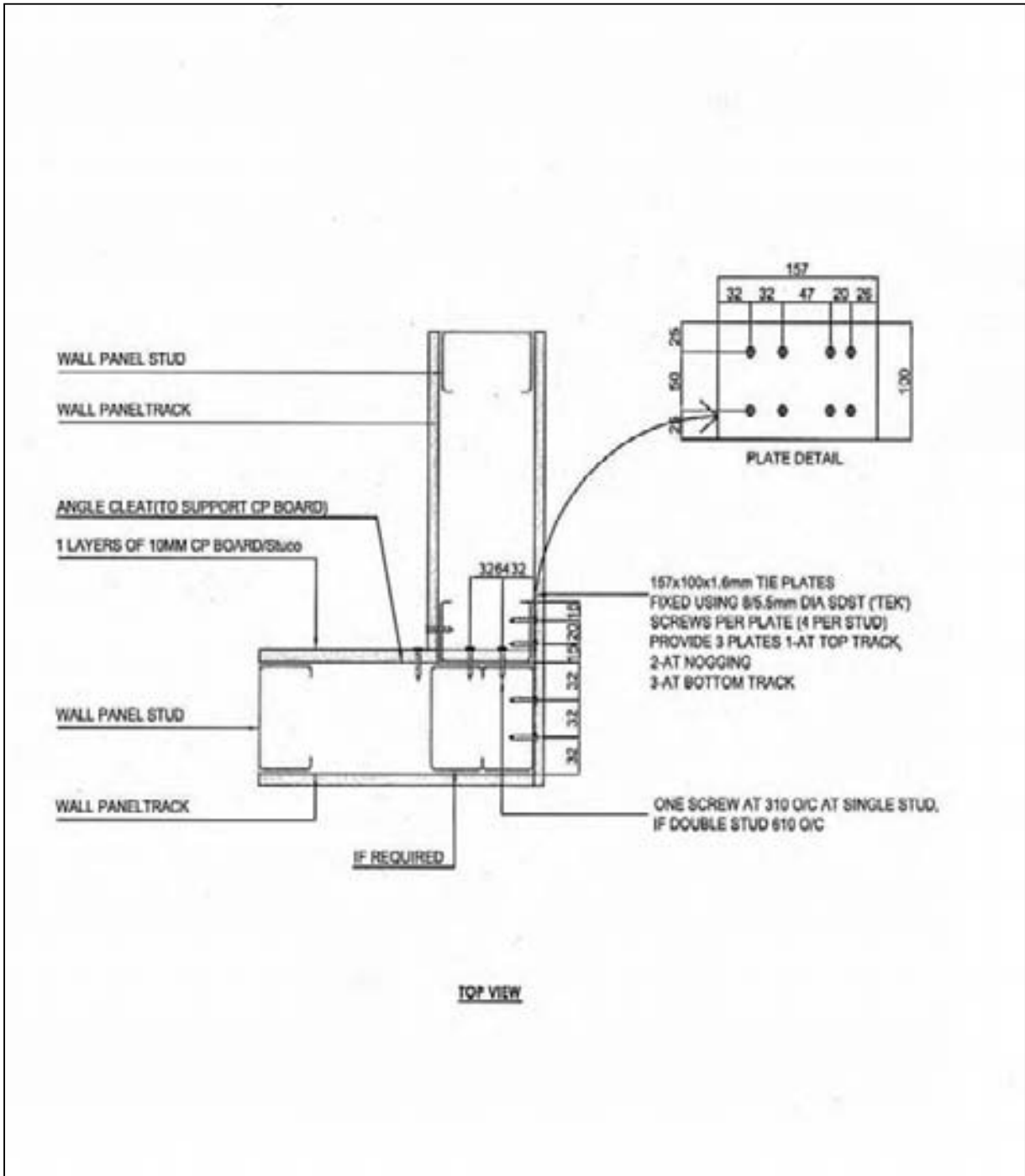
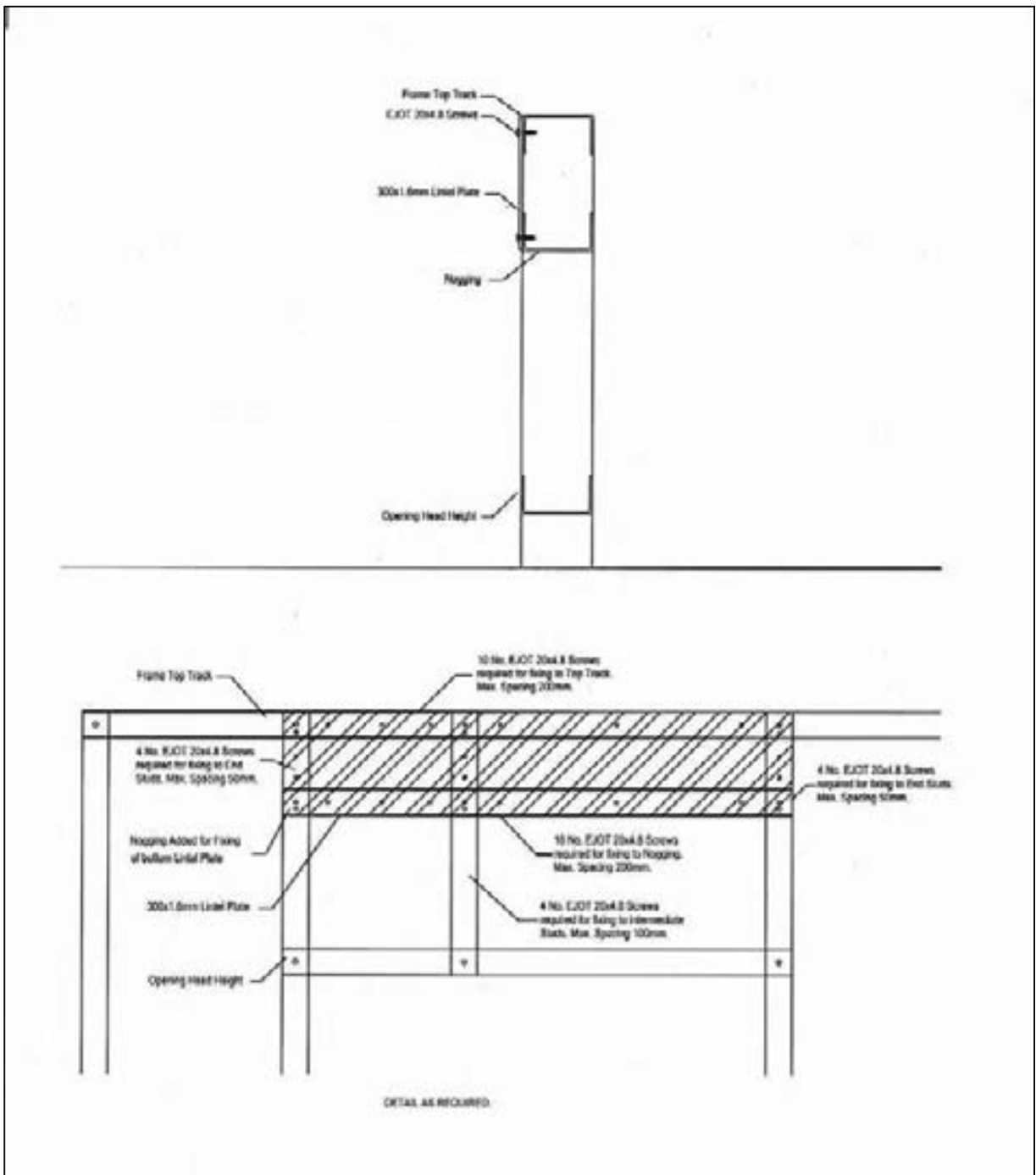


Fig 25



**TWO WALL CONNECTION
WALL TO WALL CONNECTION**

Fig. 26



TYPICAL LINTEL DETAIL
LINTEL PLATE FIXING DETAIL

Fig. 27

