GUYANA STANDARD

Building Code of Guyana
Section 9: Structural steel

Prepared by
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Contents

Foreword

This Section of the National Building Code recommends various load and resistance factors to ensure safety in Structural Steel design and construction.

The Sub-Sections relating to fabrication and erection should serve to remind designers that design and construction are part of the same sequence. The review of construction by competent engineers is of equal importance to the design.

This Code sets out minimum requirements for steel structures as outlined in the Scope. Although the intended primary application of this Section is stated in the Scope, it is important to note that it remains the responsibility of the user of this Section to judge its suitability for his/her particular purpose.

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2. Scope

The term "Steel Structures" relates to structural members and frames which consist primarily of structural steel components, including the detailed parts, welds, bolts or other fasteners required in fabrication and erection. Composition construction, defined as construction which depends upon the participation of structural elements of steel and other materials in resisting loads and forces jointly with structural members, is permitted under this section of the Code.

This Code deals with the design and construction of steel buildings which should be carried out mainly in accordance with the recommendations of Part 2, Section 7B "**Structural Design Requirements – Structural Steel – Working Stress Design"** of the Caribbean Unified Building Code (**CUBIC**), 1985

The general requirements for construction of light gauge steel framed structures have been derived from recommendations of the Dominican Building Code, while the requirements for the construction of small houses using light steel frame construction have been derived from the Dominican Building Guidelines.

2 Definitions

The following words and terms used in this code shall have the meaning shown herein.

2.1 steel construction, cold-formed: That type of construction made up entirely, or in part of steel structural members cold formed to shape from sheet or strip steel such as roofdeck, floor and wall panels, studs, floor joists, roof joists and other structural elements.

2.2 steel joist: Any steel structural member of a building made of hot-rolled or cold-formed solid or open web sections, or riveted or welded bars, strip or sheet steel members, or slotted and expanded, or otherwise deformed rolled sections.

2.3 Steel member, structural: Any steel structural member of a building or structure consisting of a rolled steel structural shape other than cold-formed steel, or steel joist members.

3 Design

3.1 Basis of design

(a) Steel and iron members shall be designed by methods admitting of rational analysis according to established principles of mechanics.

(b) The quality, design, fabrication and erection of steel and iron used structurally in building or structures shall conform to the provisions of this Code and to Part 2 Section 7 B of CUBIC (1985) or to any other relevant approved standard.

3.2 Application

The requirements set forth in **3.1** and **3.17** (inclusive relevant recommendations of the Dominican Building Code), herein, are applicable to structures and do not apply to members formed of flat rolled sheet or strip steel, light gauge steel construction, (except structural frames) or other miscellaneous light steel construction.

3.3 Material standards

Steel for structural applications in buildings shall conform to the "Standard Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use" by the American Society for Testing Materials, ANSI/ASTM A6, or the equivalent British Standard.

3.4 Cold formed stainless steel

The design, fabrication and erection of cold-formed stainless steel construction shall conform to the "Specification for the Design of Cold Formed Stainless Structural Members" of American Iron and Steel Institute or the equivalent British Institution.

3.5 Cold formed steel structural members

(a) The design and construction of cold formed steel structural members shall be in accordance with Part 2, Section 7 B, Sub-Section 14, of CUBIC (1985). This Sub-Section gives information on the working stress design for structural members formed from the shaping of flat rolled steel at ambient temperature to form a structural section.

(b) The developer may utilise any other method of design provided the material used and the design developed, will lead to a building which is resistant to the environment in which it is built. The material used and the design must be approved by the Authority.

3.6 Open web steel joist construction

The design, fabrication and erection of open web steel joist construction shall comply with the following specifications: "Standard Specifications for Open Web Steel Joists, H-Series" adopted by American Institute of Steel Construction and Steel Joist Institute or to Part 2, Section 7B, Sub-Section 17 of CUBIC (1985).

3.7 Welding

Details of design, workmanship and techniques for welding, inspection of welding, and qualification of welding operators shall conform to the following specification:

(a) "Structural Welding Code" by American Welding Society or the equivalent British Standard.

(b) "Specifications for Welding Sheet in Buildings" by American Welding Society or the equivalent British Standard.

3.8 High tension bolts

The design and assembly of structural joints and connections using high strength steel bolts shall conform to the "Specifications for Structural Joints Using ASTM A325 or ASTM A490 Bolts", or the equivalent British Standard, approved by the Research Council or Riveted and Bolted Structural Joints of the Engineering Foundation, or the equivalent British Institution.

3.9 Tests

The Authority shall consider the need for tests and/or mill records to determine the quality of materials and assemblies.

3.10 Design loads

Designs shall be based on the dead, live, wind and other loads set forth in CUBIC, the American Standard or the British Standard and the additional stress considerations set forth in this code.

3.11 Minimum thickness of material

(a) The minimum thickness of steel and iron used in buildings or other structures or to resist wind forces, shall not be less than as set forth in BS 5950 "Structural Use of Steelwork in Buildings" or equivalent American Standard and where structural members are exposed to industrial fumes, salt water, salt water spray and other corrosive agents, such members shall have a minimum web thickness of 6 mm (0.25") unless the steel used in an atmospheric corrosion-resistant grade approved by the Authority. It is recommended that in corrosive atmosphere all steel members be protected against corrosion by concrete haunching or other approved forms of protection.

(b) In the main structural framework of buildings primary members shall be construed to include any steel member used as a column, beam or to support walls or partitions including trusses, isolated lintels spanning openings of 2400 mm (8ft) or more and any member required to brace a column or a truss or to support 18 m^2 (200 sq.ft.) of floor or roof area.

(c) Secondary members shall be construed to include all other steel members, including filling-in beams of floor systems which individually support less than 18 m^2 (200 sq.ft). of floor or roof area.

(d) For primary members of the structural frame, all steel used shall be at least 5 mm (0.20 inches) in thickness for interior work. All steel in exterior walls of structures except lintels spanning an opening of less than 2400 mm (8 ft) shall be at least 5 mm (0.20 inches) in thickness when protected as required in **3.9** and at least 6 mm (0.25 inches) thick when not so protected.

(e) Unless otherwise determined by tests, the thickness of fire-resistive members shall be assumed to have the resistance rating as detailed in **Table 1.**

Table 1

Fire resistance of concrete members

Thickness of (mm)	**1 hr.**	**2 hr.**	**3 hr.**	**4 hr.**
Cement concrete over 2000 psi	2.5	37.5	50	50
Cement concrete 1600 – 2000 psi	37.5	50	75	100
Cement concrete 1600 – 2000 psi With wire fabric	37.5	50	50	75
Concrete block (Nominal dimensions)	-	-	100	100

3.12 Connections

(a) Any suitable mechanical fastener, special device or other means may be used to join component parts provided that the type of fastening device is compatible with the service connection.

(b) High strength steel bolts may be used in lieu of rivets.

(c) Welded connections shall be in accordance with BS 2642 “General Requirements for the Arc Welding of Steel” and/or CSA Standard W59, “Welded Construction (Metal-Arc Welding)”.

(d) A competent welding supervisor, who shall be approved by the Authority, shall be present at all times when welding is in progress.

(e) It shall be permissible to use ribbed or spliced bolts in place of rivets or ordinary bolts. The diameter of the bolt shall be identical to that of the rivet.

3.13 Pipe columns

3.13.1 General

(a) Steel or wrought iron pipes maybe used as compression members. The pipes shall be new material, they shall be straight and the wall thickness shall not be less than 5 mm (0.2 inches).

(b) Where pipe columns supportloads in excess of 454 N (1000 lbs) or are required to be fire resistive, the pipe shall be filled with 1:3:6 concrete.

3.13.2 (a) Only the load-bearing capacity of the shell shall be considered in determining the allowable load on a pipe compression member when filled with concrete.

(b) Load-bearing pipe columns shall be provided with steel bearing plates so designed that the bearing stresses of the material on which the material is to be placed shall not be exceeded and so that the bending stresses in the steel plate shall not exceed those permitted.

3.14 Composite beams

(a) Composite beams shall be the term used to apply to any rolled or fabricated steel floor beam entirely encased in a poured concrete haunch supporting a concrete slab on either side. At its narrowest point the concrete haunch shall be at least 100 mm (4 inches) wider than the flange of the beam. The top of the beam shall be at least 50 mm (2 inches) above the bottom of the slab and least 37.5 mm (1.5 inches) below the top of the slab. There should be no openings in the slab adjacent to the beam. The concrete casing shall be adequately provided with mesh or other reinforcement throughout its depth and across its soffit.

(b) Uncased beams may be designed as composite beams provided that this is based on the requirements of BS 5950 or equivalent standard approved by the Authority.

3.14.1 Basis of design

The basis of design of composite beams shall be carried out by a professionally qualified engineer using a method acceptable to the Authority. Particular attention shall be paid to the design of shear connectors, and to the provision of adequate resistance to end shear forces.

3.14.2 Protection of the metal

All field rivets and bolts and abrasions to the shop coat shall be spot painted. Buildings or structures not encased in concrete shall be field painted, in addition to the shop coats, with not less than 1 coat of lead, graphite, asphalt paint or other approved paint which will not act as a solvent for the shop coat.

3.15 Light gauge steel construction

3.15.1 Application

(a) Light guage steel construction shall include structural decks or members formed of sheet or strip steel less than 5 mm (0.2 inches) thick and used for load-bearing purposes.

(b) The use of light gauge steel construction shall be reserved for single or two storey buildings in Group E Occupancy or in Group D Occupancy provided the building is not greater than 180 m^2 (2000 sq.ft.) in floor area.

(c) This sub-section provides information on the framing requirements for small steel structures using standard sections.

3.15.2 Duties of the developer

(a) For the design, fabrication and erection of prefabricated steel buildings composed of light gauge steel members, the developer shall file with the Authority duplicate copies of a certificate from a recognised testing laboratory to the effect that tests have been made on this particular type of prefabricated construction. The test results should show the dead loads, live loads and wind loads sustained by the construction together with a physical description of the building and a description of the tests.

(b) Panels and other elements tested for loads shall sustain without failure a superimposed load equal to two times the live load. Recovery within 24 hours after removal of the full test load, shall be not less than 75 percent of the observed deflection. The measured deflection for any panel or element under full live load shall not be greater than 1/360 of the span for roof decks without ceilings.

(c) All tests must be carried out in accordance with the applicable standard of the ASTM or the relevant British Standard.

(d) It is the responsibility of the developer to prove by calculations or test results that the design proposed will provide a building that is resistant to the wind and other loads given in **3.10**, and that the corrosion protection of the steel members will be adequate over the projected life of the building. The building must have the fire resistance required for the class of use.

(e) It is expected that the developer will supply the following information when applying for a building permit:

(i) complete structural drawings of the building. The drawings and written information must give the sizes and thickness of all members, the connections used, and methods of field assembly;

(ii) test results required under **3.15.2 (a)**;

(iii) test data and specifications of the corrosion protection method to be used;

(iv) other standard information required by the Authority.

3.15.3 General standard

The design and construction of light gauge steel structures shall be carried out in accordance with the relevant standards set forth by the American Iron and Steel Institute or the British standards or other relevant standard or code approved by the Authority.

The design requirements may be varied by the developer, provided that tests on the materials and assemblies show that the structure can accommodate the imposed loads safely and can resist the wind forces in accordance with the requirements of **3.10.**

3.15.4 Structural members other than decks

Design and fabrication shall be as set forth in **3.15.2** Special attention shall be paid to the following:

(a) All primary and secondary members must be designed in accordance with the standards given in **3.15.1** and **3.15.2** or in accordance with any other standard approved by the Authority. Except that the minimum thickness of steel for primary members shall be 16 gauge, and the spacing of studs shall be no greater than 600 mm (24 inches) on centres and provision shall be made to resist horizontal wind forces by diagonal members of diaphragm panels attached to the studs.

(b) Light gauge steel for the treads, risers, stringers and landings of stairways shall have a minimum thickness of 12 gauge.

(c) Light gauge steel studs for non-bearing partitions shall have a minimum thickness of 18 gauge.

(d) Light gauge steel joists or rafters shall be designed with due consideration for wind pressure and suction at the relevant level.

(e) Unless other wise provided for in the design, the joist or rafter members shall have not less than 100 mm (4 inches) of bearing on reinforced concrete nor less than 50 mm (2 inches) on steel supports, except that where opposite joist butt over a steel support is positive, approved means of attachment to the steel is furnished, a shorter bearing length may be used. Each end of each member shall be anchored. Resistance to diaphragm action shall be provided by the deck or diagonal members. Bridging shall be provided, spaced not further apart than 32 times the flange width. Such bridging shall be solid sections of the hoist material or be cross bridging formed from approved open-welded joists.

(f) Light gauge steel used in sandwich construction for wall panels for the exterior or enclosing walls of buildings shall have a minimum thickness of 24 gauge for the sheeting. The minimum thickness for secondary members supporting exterior panel construction shall be 18 gauge.

(g) Light gauge steel members resisting lateral stresses in interior partitions of buildings of two storeys or more in height shall not be less than 16 gauge.

(h) Light gauge steel members shall not be used in locations subject to corrosive agents or continuous dampness.

3.16 Structural sheets

Structural sheet-metal sections may be used for floor decks, roof decks and wall cladding to span between supports; provided the design is based on rational analysis, and design and fabrication comply with the standard set forth in **3.1** or with any other standard approved by the Authority and as follows:

(a) Sheet-metal sections shall have a minimum thickness of 18 gauge for floors, or 24 gauge for roof and walls and shall be protected as set forth in this sub section.

(b) The span of sheet-metal sections used for floor systems shall not exceed 40 times the overall depth of the section.

(c) No structural value shall be allowed for any fill material used with deck systems except in the case of composite floor systems which shall be designed to the approval of the Authority.

(d) The shape of the sections as placed in buildings shall be such as to eliminate any possibility of lateral displacement for compression area.

(e) Where large openings occur, the perimeter of the openings shall be framed with adequate supports for the floor panels. Small openings shall be reinforced so that the allowable stresses in the adjoining materials are not exceeded.

(f) Positive anchorage of sheet-metal roofs or decks shall be provided by proven mechanical connectors. The anchorage must be capable of resisting the uplift forces caused by wind and other loads described in **3.10**.

(g) Bolts and rivets shall not be less than 5 mm (0.2 inches) in diameter. Lead, neoprene, or other approved washers not less than 12.5 mm (½") in diameter shall be provided under the heads of bolts and rivets.

(h) Roofing sheets and other structural sheet metal sections spanning between supports shall be designed to support the live load without deflecting more than 1/180 of the span and without permanent deformation.

(i) All members formed of light gauge strip or sheet metal shall be treated with protective paint coatings or shall be galvanised. The anti-corrosion treatment must be approved by the Authority.

(j) Valley fixings for corrugated roof sheets are stronger than ridge fixings, and are recommended provided that measures are taken to avoid leaks, such as the use of suitable washers and the use of self aligning tools for the installation of fixing screws in accordance with the manufacturer's instructions.

3.17 Small buildings

Small buildings are defined as buildings of less than 270 m^2 (3000 sq.ft.) in floor area in Residential Buildings and General Merchandise Stores and not more than two storeys.

3.17.1 Application of sheet steel stud wall framing

This Sub-Section applies to sheet steel studs for use in non-load bearing exterior walls and interior partitions. Information on the design and construction of steel framed structures using cold formed steel sections can also be found in the Cold Formed Steel Design Manual published by the American Iron and Steel Institute or the equivalent British Standard.

3.17.2 Design criteria

(a) Where loadbearing steel studs are used they shall be designed in conformance with the relevant BS or ASTM standards.

(b) Steel studs and runners shall conform to ASTM C645-76, "Non Load (Axial) Bearing Steel Studs, Runners (Track), and Rigid Furring Channels for Screws", or the equivalent British Standard.

(c) Screws for the application of cladding materials to steel studs, runners and furring channels shall conform to ASTM C646-78a, "Steel Drill Screws for the Application of Gypsum Sheet Material to Light Gauge Steel Studs", or the equivalent British Standard.

(d) Steel stud framing shall be clad on both sides with lath and plaster or sheet-type material, fastened with screws or other acceptable fasteners at the appropriate spacing as required for interior finishes. Screws used for attaching wall finishes shall penetrate at least 9 mm (0.375 inches) through the metal.

(e) Except as required in **3.17.2 (d)** steel studs in non-loading bearing partitions shall have a metal thickness of not less than 24 gauge.

(f) Runners for interior and exterior non-loadbearing walls shall have a thickness of at least 24 gauge exclusive of coatings and shall have at least 25 mm (1inch) flanges. Note that except otherwise approved by an Engineer, where the runners and other members are required to resist lateral loads the minimum thickness of the material shall be as set forth in **3.11**.

(g) Where openings for doors in non-loadbearing fire separation required to have fire-resistance rating do not exceed 1.2 m (4ft) in width, the width of steel studs shall be at least 62.5 mm (2.5 inches). Where openings exceed 1.2 m (4 ft) in width, the stud width shall be at least 87.5 mm (3.5 inches). The metal thickness of the studs must be adequate for the size of the stud being used.

(h) The distance of the first stud beyond the jamb of any door opening in a fire separation required to have a fire resistance rating shall not exceed 400 mm (16 inches). Where the distance between the framing over the opening at the top runner exceeds 400 mm (16 inches) in such walls, intermediate support shall be installed at intervals of not more than 400 mm (16 inches) above the opening.

(i) The size of spacing of non-loadbearing steel studs for exterior walls shall be in conformance with **Table 2**

Table 2

Steel studs for Non-loadbearing exterior walls

Minimum stud dimension mm (in.) (Nominal)	Minimal metal thickness (excluding coatings) mm (in.)	Minimum stud length mm (ft-in)		
		Spacing of studs mm(in) – centre to centre		
		300 (12)	400 (16)	600 (24)
31 x 100 (1-1/4 x 4)	0.525 (0.021)	2850 (9-6)	2400 (8-0)	-
31 x 100 (1-1/4 x 4)	0.675 (0.027)	3300 (11-0)	2650 (8-10)	2350 (7-10)
31 x 100 (1-1/4 x 4)	0. 825 (0.033)	3450 (11-6)	3000 (10-0)	2650 (8-10)
31 x 100 (1-1/4 x 4)	0.991 (0.039)	3900 (13-0)	3250 (10-10)	3000 (10-0)

3.17.3 Size of framing

Except as required in **3.17.2** (**f**) and (**h**) the size and spacing of steel studs for non-loadbearing partitions shall conform to **Table 3**.

Table 3

Steel studs for non-loadbearing partitions

Minimum stud size mm (in.)	Maximum stud spacing mm (in.)	Maximum wall height mm (ft-in)
31x 37.5 (1-4/4 x 1-1/2)	400 (16) 600 (24)	2850 (9-6) 2550(8-6)
31 x 62.5 (1-1/4 x 2-1/2)	400 (16) 600(24)	3900(13-0) 3400(11-6)
37.5 x 87.5 (1-1/2 x 3-1/2)	400(16) 600(24)	5100(17-0) 4800(16-0)

3.17.4 Installation

(a) Runners shall be provided at the top and bottom of walls and partitions. Such runners shall be securely attached to the building at approximately 50 mm (2 inches) from the end of the runners, and at intervals of not more than 600 mm (2 ft) on centres for interior studs. Such fasteners shall consist of the equivalent of 62.5 mm (2.5 inches) nails or 25 mm(1inch) screws.

(b) Studs at openings and which are not full wall height shall be supported by a runner at the ends of the studs, securely fastening to the full length studs at the sides of the openings.

(c) Steel studs used in walls required to have a fire resistance rating shall be installed so that there is at lease 12.5 mm (0.5 inch) clearance between the top of the stud and the top of the runner to allow for expansion in the event of fire. Except as provided in **3.17.2,** studs in such walls shall not be attached to the runners in a manner that will prevent expansion.

(d) Door openings in non-loadbearing fire separations are required to have a fire resistance rating which shall be framed with 2 runner sections back to back.

(e) Steel studs shall be installed with webs at right angels to the wall face and except at openings shall be continuous for the full wall height.

(f) Corners and intersections of walls and partitions shall be constructed to provide support for cladding materials.

(g) Studs shall be doubled on each side of every opening where such openings involve more than one stud piece, and shall be tripled where the openings in exterior walls exceed 2325 mm (7ft – 9in.) in width. Such studs shall suitably be tied together to act as a single structural unit in resisting transverse loads.

(f) Studs shall be attached to runners by screws, crimping, welding or other suitable method around wall openings, and elsewhere where necessary to keep the studs in alignment during construction.

4 Construction

4.1 Management

4.1.1 Ordering and purchasing

(a) Most suppliers of steel buildings require information setting out the plan and dimensions of the proposed building. Its height, type of framing and design parameters such as basic wind speed and gravity loading.

(b) The design and construction of steel structures are generally outside the scope of these guidelines. However, there is an increasing number of steel shells being used for factories and small manufacturing enterprises. The information contained in these guidelines is intended to assist the builder in understanding the basic considerations for ordering, storing and erecting the steel structure.

(c) It is further recommended that, in all cases, when contemplating the use of steel structures, experienced professional advice be sought.

4.2 Handling

(a) The performance of a steel framed building will depend to a large extent upon the way it is handled in the early stages.

(b) Preferably, steel work should by cleaned of rust by shot or sand blasting and then painted with two coats of red lead oxide metal primer.

(c) This treatment will ensure that it reaches the site in very good condition.

(d) Before erection, the steel work should be primed with red lead oxide primer to ensure that all surfaces are primed before the final decoration is applied.

4.3 Foundations

4.3.1 General

(a) Foundations for steel framed buildings generally consist of a reinforced concrete pad located at a suitable depth on a bearing stratum.

(b) The pad supports a stub column which has the column holding down bolts cast into it.

(c) The height of the stub column is such that the column base is located at the desired elevation.

(d) Since steel framed buildings are relatively light weight structures, the footing size is unusually arrived at by determining the size of the adequate anchor to prevent uplift due to wind. The size of footing should therefore be provided by the designer or supplier, and the horizontal restraint needed at the column bases must also be shown by the designer.

(e) Because of this, it is not possible to provide specific design guidelines, since the size of the footing is dependent upon the forces which would be generated by the wind. Experienced engineers would be required to carry out a wind analysis, the results of which would permit the design of the footing to be undertaken.

(f) When hollow concrete blocks are to be used to construct the walls, strip footings between the column footings are used for their support.

4.4 Walls

4.4.1 General

For steel framed buildings, two systems are generally used for walls. There are hollow concrete block walls or metal cladding.

4.4.2 Concrete walls

(a) When concrete walls are used the vertical steel reinforcement is anchored to the footing in the normal manner and anchored at the top by welding to the longitudinal beam, or fixed to a concrete beam constructed on top of the wall.

(b) The horizontal reinforcement is welded to the web of the columns. If the columns are encased in concrete the reinforcement can be carried to the face of the steel column.

(c) Care must be taken to fix these walls to the steel frame so as to provide lateral continuity to the walls and to prevent the wall from collapsing either under the shaking from an earth tremor or from the pressure due to high winds.

(d) It is however, sometimes necessary to install a flexible joint between the block wall and the steel column where the walls have not been used to provide lateral stability. In this event the steel frame must be adequately braced to accommodate the lateral loads without collapse.

4.4.3 Metal cladding

(a) Where metal cladding is used, Z-purlins are attached to the columns with suitable fixings.

(b) The vertical siding, as the sheeting is then called, is attached to the Z-purlins in the normal manner employed for roofs. Fixings made in the valley rather than on the crowns would provide greater wind resistance. Care must be taken to prevent leaks.

4.4.4 Frames

(a) The type of frame most commonly used in the region is the portal frame with pinned bases. This kind of frame is commonly used in factory shells, warehouses and some commercial buildings.

(b) The frame consists of two columns and two rafters and all constructions are usually bolted, although welded connections are sometimes used.

(c) The portal frames are linked by longitudinal beams at the top of the columns and purlins between the rafters.

(d) The first and last bays are usually fitted with diagonal bracing in the plane of the columns and in the plane of the roof. This diagonal bracing is very important to the stability of the frame and must not be left out unless other arrangements are made to provide resistance to lateral loads.

(e) Where the end bays must be left clear for doors, the diagonal bracing is replaced by a longitudinal frame referred to as “goal-post bracing”, or diagonal bracing placed in other bays.

(f) The roof bracing is usually of tabular steel while the column bracing is similar or is made of adjustable steel rod acting in tension, in which case it must be cross bracing.

(g) The roof is usually clad with corrugated galvanised or plastic coated steel sheets or corrugated aluminum sheets. These sheets are fixed to the purlins by self-tapping screws fitted with flexible washers driven through the crown of the corrugation. If special aligning guns are used, valley fixings would provide much greater wind resistance than crown fixings.

4.4.5 Erection

(a) The steel frame are erected on the prepared foundation which will have the holding down bolts projecting above the level of the stub columns. These bolts are usually cast in PVC sleeves so that some adjustment is possible.

(b) Firstly, the columns are lifted and slipped over the bolts. Nuts and washers are put on and partly tightened.

(c) The roof assembly is then lifted and the connections to the two columns made.

(d) This process is repeated with the second frame and the two are then joined by one purlin on each side of the crown.

(e) After all the frames have been erected, the columns are plumbed and the holding down bolts are grouted, the longitudinal beams gouted and all connections completed.

(f) The remaining purlins, the roof bracing and the diagonal column bracing are then installed.

(g) The roof sheeting and walls are then added to complete the frame.

4.5 Performance specifications for small steel framed buildings

4.5.1 Introduction

(a) It is recognised that there may be significant savings in labor in the construction of pre-engineered buildings, especially in view of the technology affecting the design of such buildings. The criteria to be considered in the appraisal of pre-engineered buildings are:

(i) Resistance to wind and earthquake forces.

(ii) Resistance to corrosion.

(iii) Compatibility with environmental and aesthetic standards.

(b) Other economic and social criteria may also be considered by the Planning Authorities, but the structural characteristics must be in accordance with the minimum requirements of the Building Code.

(c) The following specifications are for the construction of small single storey buildings of less than 270m^2 (3000 sq.ft.). The design of larger buildings must be carried out by a rational method in accordance with an approved Code or Standard.

4.5.2 Outline specifications

(a) Roof pitch is 25 degrees minimum. Hipped roof preferable. If the roof is composed of light steel joists, the design and fixing of these joists must be in accordance with the requirements of the Code.

(b) Roof sheets are to be minimum of 22 gauge if of aluminum, or of 24 gauge if of steel. Purlins are be spaced at a maximum of 600 mm (2 ft.) on centre and fastened with drive screws at every crown; provided that the crown, are not further than 300 mm (12 inches) apart.

(c) Roof and cladding material if of metal are to be protected with approved non-corrosive covering or galvanising.

(d) Joints and connections are to be capable of withstanding the horizontal and vertical forces.

(e) Wall panels or cladding of steel plate shall be a minimum of 16 gauge. Steel plate panel should be no greater than 1200 mm x 300 mm (4 ft by10 ft) and be supported firmly at sill and plate levels. If panels are built up to form a sandwich board, the panels should be tested for resistance to wind forces at the unrestrained spacing recommended by the manufacturer. The connections between the panels and the steel frame must be shown on the drawings. If the panels are of corrugated sheeting, the gauge of the sheeting must be at least the same gauge as specified for the roof sheets.

(f) Intermediate studs are not to exceed 600 mm (2ft) on centre and horizontal connector pieces to form unrestrained panels of no more than 600 mm x 600 mm (2ft by 2ft) should be installed. The use and spacing of horizontal connector or bridging members is dependent on the strength of the in fill panel.

(g) Sill beam and plate members are to be American Standard Channel Sections (or British Standard equivalent) at least 75 mm (3 ins) wide. If other steel sections are being used, the developer must show that such sections are capable of withstanding the vertical uplift loads imposed without tearing of the metal.

(h) The sill member should be bolted to the concrete floor slab or concrete beam at least every 600 mm (2 ft) on centre. The bolt should penetrate the concrete at least 100 mm (4 inches).

(i) Where cladding is of concrete block, the developer must show in the drawings the connection between the cladding and the steel frames.

(j) All end frames should be cross braced, except where the developer can demonstrate on the drawings that the concrete block cladding is suitably connected to the frames and can act as lateral support to the frames.

4.5.3 General review by the authority

(a) All proposed technology will be seriously considered and examined by the Authority or by an experienced engineer appointed by the Authority, to determine whether the building is acceptable.

(b) The engineer must recommend minor changes which are, in his/her opinion, needed to make the building resistant to the environmental hazards. Such changes may be the placing of extra holding down bolts, installation of cross bracing in end frames or extra fastening for roof sheets.

(c) However, it is the responsibility of the developer to show by supporting documentation that the building proposed is structurally adequate.