SP 47 (1988): Handbook on Structures with Steel Lattice Portal Frames (Without Cranes) [CED 12: Functional Requirements in Buildings]

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HANDBOOK
ON
STRUCTURES WITH STEEL LATTICE PORTAL FRAMES

(Without Cranes)

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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FOREWORD

The Department of Science and Technology set up an Expert Group on Housing and Construction Technology in 1972 This Group carried out in-depth studies in various areas of civil engineering and construction practices followed in the country During the preparation of the Fifth Five-Year Plan in 1975, the Group was assigned the task of producing a Science and Technology Plan for research, development and extension work in the sector of housing and construction technology As a result of this and on the recommendation of the Department of Science and Technology, the Planning Commission approved the following two projects which were assigned to the Bureau of Indian Standards (BIS)

a) *Project B-7* Development Programme on Code Implementation for Building and Civil Engineering Construction, and

b) *Project B-8* Typification of Industrial Structures

The Bureau has set up a Special Committee for the Implementation of Science and Technology Projects (SCIP) consisting of experts to advise and monitor the execution of these projects A Working Group for Project B-8 under SCIP oversees the work of Project B-8

In a developing country like India, the capital outlay under each Five-Year Plan towards setting up of industries and consequently construction of industrial buildings is very high It is, therefore, necessary that the various parameters of industrial buildings be standardized on broad norms so that it will be feasible to easily adopt prefabricated members, particularly where repetitive structures could be used

The standardization of parameters for industries by itself will be, no doubt, a difficult task as it will not be possible to specify the requirements of each industry The layout, including height will vary from industry to industry, for it depends on the process of manufacture and end products However, a little more detailed analysis of the requirements indicates that the problem may not be as difficult as it appears Although it would not be possible to specify any constraint on the parameters, a broad norm can be given within which most industries could be accommodated

The object of Project B-8 is to typify at national level the common forms of industrial structures used in light and medium engineering industries, warehouses, workshops and process industries, and to obtain economical designs under these conditions Even if an industrial complex is classified as heavy industry, it need not necessarily mean that all the industrial structures coming within the complex should be heavy industrial structures and that many structures could be from the typified design

The main objective of typification of industrial structures is to reduce the variety to the minimum and provide standard prefabricated designs so that the structures could be easily mass produced and made available to the user almost off the shelf In doing so, there will be tremendous saving in time in putting up an industry into production and hence increased production. This would indirectly increase the overall economy of the country. This would also help in the orderly use of scarce materials like steel and cement. This would be of immense use to structural engineers as well, since it would relieve them, to a large extent, from the routine and repetitive calculations. Thus the engineer's time could be used to look at more innovative and economical alternatives.

The project on typification of industrial structures involved the following three main tasks prior to preparation of typified design:

Task I — Survey and classification of industrial structures into different types;

Task II — Identification of industrial structures repeated a large number of times in the country, which are amenable for typification from the classified list prepared during Task I; and

Task III – Specifying the elements of the industrial structures to be typified taking into consideration a number of parameters, such as structures with cranes and without cranes, span length, height, support conditions, slope of roof, wind and earthquake forces, spacing, field and shop connections, material (steel, reinforced concrete), etc.

The data regarding physical parameters like span, spacing, roof slope, column heights, crane loading, etc, of existing structures has been obtained from several public sector enterprises through the Bureau of Public Enterprises (BPE). Some information from private industries has also been collected by BIS.

The typified design for the following types of industrial structures in steel and reinforced concrete is envisaged to be brought out based on appropriate Indian Standards:

a) *Steel Structures*

1) Structures with steel roof trusses (with and without cranes)
2) Structures with steel kneebraced trusses (without cranes)
3) Structures with steel portal frames (without cranes)
4) Structures with steel portal frames (with cranes)
5) Structures with steel lattice portal frames (without cranes)

b) *Reinforced Concrete Structures*

1) Structures with RCC roof trusses (with and without cranes)
2) Structures with RCC portal frames (without cranes)
3) Structures with RCC portal frames (with cranes)

In each case of structures with cranes, the maximum capacity of crane considered is limited to 20 tonnes, normal range in light industries.

The handbook presents analysis and design results for structures with steel lattice portal frames fabricated using equal angle sections and lacing rods/angles. The portal frame has been analyzed and designed for gravity and lateral loads (wind and earthquake forces) using the moment resisting frame action, with pinned and fixed base alternatives. The analysis and design results have been presented for purlins, rafter and column members, and base plates.

Adequate wind bracing along the length of the building should be provided to withstand the wind on end gable, and drag force on the roof and walls. Since the design for this depends upon the length of the building, locations of the expansion joint, etc, the typified design of these bracings is not given in the Handbook. However, an illustrative example of bracing design has been included.

Some of the points to be noted regarding analysis and design of these structures are as follows:

a) The typified designs have been given for the following parameters:

Span lengths	= 9, 12, 18, 24 and 30 metres
Spacing of frames	= 4.5 and 6.0 metres
Roof slopes	= 1 in 3, 1 in 4 and 1 in 5

Span (m)	*Column Height* (m)
9	4.5, 6.0
12	4.5, 6.0, 9.0
18	6.0, 9.0, 12.0
24	9.0, 12.0
30	9.0, 12.0

Wind zones	= I, II and III
Earthquake zones	= I, II, III, IV and V
Type of support	= Fixed and hinged

b) The analysis of portal frames has been made using a computer programme, based on the stiffness method of analysis.

c) Structural design of angle sections is based on IS 800 : 1984.

d) The internal pressure/section specified in IS 875 : 1964 for buildings with normal permeability ($\pm 0.2\ p$) has been considered in design.

e) The joint detailings have been included to illustrate one method of detailing and they should not be considered as the only available method for detailing.

f) The typified design results are given for purlins, girts and frame members. Design of other elements, such as column base plate and fasteners, and eaves beam are also covered. Bracing and foundation designs have not been typified because of varying design parameters. However, a typical example of bracing design and a footing design is included.

g) A detailed design example in the design office format is given in the Handbook illustrating the use of analysis and design information presented in the Handbook.

h) On the basis of typified designs for different spans, spacings, roof slopes, etc, some conclusions regarding more economical designs are covered in the Handbook.

j) The Handbook is expected to be used by qualified engineers only.

The Handbook is based on the work done by Structural Engineering Laboratory, Department of Civil Engineering, Indian Institute of Technology (IIT), Madras. The draft was circulated for review to National Projects Construction Corporation Limited, New Delhi; Food Corporation of India, New Delhi; Hindustan Prefab Limited, New Delhi; University of Roorkee, Roorkee; Engineer-in-Chief's Branch, Army Headquarters, New Delhi; Engineering Construction Corporation Limited, Madras; Braithwaite and Company Limited, Calcutta; C. R. Narayana Rao Architects & Engineers, Madras; Metallurgical and Engineering Consultants (India) Limited, Ranchi; Gammon India Limited, Bombay; Tata Consulting Engineers, Bombay; Engineers India Limited, New Delhi; National Thermal Power Corporation Limited, New Delhi; Bharat Heavy Electricals Limited, Ranipet; Hindustan Steelworks Construction Limited, Calcutta; City and Industrial Development Corporation Maharashtra Limited, Bombay; Central Building Research Institute (CSIR), Roorkee; National Council for Cement and Building Materials, New Delhi; Structural Engineering Research Centre (CSIR), Madras; Central Public Works Department, New Delhi; M. N. Dastur & Company Private Limited, Calcutta; Braithwaite Burn & Jessop Construction Company Limited, Calcutta; National Industrial Development Corporation Limited, New Delhi; Research, Designs and Standards Organization, Lucknow; Jessop & Company Limited, Calcutta; and National Hydraulic Power Corporation Limited, New Delhi. The views received have been taken into consideration while finalizing the Handbook.

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CONTENTS

1 GENERAL

1.1 Steel lattice portal frames are one of the structural systems commonly used in industrial buildings. The lateral load resistance (due to wind, earthquake, etc) of such systems may be derived from the frame action or by means of longitudinal and lateral bracings. Lattice steel portal frames have been designed for dead, live, wind and earthquake loads as per appropriate Indian Standards applied through the purlins and girts.

The analysis and design results are given for purlins, girts and frame members for the following parameters:

Span length	= 9, 12, 18, 24 and 30 metres
Spacing of frames	= 4.5 and 6.0 metres
Roof slope	= 1 in 3, 1 in 4 and 1 in 5
Number of bays	= 1

Span (m)	*Column Height* (m)
9.0	4.5, 6.0
12.0	4.5, 6.0, 9.0
18.0	6.0, 9.0, 12.0
24.0	9.0, 12.0
30.0	9.0, 12.0

Wind zones	= I, II and III
Earthquake zones	= I, II, III, IV and V
Type of support	= Fixed and hinged

The analysis and design results are presented for both fixed and hinged support conditions.

1.2 Lattice Portal Frame Configuration

Figure 1 shows the configuration of the lattice portal frame. Purlins may be appropriately located on the rafter members subject to the maximum spacing of 1.4 m.

The portal frame is discretized into 16 elements for the purpose of analysis, the stanchion being divided into 3 elements and the rafter into 5 elements as shown in Fig. 1.

1.3 Terminology

Span – The centre line distance of roof columns in the transverse direction.

Spacing between Portals – The centre line distance of two portal frames in longitudinal direction.

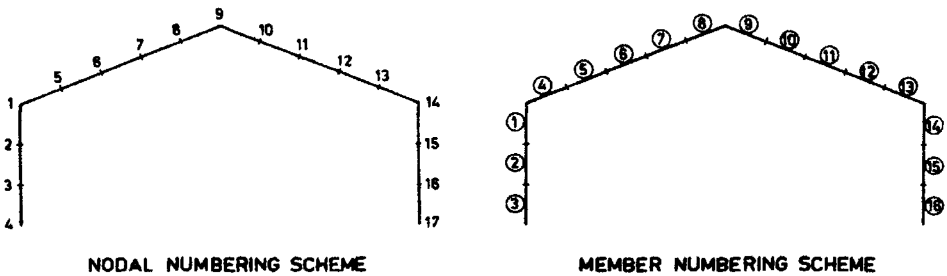


FIG. 1 ANALYSIS MODEL OF GABLE FRAME

Slope — It is the slope of the roof material with respect to the span length. It is obtained by dividing the height of portal frame by half the span.

Column Height — It is the height of column centre line from the bottom of base plate to the intersection of column and beam centre line.

Bay – The space between successive column of a bent.

Height of Frame — It is the height of the crown of the structure from the base of fixity of column.

Girts — Beam members carrying side sheeting and supported by columns.

Purlins — Beam members carrying roof sheeting and supported by frames or beams.

2 LATTICE PORTAL FRAME ANALYSIS

2.1 Computer Programme

In the computer programme, the analysis is carried out by the subroutine PFSOLV, which is based on the direct stiffness method of analysis of plane frames. It automatically generates the necessary data like nodal coordinates, member properties and nodal forces, given the portal configuration, by calling CONFIG, AREAS and MEMBER subroutines. It then assembles the global stiffness matrix and the system equations. Then the boundary conditions are introduced and the system of equations is solved for the displacements. It then calculates the member end forces. In order to achieve maximum computational efficiency, the joint loads under the various load cases are stored simultaneously in the right-hand side, as a force matrix of dimensions (= number of degrees of freedom × number of load cases) rather than as a vector. Thus the triangularization of the stiffness matrix in the solution by Gauss-elimination needs to be performed only once. The portal frame is discretized into 16 elements for the purpose of analysis, the stanchion being divided into 3 elements and the rafter into 5 elements as shown in Fig. 1.

For the tapered sections, average moments of inertia are computed for each element and used in the analysis. The corner leg angles of each individual member are kept equal. The moment of inertia at any section of a latticed member is given by

$$I_x = A d_x^2$$

where

A = area of one of the corner legs, and

d_x = centroidal distance between the corner legs perpendicular to x-axis. Hence, the average moment of inertia of a member with depths d_1 and d_2 at its ends $(d_1 > d_2)$ is given by:

$$I_{Avg} = \frac{I}{L}\int_0^L \frac{A(d_1 - d_2)\,x^2}{L}\,dx.$$

When simplified, this leads to

$$I_{Avg} = \frac{A}{3}\,(d_1^2 + d_1 d_2 + d_2^2)$$

The final design typified is for prismatic lattice members due to economy of fabrications.

2.2 Loading

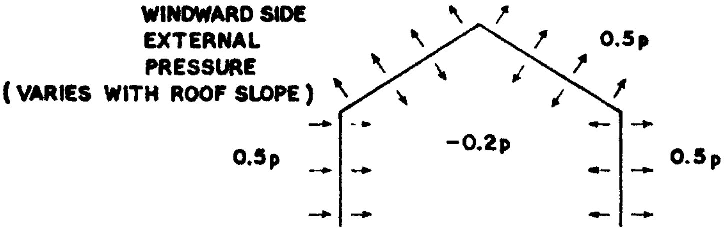
Lattice portal frames have been analyzed for dead load, live load and wind load, and subsequently checked for earthquake load. The total dead load on the frame, excluding the column portion, varies from 40 to 60 kgf/m^2. The live load has been taken on the basis of IS 875 : 1964 provision for roof live loads after reducing for roof slope and supporting member as allowed in the Code. The basic wind pressure for the three wind zones have been considered as specified in IS 875 : 1964. The internal pressure/suction specified in IS 875 : 1964, for buildings with normal permeability ($\pm$ 0.2 p) has been included. Under each basic wind pressure, the following three different wind load conditions (*see* Fig. 2) have been analyzed:

a) Wind perpendicular to ridge with internal suction (WL_1),

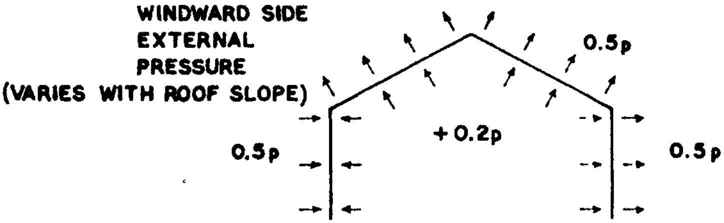
b) Wind perpendicular to ridge with internal pressure (WL_2), and

c) Wind parallel to ridge with internal pressure (WL_3).

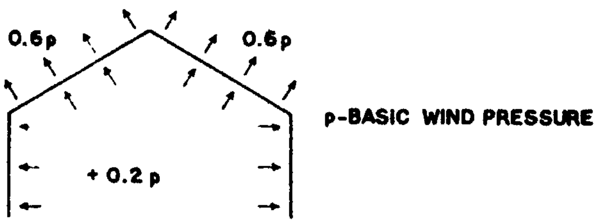
A few typical short and long span lattice portal frames were analyzed for earthquake forces according to IS 1893 : 1984 and it was found that earthquake forces do not govern the design. The



WL_1 WIND PERPENDICULAR TO RIDGE WITH INTERNAL SUCTION



WL_2 WIND PERPENDICULAR TO RIDGE WITH INTERNAL PRESSURE



WL_3 WIND PARALLEL TO RIDGE WITH INTERNAL PRESSURE

FIG. 2 WIND LOAD ON PORTAL FRAMES

member forces even due to the severest earthquake were found to be less than those due to the minimum basic wind pressure of 100 kgf/m^2.

2.2.1 *Load Combination*

The following load combination have been considered in calculating the design forces for beam and column in accordance with IS 875 : 1964.

a) $DL + LL$

b) 0.75 $(DL + C_n \times WL_1)$

c) 0.75 $(DL + C_n \times WL_2)$

d) 0.75 $(DL + C_n \times WL_3)$

Where $C_n = 0.75$ for column forces if the building height is less than or equal to 30 metres, $C_n = 0.75$ for beam forces if the height of frame is less than or equal to 10 metres and $C_n = 1.0$ for other cases. In the calculation of design forces for dead and wind load combination, the actual forces have been reduced by 25 percent to account for $33\frac{1}{3}$ percent increase in allowable stresses under this load combination.

2.2.2 *Analysis Results*

The maximum governing values of design forces obtained from results of analysis have been presented in Tables 1 to 24. In these tables column and beam (rafter) forces are given at the base, haunch and crown of the portal frame. Tables 25 to 48 give forces for foundation design.

3 DESIGN

3.1 The design of lattice portal frame members, purlins, base plate, etc, has been made following the provisions of IS 800 : 1984.

Allowable stress in the design for hot rolled sections is taken from IS 800 : 1984 corresponding to steel conforming to IS 226 : 1975 and IS 2062 : 1984. Allowable stress in the design of bolts is taken from IS 3757 : 1972 corresponding to steel conforming to IS 2062 : 1984. Since forces in members due to wind load combination have been already reduced to account for increase in allowable stress, no further increase in allowable stress is considered in the design. The design assumptions and methodology of design are described below.

3.2 Purlin and Girt Design

The purlins have been designed to span the spacing between frames (4.5 and 6.0 m) and transfer the loads from sheeting to the frames taking into consideration biaxial bending. The self weight and roof sheeting weight are the dead loads, the prescribed live load after reduction for the roof slope is the live load, and the maximum possible uplift including that due to internal pressure is the wind load that the purlins and girts have been designed for.

The maximum spacing between purlins has been taken as 1.4 m and maximum spacing between girts has been taken as 1.7 m for 6 mm thick asbestos sheets laid in accordance with IS 3007 (Part 1) : 1964. The design has been done using asbestos cement (AC) sheeting for all cladding. However, corrugated galvanized iron (CGI) sheet cladding may also be used with the same spacing and size of purlin or girt. If purlins/girts are spaced farther apart to support CGI sheeting as recommended by manufacturers, the purlins and girts will have to be redesigned for additional loading. The main frame members, however, need not be changed. The purlins and girts have been designed to span between the rafters or columns spaced at 4.5 or 6.0 m and to transfer the loads (dead, live, wind and earthquake loads) from the sheeting to the supporting frame taking into consideration biaxial bending. The purlins and girts have been designed for the normal wind pressure on claddings according to IS 875 : 1964 for the case of buildings with normal permeability. However, claddings and cladding fasteners have to be designed for increased wind pressure due to local effects according to IS 875 : 1964.

The design has been presented for channel purlins/girts and also for tubular purlins/girts. However, design for channel purlins/girts is given with sag rod in the mid-span and also without the use of any sag rod. When sag rods are used, the diagonal sag rods are to be provided at the topmost panel and also at every eighth panel for purlins and at every seventh panel of girts. The design of tubular purlins/girts is based on IS 806 : 1968.

The typified purlins and girts sizes are as follows:

Purlins (For All 3 Wind Zones)

a) *Channels*

Span (m)	*Maximum Spacing* (m)	*Purlin Size* Without Sag Rod	With Sag Rod
4.5	1.4	ISMC 125 × 12.7	ISMC 100 × 9.2 ISRO 10 mm ϕ sag rods
6.0	1.4	ISMC 150 × 16.4	ISMC 125 × 12.7 ISRO 12 mm ϕ sag rods

b) *Tubes*

Span (m)	*Maximum Spacing* (m)	*Purlin Size (With Sag Rod)*
4.5	1.4	125 *L*
6.0	1.4	150 *L*

Girts (For All 3 Wind Zones)

a) *Channels*

Span (m)	*Maximum Spacing* (m)	*Girt Size* Without Sag Rod	With Sag Rod
4.5	1.7	ISMC 125 × 12.7	ISMC 100 × 9.2 ISRO 10 mm ϕ sag rods
6.0	1.7	ISMC 150 × 16.4	ISMC 125 × 12.7 ISRO 22 mm ϕ sag rods

b) *Tubes*

Span (m)	*Maximum Spacing* (m)	*Basic Wind* (kgf/m^2)	*Girt Size (Without Sag Rod)*
4.5	1.7	100	80 *L*
		150	90 *L*
		200	100 *L*
6.0	1.7	100	100 *L*
		150	100 *M*
		200	125 *M*

The standard connection details of purlins and girts to the framing is shown in Fig. 3. The sag rod and diagonal sag rod details used in channel purlins and girts are given in Fig. 4. The diagonal sag rods have been designed to carry the weak axis load from 8 purlins or 7 girts as the case may be. If more purlins or girts are present in a given face, additional diagonal sag rods should be used.

NOTE Instead of simply supported purlin and girt design given in this typified design, balanced cantilever design may also be used to get relatively economical sections. Instead of hot-rolled channel and steel tubular sections used for purlins and girts, various appropriate coldformed steel sections may also be used, if desired with appropriate sizing.

3.3 Lattice Portal Frame Design

The beam and column members of the portal frame have been designed for the maximum forces (axial force, bending moment and shear force) obtained from load combinations mentioned in **2.0**.

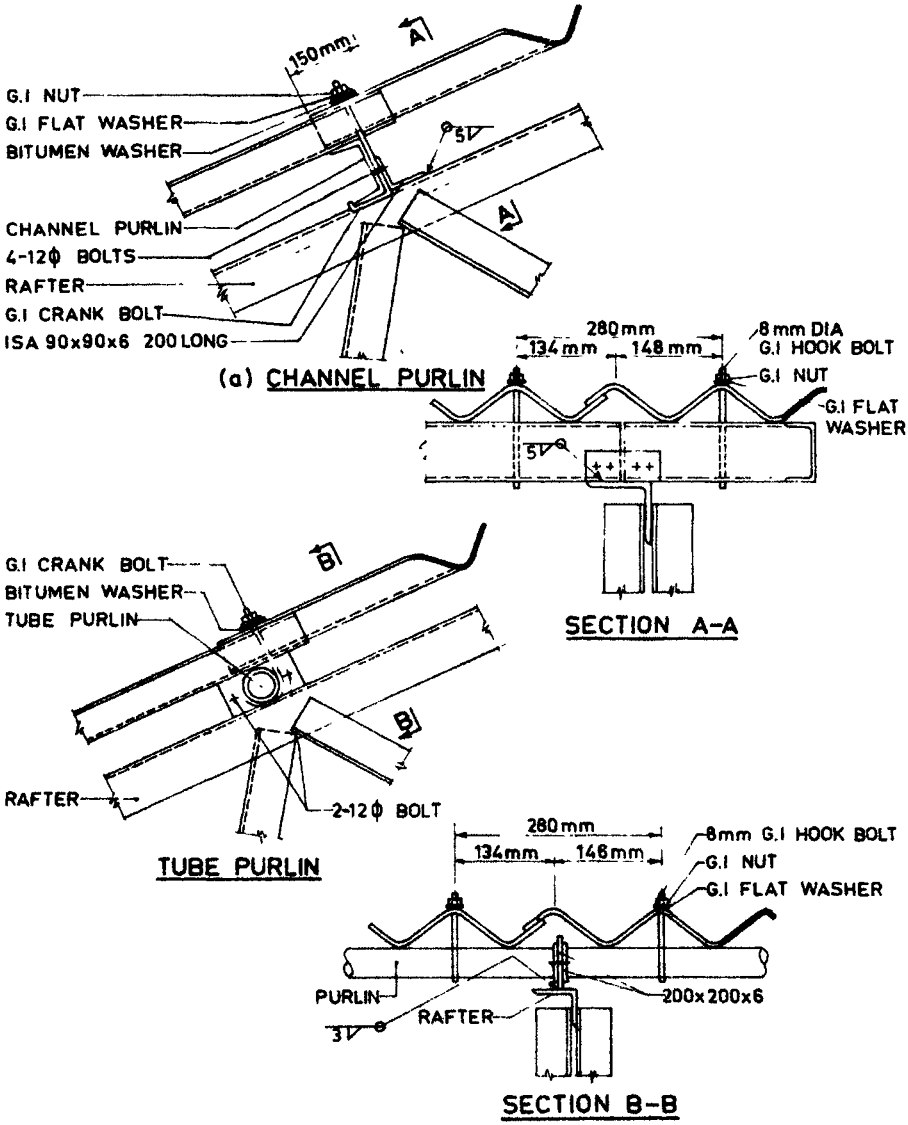


FIG. 3 PURLIN RAFTER AND SHEETING CONNECTIONS

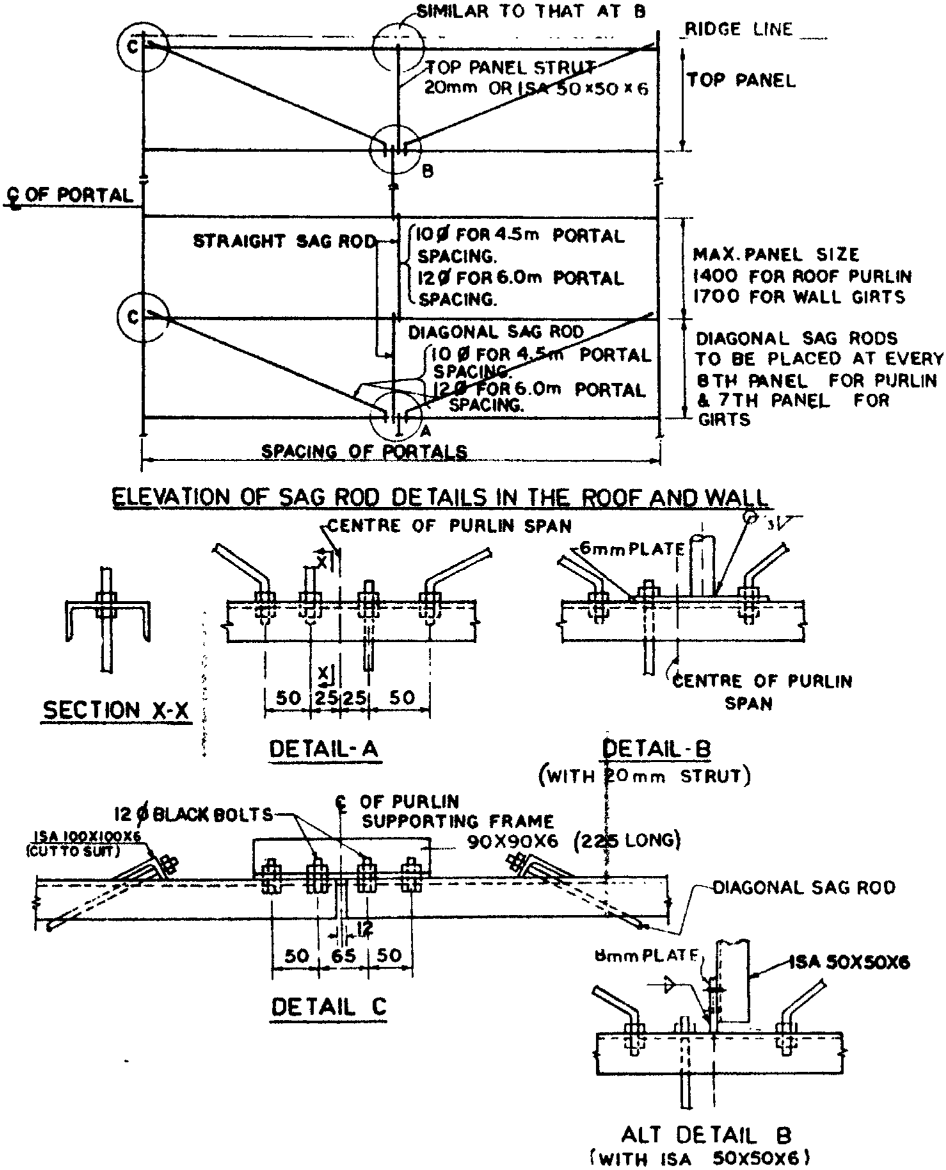


Fig. 4 Sag Rod Details

3.3.1 *Design Criteria*

In the design of structures, there are two broad classes of design criteria, namely, strength criteria and serviceability criteria. The strength criteria ensures that none of the members fail due to inability to withstand the forces they are subjected to. The serviceability criteria serve to prevent unsightly deflections. For steel structures, there are additional stability criteria to ensure that members do not become very slender.

The side sway (deflection) is limited to 1/325 of the column height and crown deflection is limited to 1/325 of span length.

3.3.1.1 The strength criteria adopted are the one based on the interaction formulae for various combinations of flexural and axial stresses as given below:

$$\frac{f_{ac}}{F_{at}} + \frac{M_c}{2\,A_{lt}\,dF_{bc}} < 1.0 \qquad \ldots (1)$$

$$-\frac{f_{ac}}{F_{at}} + \frac{M_c}{2A_l\,dF_{at}} < 1.0 \qquad \ldots (2)$$

$$\frac{f_{at}}{F_{at}} + \frac{M_t}{2A_{leg(t)}\,dF_{at}} < 1.0 \qquad \ldots (3)$$

$$-\frac{f_{at}}{F_{ac}} + \frac{M_t}{2A_{lt}\,dF_{bc}} < 1.0 \qquad \ldots (4)$$

where f_{ac} and f_{at} are actual axial compressive and tensile stresses, respectively. F_{ac}, F_{at} and F_{bc} are the allowable stresses under axial compression, axial tension and bending compression, respectively. M_c and M_t are the bending moments at the critical section acting simultaneously with compressive and tensile force, respectively. d, A_l and A_{lt} are the centroidal distance between the corner leg members in the depth plane, gross and net area of corner leg members, respectively.

Equations (1) and (2) check for compressive and tensile stresses under combined action of axial compression and bending whereas equations (3) and (4) check for tensile and compressive stresses under combined action of axial tension and bending, respectively.

3.3.1.2 The effective length factors for the frame members for axial compression and bending compression have been taken as follows according to IS 800 : 1984.

Member and Load	*Effective Length Factor*	
	Hinged Base	Fixed Base
Axial compression		
Strong axis	3.0	1.5
Weak axis	0.75	0.75
Bending compression		
Columns	0.75	0.75

The maximum slenderness ratio of column has been limited to 250 since they are essentially members in bending.

NOTE — Generally, the slenderness ratio works out to be very small according to IS 800 : 1984 and hence small variations from the effective lengths used do not affect the design very much.

The rafter is under reverse curvature, which means that the effective length factor is less than one. However, the haunch ends are subjected to sway and crown ends to vertical deflection, in which case the factor is greater than one. Therefore, as an approximation, the effective length factor for strong-axis buckling has been considered as 1.0. Since the axial compression in rafter is small and the slenderness ratio is also small, the effect of deviation of effective length of rafter from the assumed value has negligible effect on design.

3.3.1.3 The lacings in the depth plane are designed to withstand the axial force due to total shear at a section equal to sum of the actual shear from analysis and 2.5 percent of the column compression. The lacings in the width plane are designed to withstand axial force due to shear at a section equal to 2.5 percent of column compression only. The following aspects of IS 800 : 1984 regarding laced members have been considered in design.

a) The most unfavourable slenderness ratios of the main members is restricted to 180.

b) The slenderness ratio of single lacings is calculated with effective length equal to distance between inner ends of the effective length of welds and is restricted to be less than 145.

c) The angle of inclination of the lacings to the axis of the member is restricted to be between 40 and 70°

d) Single-laced systems on opposite sides of the main components shall be in the same direction so that one be the shadow of the other.

e) The lacings of compression members are designed to resist a total transverse shear S at any point in the length of the member equal to 2.5 percent of the axial force in the member. This shear is considered as divided equally among all transverse lacing systems in parallel planes.

f) For members carrying calculated bending stresses due to eccentricity of loading, applied and moments and/or lateral loading, the lacing shall be proportioned to resist the shear due to the bending in addition to that specified in (e) and additional shear equal to the flexural shear are to be resisted.

In addition to the interaction formulae in the design of the overall member at critical sections, checking the strength of individual legs in compression, tension and limiting deflection ensure satisfactory design of latticed members.

3.3.2 *Design Steps*

The choice of the initial sections for the analysis of lattice members is based on the findings of a parametric optimum design study of lattice portal frame configuration. The parametric equation developed in the study relate to the design parameters, such as overall depth, width, etc, along with the basic parameters such as span, length, spacing, column height and wind zone. The polynomial equations are in the form of:

$$D = k \times (L)^{k} \times (h)^{k_2} \times (s)^{k_3} \times (w)^{k_4}$$

where L = span, h = column height, s = spacing of frames in meters, w = basic wind pressure in kg/m^2, and D is the design parameter such as overall dimensions of the cross-section.

Design parameters for which coefficients given are portal depth at stanchion haunch and base, rafter haunch and crown; width of the portal; minimum average moment of inertia of stanchion and rafter to limit away and crown deflections, respectively. Separate coefficients are provided for hinged and fixed base conditions. The values of constants k, k_1, k_2, k_3 and k_4 for these design parameters are presented in Table 49.

3.3.2.1 Based on the polynomial equations, the initial sections are obtained as follows for use in the nalysis:

a) Calculate the depth at various sections, width of portal, minimum average moments of inertia of stanchion and rafter.

b) The initial area of leg is calculated as

$$A = 3I_{avg}/(d_1^2 + d_1 + d_2 + d_2^2)$$

where d_1 and d_2 are the depths at the two ends of the member.

c) Calculate the minimum permissible radius of gyration of the leg that ensures slenderness ratio of the individual members between lacing connections to be less than 50.

d) If the area calculated in (b) corresponds to a section that has r_{vv} less than the value calculated in (c), the area is changed to that of the smallest section where r_{vv} is greater than the value calculated in (c).

The minimum value of area is set at 5.68 cm^2 corresponding to that of ISA 5050 × 6. In all initial trials, the lacing section used for the purpose of computation of dead load is ISA 5050 × 6.

3.3.2.2 The design for analysis forces is performed in the following steps:

a) To begin with, the deflections (sway and vertical) are calculated for the load combinations and the governing deflection is selected.

b) If deflections exceed permissible values, the required area is calculated from:

$$A_{req} = A_{provided} \times \frac{\text{calculated deflection}}{\text{permissible deflection}}$$

This is based on the fact that deflection is proportional to $\frac{M}{EI}$ and I is proportional to A.

The angle section with the area closest to the required area is chosen and the analysis is carried out again.

c) The analysis results for various combinations of loading are calculated. These are moments, shears and axial forces at all critical sections corresponding to maximum axial compression and maximum axial tension in the member.

d) The sectional properties of the stanchion and rafter at various critical sections are calculated.

e) Based on (c) and (d), the stanchion is checked as an overall flexural compression member, the individual legs are checked according to the design criteria.

f) If the stanchion is found to fail in any respect, the next larger section is chosen and the analysis is performed again.

g) Steps (e) and (f) are repeated for the rafter.

Since the economy associated with using tapered lattice members is expected to be off set by the added cost of fabrication, only prismatic members are designed for both column and rafter.

3.3.3 *Minimum Thickness of Metal*

Minimum thickness of structural steel sections has been provided as 6.0 mm assuming they are fully accessible for cleaning and repainting. Where structural steel sections are not fully accessible for cleaning and repainting, thickness may be increased in accordance with IS 800 : 1984.

Minimum thickness of steel tubes has been provided as 2.6 mm assuming construction is not exposed to weather and tubes are applied with one coat of zinc primer conforming to IS 104 : 1979 followed by a coat of paint conforming to IS 2074 : 1979 and further two coats of paint conforming to IS 123 : 1962. In case the construction is exposed to weather or where regular maintenance is not possible, minimum thickness of tubes may be increased in accordance with IS 806 : 1968.

3.3.4 *Design Results*

The design results are presented in Tables 50 to 73. Each table is for a particular span, length, column height and spacing of frames; and includes details for two support conditions, namely, hinged and fixed; three roof slopes and three wind zones. The following design values of column and rafter members for each frame is given for overall depth and width of lattice member, and sizes of corner leg and laxing intersection with corner leg members.

The total weight of the frame per unit covered area is also given in the last column of tables which includes only the weight of the frame members and excludes other weights, such as purlins, eaves, girders and bracings.

4 FOUNDATION FORCES

4.1 Foundation design forces (due to dead, live and wind loads) are presented for both fixed and hinged base conditions. The fixed support results may be used only if the type of foundation used ensures fixity at the base. Simple isolated footing located in a good stiff soil may be considered to provide fixity at the base. Foundation forces due to dead load, live load and wind load have been presented separately to facilitate the use of working stress or limit design of footing as desired by the engineer. Critical value of the foundation forces have been presented in Tables 25 to 48.

Foundations supporting the frames may be designed using simple spread footings, pile foundations or caisson foundations depending upon the type of soil and type of support condition assumed in the analysis, and design. A typical foundation design is shown in **6**.

5 FABRICATION DETAILS

5.0 Typical details of connections are discussed below.

The details given here are by no means all encompassing or the only possible method of detailing. Field connections may be either welded or bolted.

NOTE — Portal frames may be fabricated using different methods. An I section with variable depth can be fabricated using plates, but this requires a large quantity of material and high fabrication cost. Hot-rolled beam sections may be split and rejoined by welding to produce required tapers in the frame which also results in overall economy.

For smaller spans, portal frames made of prismatic rolled sections may work out more economical since the cost involved in fabrication for providing tapers may outweigh the economy achieved by saving material. Portal frames may also be fabricated from latticed members, in which main leg members may be jointed together by appropriate lacing members. The main leg members may be channels, joists and tubular sections for angle sections. Joists and channels may be used where large stiffnesses are required to satisfy strength and deflection criteria as in crane-operated warehouses and industrial buildings with cranes.

For light industrial frames lattice angle or tubular members may be used economically. The advantage of this type of construction is that the lateral dimensions of the structure can be adjusted to derive maximum efficiency. The total cost of the structure depends mainly on the weight of the structure, since material fabrication and erection costs are specified in terms of the weight of the structure. It is of advantage to reduce the weight of the structure as in the case of lattice portal frames where material is judiciously used.

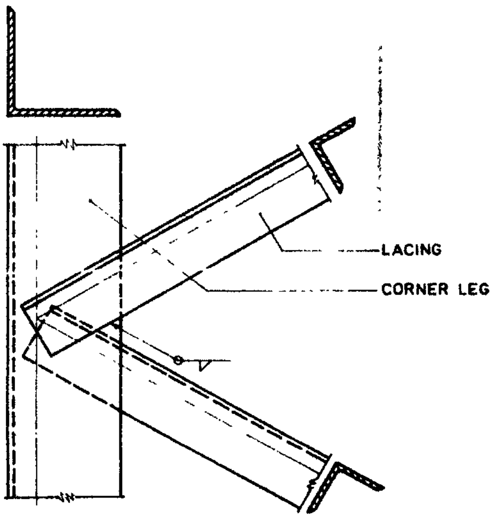
5.1 Purlin/Girt Connection Detail

The sheetings and the fasteners connecting sheetings to supporting members should be capable of resisting local high pressure as recommended in IS 875 : 1984. The connection detail between rafter and channel/tube purlin is shown in Fig. 3. Purlins are to be located in such a way that the spacing between purlins does not exceed 1.4 m and spacing between girts not to exceed 1.7 m, in the case of AC sheets. Larger spacing may be used in case CGI sheeting is used. The purlins and girts have to be redesigned if spaced farther apart for CGI sheetings than that recommended for AC sheetings. The channel purlins/girts continuous at the frame shall be connected with two 12 mm diameter bolts to cleat angles. Channel purlins and girts discontinuous at the frame shall be connected to cleat angle with two 12 mm diameter bolts at each portal. The straight sag rod and diagonal sag rod details are shown in Fig. 4 as applicable to roof purlins and wall girts. In wide roofs having large number of purlins and in high wall claddings having large number of girts, the diagonal sag rods should be used at every eighth panel for purlins and at every seventh panel for girts. The top most panel close to the ridge in the roof, and the top most panel close to the eaves in the wall should have diagonal sag rods and, in addition, should support the top purlin or girt as the case may be by a strut as shown in Fig. 4.

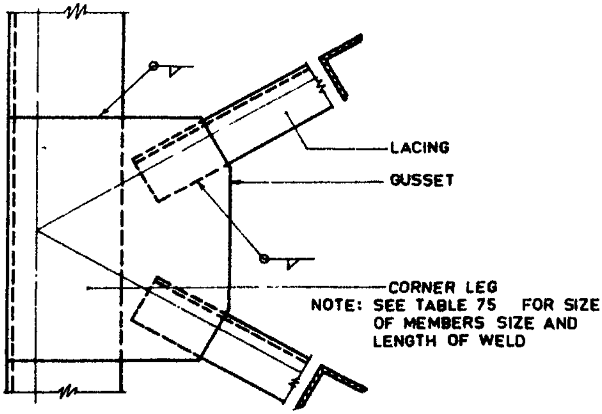
5.2 Connection Details

5.2.1 *Lacing Connections*

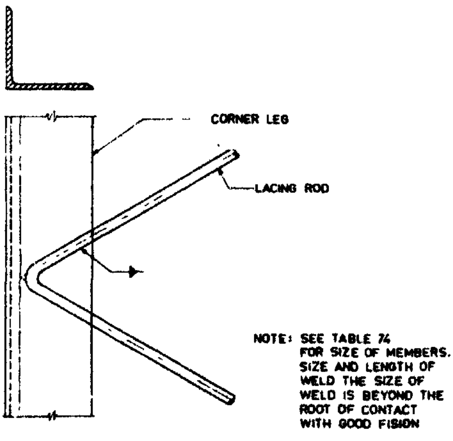
The details of the connection between lacings and corner leg members in stanchions and rafters is shown in Fig. 5. Three typical details are shown in Fig. 5. Figure 5C is for the connection between lacing rod and corner leg angle. Figure 5A and 5B give the details of connection between the angle lacing and the angle corner leg member, and Fig. 5C showing the direct connection and showing connection through gusset. Any one of these two details may be used depending upon the clearance available for the direct connection. The size of weld as well as the thickness of gusset plates in the connection between lacing and corner leg members are given in Table 74.



(a) ANGLE LACINGS CONNECTION WITHOUT GUSSET PLATE



(b) ANGLE LACING CONNECTION WITH GUSSET PLATE



(c) ROD LACING CONNECTION

FIG. 5 LACING CONNECTION DETAILS

5.2.2 *Haunch Crown Connections*

Typical details of connection between the lattice members at the haunch and crown points are shown in Fig. 6 and 7. The sizes of fasteners required in this connection are given in Table 75.

5.3 Column Base Details

Column base details are shown in Fig. 8. The sizes of base plate and anchor bolts are given in Table 76.

5.4 Gutter Details

Typical gutter details have been presented in Fig. 9.

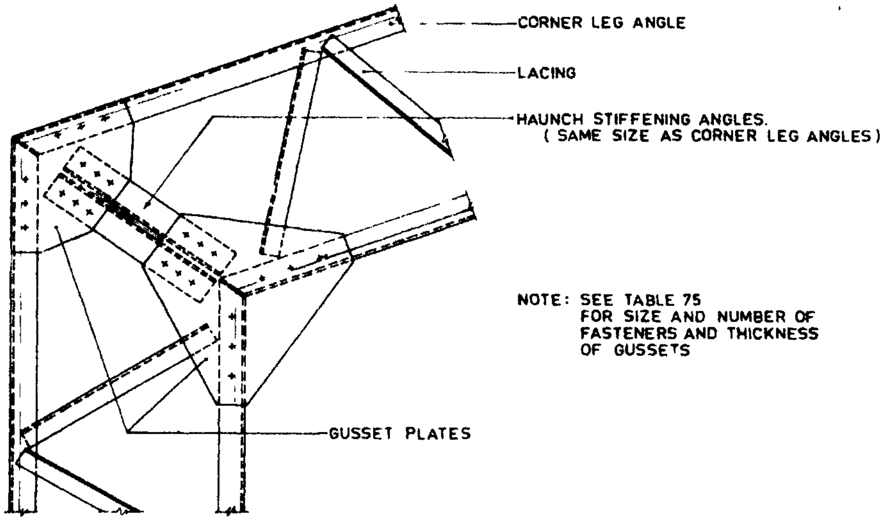


FIG. 6 HAUNCH CONNECTION DETAIL

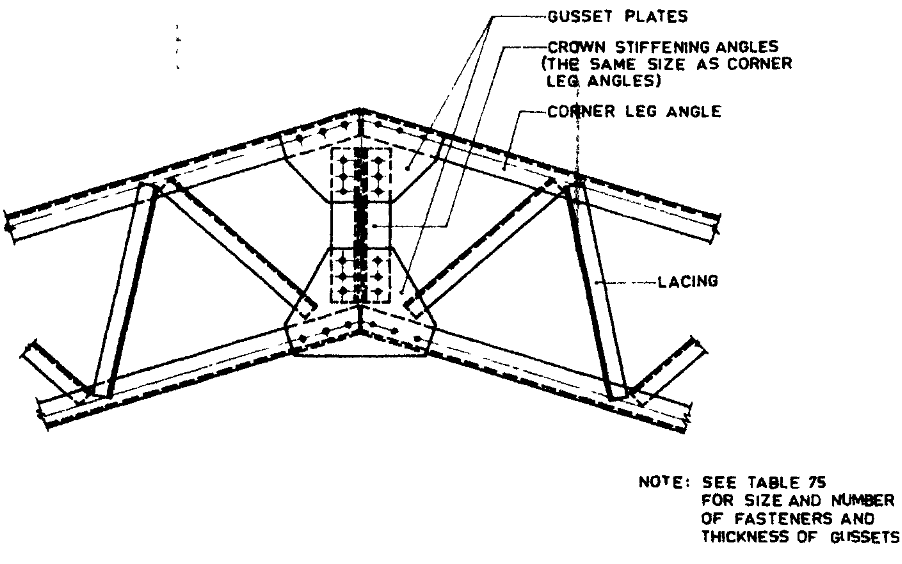


FIG. 7 CROWN CONNECTION DETAIL

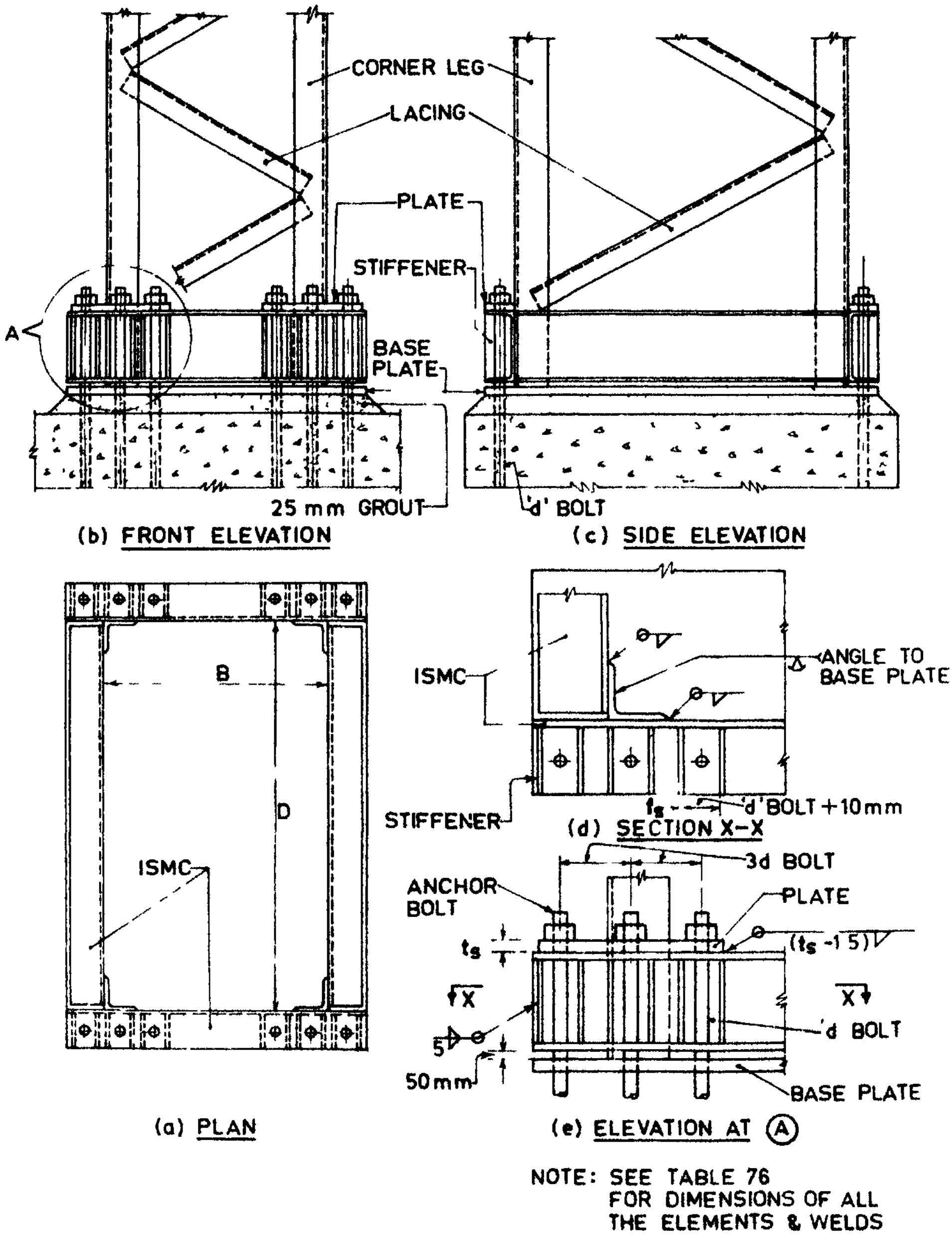


FIG. 8 BASE CONNECTION DETAILS

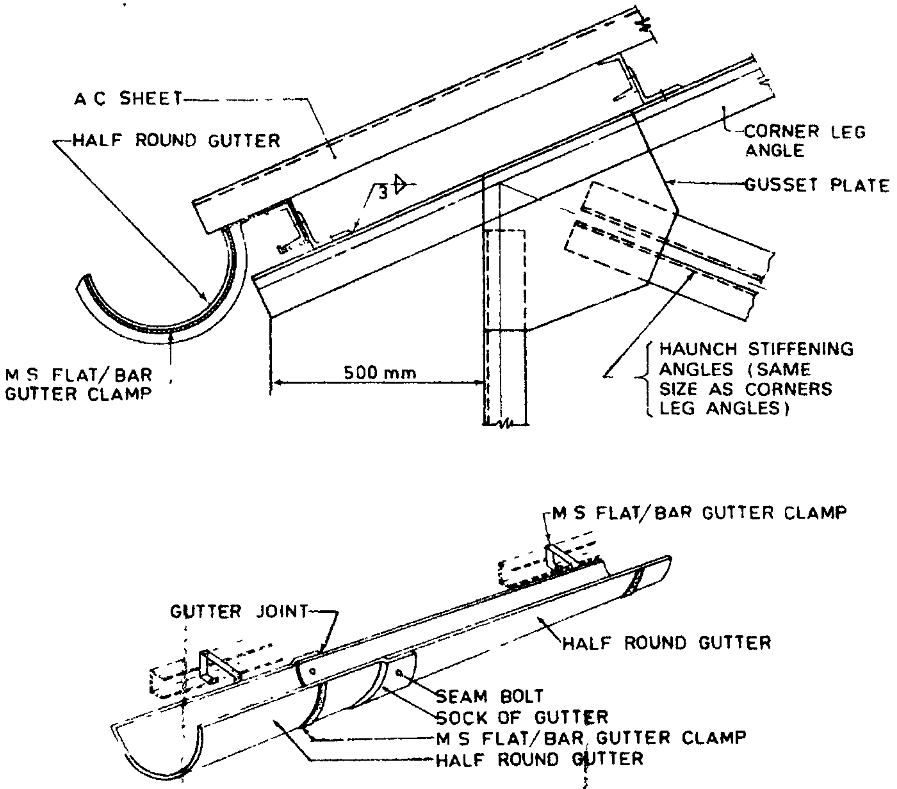


FIG. 9 GUTTER DETAIL AT EITHER END AND STRUCTURE

5.5 Expansion Joint Details

Expansion joints are not usually necessary when the building dimensions are less than 180 m. When the buildings are longer, the expansion joint is to be provided by constructing two different super structural support systems on either sides of the joint with the gap being properly bridged by wall cladding and roof sheeting.

The wind bracing and other structural system are also to be discontinuous across the expansion joints and hence the bracing systems should be structurally independent in each segment of the structure subdivided by expansion joints.

5.6 Eaves beams have to be provided along the length of the building at the junctions of stanchions and rafters. These beams have been designed so that the maximum slenderness ratio is restricted to 250. ISMB 200 and ISMB 250 sections may be used for eaves beams in frames spaced 4.5 and 6.0 m respectively. The beams may be connected to stanchions using one ISA 90 × 90 × 6 web framing angle with 16 dia block bolts 3 and 4 numbers respectively. The eaves beams may be either hot-rolled sections or built-up lattices.

5.7 Bracing Details

Various bracing systems are shown schematically in Fig. 10. Even though bracing may appear to be a secondary matter, it is highly important and deserves careful consideration. Probably more failures or at least unsatisfactory performances, have resulted from inadequate bracing than from deficiencies in the main framing system. It is apparent from Fig. 10 that the bracing in even simple structures is highly

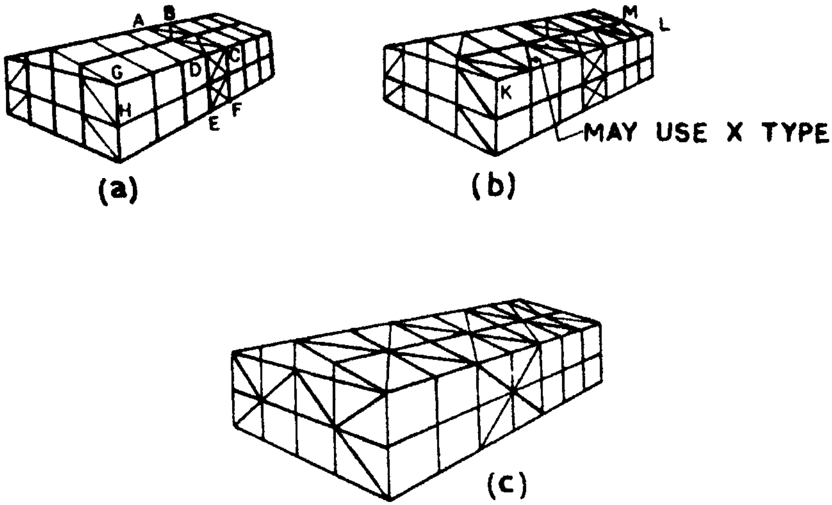


FIG. 10 BRACING ARRANGEMENTS

indeterminate. There can be several alternatives by which loads may be carried to the ground and, in a number of bays, redundant diagonals may be used. These may be so slender, however, that they are incapable of carrying appreciable compression, which reduces the system to one in which only the tension diagonals are effective. These bracings are necessary to ensure integral behaviour of the structure and to avoid differential displacements of frames which may cause undesirable cracking of claddings. A typical example of the design of bracings is shown in 6. Typification of bracing system has not been attempted since lot of variations are possible due to different design parameters like length of building, span, spacing, height, wind zones, etc.

The bracings in the roof along the length of the building in the panels adjacent to the eaves are provided to minimize differential movement of frames. These bracings are designed nominally based on minimum slenderness ratio.

The bracings in the roof across the building at the two end bays and necessary number of interior bays (spacing not to exceed 90 m) are provided to take care of wind loads on the gable ends and wind drag on roof due to wind parallel to the ridge. Since these bracings are not in a plane but are discontinuous at the ridge, the reaction point of the bracings system and load points are not in a plane. The longitudinal bracings are to be designed to take care of this unbalanced force as shown in 6.

The force from the cross bracings are transferred to the vertical bracings in the longitudinal walls through eaves beams. The vertical bracings in the longitudinal walls are shown for the central bay in Fig. 10. This arrangement of vertical bracings is suggested to avoid the temperature stresses which may develop if two end bays are braced as is done frequently in practice. However, if central bay bracing is utilized, temporary bracing may be necessary at the starting point of erection for the purpose of stability during erection.

Vertical bracings are usually provided also at the gable ends to give additional stiffness to the building in the transverse direction. These bracings are nominally designed based on minimum slenderness ratio.

5.8 Erection Procedure

The structure with steel portal frames have to be erected taking into consideration the stability and strength of the structure during erection. Temporary bracings and other such precautions should be taken as found necessary during construction. Recommendations of IS 800 : 1984 regarding fabrication and erection shall be followed. For laying of asbestos cement sheets, recommendations of IS 3007 (Part 1) : 1964 shall be followed.

6 DESIGN EXAMPLE

6.0 Basic Parameters and Loadings

Basic parameters for the analysis and design are:

Plan area	= 18.0 × 42.0 m
Portal span	= 18.0 m
Type of support	= Hinged
Column spacing	= 6.0 m
Column height	= 6.0 m
No. of bays	= 1
Type of sheeting	= AC sheeting
Roof slope	= 1 in 3 (18.435°)
Location of building	= Hyderabad
Wind pressure	= 100 kg/m² = 1 000 N/m²

Assume normal permeability

Weight of roof materials (including extra weight due to overlaps and fasteners) = 17 kg/m²

Live load $= 75 - 2 \times (18.435° - 10°)$

$= 58.13$ kg/m² $= 581.3$ N/m²

External windward side pressure $= 0.7 - (0.7 - 0.4) \dfrac{(18.435 - 10)}{10}$

$= 0.45\ P$

Wind load details are as given below:

Load	Wind Direction	Normal Permeability N/m²	Wind Pressure, N/m² Columns Windward	Columns Leeward	Rafters Windward	Rafters Leeward
1	Perpendicular to ridge (WL_1)	−200	700	300	−250	−300
2	Perpendicular to ridge (WL_2)	+200	300	700	−650	−700
3	Parallel to ridge (WL_3)	+200	200	200	−600	−600

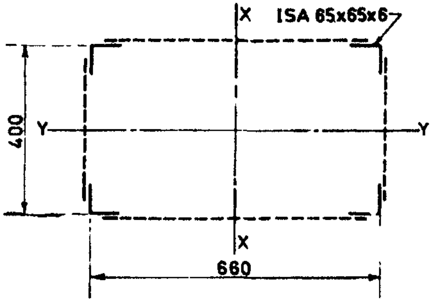
NOTES

1 The preliminary sections for the columns and rafters were obtained by the programme using the parametric equations (3.2.3) and Table 49 before finally arriving at the sections given in the Table 61.

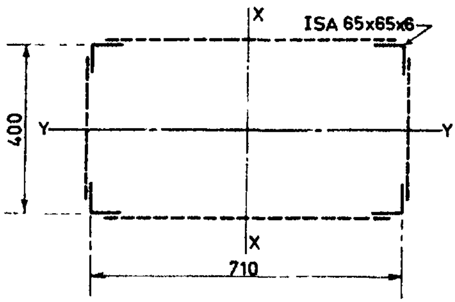
2 As the height of the frame is less than 10.0 metres, 25 percent reduction of wind pressure may be applied.

6.1 Frame Analysis Results

Column and beam sections have been taken from Table 61.

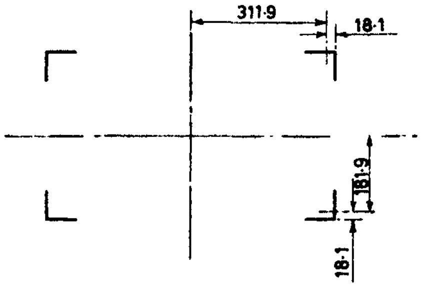


COLUMN SECTION



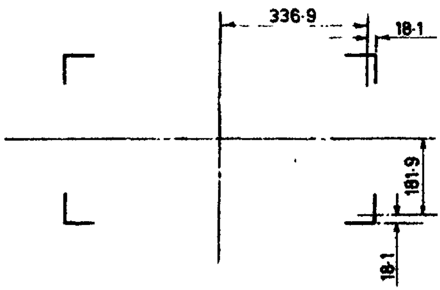
BEAM SECTION

Calculation of cross-sectional properties of column and beam.



COLUMN

$$I_{xx} = 4 \times 29.1 + 4 \times 7.44 \times 31.19^2$$
$$= 29\ 067.4 \text{ cm}^4 = 2.907 \times 10^8 \text{ mm}^4$$
$$I_{yy} = 4 \times 29.1 + 4 \times 7.44 \times 18.19^2$$
$$= 9\ 963.3 \text{ cm}^4 = 0.996 \times 10^8 \text{ mm}^4$$



BEAM

$$I_{xx} = 4 \times 29.1 + 4 \times 7.44 \times 33.69^2$$
$$= 33\ 894.5 \text{ cm}^4 = 3.389 \times 10^8 \text{ mm}^4$$
$$I_{yy} = 4 \times 29.1 + 4 \times 7.44 \times 18.19^2$$
$$= 9\ 963.3 \text{ cm}^4 = 0.996 \times 10^8 \text{ mm}^4$$

The coefficients given in Steel Designers Manual have been used for the analysis of the portal frame.

We have

$L = 18.0$ m

$h = 6.0$ m

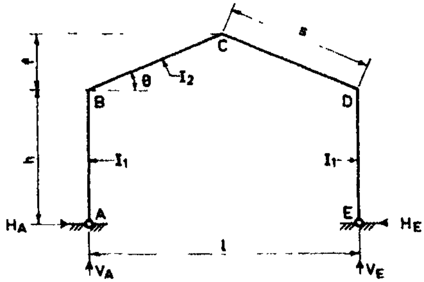
$f = 3.0$ m

$S = \sqrt{9^2 + 3^2} = 9.49$ m

$\theta = 18.435°$

$I_1 = 2.907 \times 10^8$ mm^4

$I_2 = 3.389 \times 10^8$ mm^4



Coefficients

$$K = \frac{I_2}{I_1} \times \frac{h}{s} = \frac{3.389}{2.906} \times \frac{6.0}{9.49} = 0.737$$

$$\phi = \frac{f}{h} = \frac{3.0}{6.0} = 0.5$$

$$m = 1 + \phi = 1 + 0.5 = 1.5$$

$$B = 2(K + 1) + m = 4.974$$

$$C = 1 + 2\ m = 1 + 2 \times 1.5 = 4.0$$

$$N = B + mC = 4.974 + 1.5 \times 4.0 = 10.974$$

Effect of W_1

$$M_B = M_D = \frac{-WL^2(3 + 5\ m)}{32\ N}$$

$$= \frac{-W_1 \times (18)^2\ (3 + 5 \times 1.5)}{32 \times 10.974}$$

$$= -9.69\ W_1$$

$$M_C = \frac{WL^2}{16} + m\,M_B$$

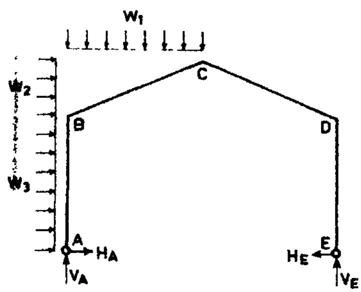
$$= \frac{W_1 \times 18^2}{16} - 1.5 \times 9.69\ W_1$$

$$M_C = 5.715\ W_1$$

$$HH_A = H_E = \frac{-M_B}{h} = \frac{9.69\ W_1}{6} = 1.615\ W_1$$

$$V_A = \frac{3\ WL}{8} = \frac{3 \times 18 \times W_1}{8} = 6.75\ W_1$$

$$V_E = \frac{WL}{8} = \frac{W_1 \times 18}{8} = 2.25\ W_1$$



Effect of W_2

$$\text{Constant } X = \frac{Wf^2(C + m)}{8\,N}$$

$$= \frac{W_2\ 3^2\ (4 + 1.5)}{8 \times 10.974} = 0.564\ W_2$$

$$M_B = X + \frac{Wfh}{2} = 0.564\ W_2 + \frac{W_2 \times 3 \times 6}{2} = 9.564\ W_2$$

$$M_C = \frac{-Wf^2}{4} + mX = \frac{-W_2 \times 3^2}{4} + 1.5 \times 0.564 \ W_2 = -1.404 \ W_2$$

$$M_D = +X - \frac{W\,fh}{2} = 0.564 \ W_2 - \frac{W_2 \times 3 \times 6}{2} = -8.436 \ W_2$$

$$V_E = -V_A = \frac{W\,fh}{2L}(1+m) = \frac{W_2 \times 3 \times 6}{2 \times 18}(1+1.5) = +1.25 \ W_2$$

$$H_A = -\frac{X}{h} - \frac{Wf}{2} = \frac{-0.564 \ W_2}{6} - \frac{W_2 \times 3}{2} = -1.594 \ W_2$$

$$H_E = -\frac{X}{h} + \frac{Wf}{2} = \frac{-0.564 \ W_2}{6} + \frac{W_2 \times 3}{2} = +1.406 \ W_2$$

Effect of W_3

$$M_D = -\frac{Wh^2}{8} \times \frac{2(B+C)+K}{N}$$

$$= -\frac{W_3 \times 6^2}{8} \times \frac{2(4.974+4.0)+0.737}{10.974} = -7.66 \ W_3$$

$$M_B = \frac{Wh^2}{2} + M_D = \frac{W_3 \times 6^2}{2} - 7.66 \ W_3 = 10.34 \ W_3$$

$$M_C = \frac{Wh^2}{4} + mM_D = \frac{W_3 \times 6^2}{4} + 1.5 \times (-7.66) W_3 = -2.49 \ W_3$$

$$-V_A = V_E = \frac{Wh^2}{2L} = W_3$$

$$H_E = \frac{-M_D}{h} = \frac{+7.66 \ W_3}{6} = 1.277 \ W_3$$

$$H_A = -(Wh - H_E) = -(W_3 \times 6 - 1.277 \ W_3) = -4.723 \ W_3$$

Summary of member forces due to these unit loads is given in Table given below:

SUMMARY OF MEMBER FORCES

Member Force	Due to W_1	Due to W_2	Due to W_3
M_B	$-9.69 \ W_1$	$+9.564 \ W_2$	$10.34 \ W_3$
M_C	$5.715 \ W_1$	$-1.404 \ W_2$	$-2.49 \ W_3$
M_D	$-9.69 \ W_1$	$-8.436 \ W_2$	$-7.66 \ W_3$
V_A	$6.75 \ W_1$	$-1.25 \ W_2$	$-W_3$
V_E	$2.25 \ W_1$	$+1.25 \ W_2$	$+W_3$
H_A	$1.615 \ W_1$	$-1.594 \ W_2$	$-4.723 \ W_3$
H_E	$1.615 \ W_1$	$+1.406 \ W_2$	$+1.277 \ W_3$

Due to loads as shown in figure (q_1 to q_6), the member forces are obtained in Table given above as follows:

$$M_B = 10.34q_1 + 9.56q_2 - 9.69q_3$$
$$-9.69q_4 + 8.436q_5 + 7.66q_6$$

$$M_C = -2.49q_1 - 1.404q_2 + 5.715q_3$$
$$+5.715q_4 + 1.404q_5 + 2.49q_6$$

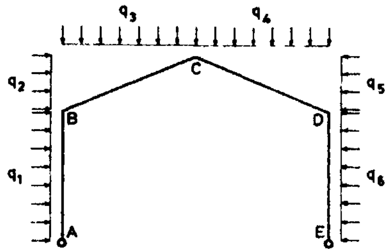
$$M_D = -7.66q_1 - 8.436q_2 - 9.69q_3 - 9.69q_4 - 9.564q_5 - 10.34q_6$$

$$V_A = -q_1 - 1.25q_2 + 6.75q_3 + 2.25q_4 - 1.25q_5 - q_6$$

$$V_F = +q_1 + 1.25q_2 + 2.25q_3 + 6.75q_4 + 1.25q_5 + q_6$$

$$H_A = -4.723q_1 - 1.594q_2 + 1.615q_3 + 1.615q_4 - 1.406q_5 - 1.277q_6$$

$$H_B = 1.277q_1 + 1.406q_2 + 1.615q_3 + 1.615q_4 + 1.594q_5 + 4.723q_6$$



Design Loads

Dead load on plan area

$$\text{AC sheet} = \frac{6 \times 17}{\cos (18.435)} = 107.51 \text{ kg/m}$$

$$\text{Purlin} = \frac{12.7 \times 6}{1.4 \cos (18.435)} = 57.37 \text{ kg/m}$$

$$\text{Frame} = \frac{14.7 \times 6}{2} = 44.1 \text{ kg/m}$$

Miscellaneous $= 3$ kg/m

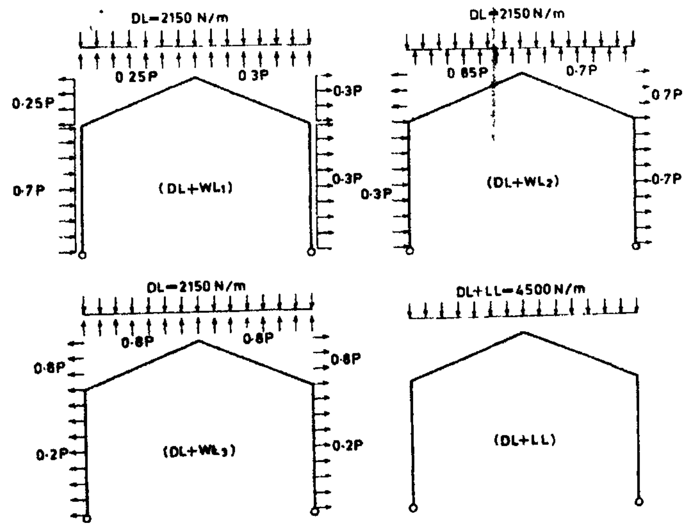
Total $= 211.98$ kg/m

$\cong 2\,150$ N/m (say)

Live Load (LL)

Live load (Table 2 of IS 875 : 1964) $= 58.13 \times 2/3 \times 6 = 232.52$ kg/m $= 2\,350$ N/m (say)

Basic wind load [Note 3(a)] under **4.2.2** of IS 875 : 1964 $= 0.75 \times 100 \times 6 = 450$ kg/m $= 4\,500$ N/m $= P$



Forces in the frame due to load combinations shown in sketch are given in the Table. The value of q_1 to q_6 for each of the four load combination are also given in Table given below. It can be seen that dead load and live load combination governs the design. The axial force in the columns have to be increased by (107.5 + 57.4) = 164.9 kg/m. 164.9 × 6 = 988.4 = 990 kg. 9.9 kN to account for AC sheeting.

DESIGN FORCES

	Loading Case			
	$DL + LL$ (N/m)	$0.75\ (DL + WL_1)$ (N/m)	$0.75\ (DL + WL_2)$ (N/m)	$0.75\ (DL + WL_3)$ (N/m)
Design forces	$q_1 = q_4 = 4\ 500$	$q_1 = 2\ 363$	$q_1 = 1\ 013$	$q_1 = -675$
	$q_1 = q_2 = 0$	$q_2 = -844$	$q_2 = -2\ 194$	$q_2 = -2\ 700$
	$q_5 = q_6 = 0$	$q_3 = 768$	$q_3 = -581.3$	$q_3 = -1\ 088$
		$q_4 = 600$	$q_4 = -750$	$q_4 = -1\ 088$
		$q_5 = 1\ 013$	$q_5 = 2\ 363$	$q_5 = 2\ 700$
		$q_6 = 1\ 013$	$q_6 = 2\ 363$	$q_6 = 6\ 750$
M_B (kN.m)	−87.21	19.41	40.43	16.22
M_C (kN.m)	51.44	7.06	2.15	−1.49
M_D (kN.m)	−87.21	−44.39	−23.38	16.22
V_A (kN)	40.50	2.95	−9.198	−9.79
V_F (kN)	40.50	9.36	−2.78	−9.79
H_A (kN)	14.54	−10.32	−9.78	−0.679
H_F (kN)	14.54	10.44	10.99	−0.679

Comparison of analysis of results obtained by actual calculations and tabulated in the Handbook is given in Table given below:

COMPARISON OF ANALYSIS RESULTS

		Compression (kN)	Moment (kN.m)	Shear (kN)
Beam	Tabulated (*see* Table 12)	25.3	87.6	30.7
	Calculated	26.6	87.2	30.8
Column	Tabulated	49.9	86.0	14.3
	Calculated	50.4	87.2	14.5

Check for Deflection — The maximum deflection in the frame occurs at joint D for wind loads WL_1 and WL_2. Unit load method is used to obtain the deflection under this load. The deflection is calculated for:

$$I_{col} = 29\ 067.4\ \text{cm}^4, \text{ and}$$

$$I_{Rafter} = 33\ 894.5\ \text{cm}^4$$

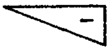
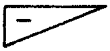
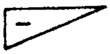
as calculated in the design section (*see* 5.3). The unit load bending moment diagram (m) is for the reduced structure with the internal hinge at node B.

$$\text{Horizontal deflection at } D = \int \frac{Mm\text{d}x}{EI}$$

This integral can be obtained by multiplying the area of $\frac{M}{EI}$ diagram of each member by the ordinate of the m diagram in the same member at the centre of gravity (C G) of $\frac{M}{EI}$ diagram. This calculation is shown in the Table given below:

DEFLECTION CALCULATION

Case (i) Loading WL_1

MEMBER (1)	MOMENT DIAGRAM (2)	ORDINATE OF m AT CG OF M DIAGRAM (3)	AREA OF M DIAGRAM (4)	$\int Mm dx$ (5) [(3) × (4)]
AB	 124 22	0	0	
	 56 70	0	0	
BC	 67.52	−1.5	640.56	−960.84
	 133.33	− 2.0	−632.3	1 264.6
	 50.66	−2.25	160.25	− 360.573
CD	 17.53	− 4 5	−166.3	748.35
	58.33 	−4 0	−276 9	1 107.6
	60.16 	−3 75	+190.24	−713.4
DE	41.03 	−4 0	− 125.49	501.96
	24.3 	−4 5	48.6	−218 7

From *Table*

$\int Mm dx$ (for columns) $= 1\,083.74$

$\int Mm dx$ (for rafters) $= 283.26$

$$\text{Deflection at D} = \Delta = \int \frac{Mm dx}{EI} = \frac{1\,083.74 \times 10^{12}}{2.047 \times 10^5 \times 33\,894 \times 10^4} + \frac{283.26 \times 10^{12}}{2.047 \times 10^5 \times 29\,070 \times 10^4}$$

$$= 15.62 + 4.761$$

$$= 20.3 \text{ mm}$$

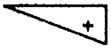
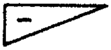
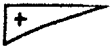
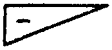
$$\text{Allowable deflection} = \frac{6\,000}{325} = 18.5$$

$$\simeq 20.3$$

Therefore, it is OK.

DEFLECTION CALCULATION

Case (ii) Loading WL_1

Member (1)	Moment Diagram (2)	Ordinate of m at CG of M Diagram (3)	Area of M Diagram (4)	$\int Mm dx$ (5) [(3) × (4)]
AB	 119.86	0	–	–
	 24.3	0	–	–
BC	 95.57	−1.5	906.7	−1 360.1
	 248.86	−2.0	−1 180.4	+2 360.8
	 131.5	−2.25	+415.9	−935.8
CD	 10.50	−4.5	−99.61	−448.2
	173.9 	−4.0	−824.9	+3 299.6
	141.69 	−3.75	+448.1	−1 680.4
DE	46.197 	−4.0	−138.591	+554.364
	56.70 	−4.5	113.4	−510.3

From *Table*

$\int Mm dx$ (for columns) = 1 236

$\int Mm dx$ (for beams) = 44.064

$$\text{Deflection at D} = \Delta = \int \frac{Mm dx}{EI} = \frac{1\,236 \times 10^{12}}{2.047 \times 10^{5} \times 33\,894 \times 10^{4}} + \frac{44.064 \times 10^{12}}{2.047 \times 10^{5} \times 29\,067 \times 10^{4}}$$

$$= 17.8 + 0.740\,4 = 18.540\,4 \text{ mm}$$

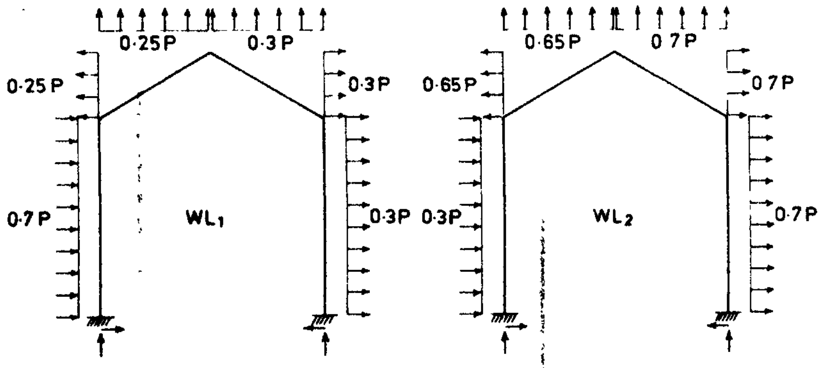
$$\text{Allowable deflection} = \frac{6\,000}{325} = 18.46 \text{ mm}$$

$$\cong 18.54 \text{ mm}$$

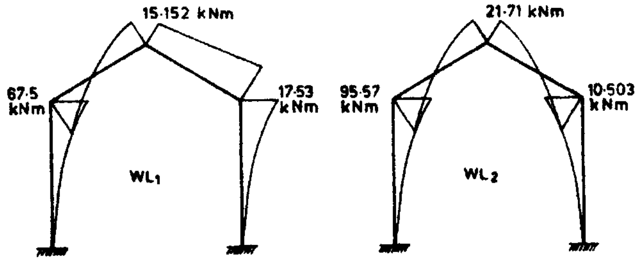
Therefore, it is OK.

The values of the loads are calculated for the two loading cases separately and substituted in the corresponding expressions so as to get the design forces as given below:

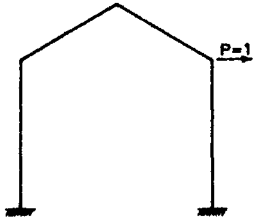
		Loading Case	
		WL_1 (N/m)	WL_2 (N/m)
Design forces	q_1	3 150	1 350
	q_2	−1 125	−2 925
	q_3	−1 125	−2 925
	q_4	−1 350	−3 150
	q_5	+1 350	3 150
	q_6	+1 350	3 150
	M_B (kN.m)	67.524	95.568
	M_C (kN.m)	−15.152	−21.71
	M_D (kN.m)	−17.53	10.503
	V_A (kN)	−15.413	−31.613
	V_E (kN)	− 6.863	−23.063
	H_A (kN)	−20.704	−19.976
	H_E (kN)	6.972	7.699



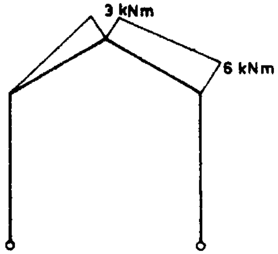
NOTE — WL_1 = Wind load with internal suction, and
WL_2 = Wind load with internal pressure.



M-DIAGRAMS



UNIT LOAD ON
RELEASED STRUCTURE



m-DIAGRAM

6.2 Purlin Design

Purlin is designed with one sag rod at mid span.

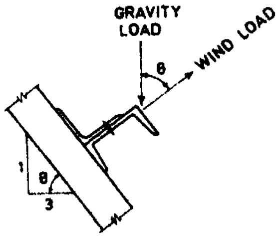
Maximum spacing of purlin	= 1.4 m
Weight of sheeting	= 1.4 × 17 = 23.80 kg/m
Self weight of purlin (say)	= 18.00 kg/m
Total dead load (*DL*)	= 41.8 kg/m
Total live load (*LL*)	= 58.13 × 1.4 = 81.38 kg/m
DL + *LL*	= 123.18 kg/m
Wind load uplift force	= 0.8 × 100 × 1.4 = 112 kg/m
Net uplift force	= 112 − 41.8 × cos (18.435°) = 72.3 kg/m

Considering the unsymmetrical bending of the channel section.

$$M_{xx} = \frac{123.18 \times \cos\ 18.435 \times 6 \times 6}{8} = 525.9 \text{ kg.m}$$

Considering the sag rod at mid span:

$$M_{yy} = \frac{123.18 \times \sin\ 18.435 \times 3 \times 3}{8} = 43.8 \text{ kg.m}$$



Checking the section ISMC 125

$$f_{bc} = \frac{52\ 590}{66.6} + \frac{4\ 380}{13.1} = 1\ 124.0 < 1\ 650 \text{ kg/cm}^2$$

Under uplift condition,

$$M_{xx} = \frac{72.3 \times 36}{8} = 325.4 \text{ kg.m}$$

$$M_{yy} = \frac{41.8 \times \sin\ 18.435 \times 9}{8} = 14.9 \text{ kg.m}$$

$$f_{bc} = \frac{32\ 540}{66.6} + \frac{1\ 490}{13.1} = 603 < 1.33 \times 1\ 650 \text{ kg/cm}^2\ (2\ 194.5 \text{ kg/cm}^2)$$

Therefore, it is OK.

Size of Sag Rod

Assume the size as ISRO 12 mm dia

Number of purlins = 8

$$\text{Total load on sag rod} = \frac{5 \times 123.18 \times \sin\ 18.435 \times 6 \times 8}{8} = 1\ 168 \text{ kg}$$

Required net area of sag roa $= \dfrac{1\ 168}{1\ 500} = 0.78\ \text{cm}^2$

Use 12 ϕ rod.

Size of Diagonal Sag Rod

Diagonal sag rods are used at least on every eighth panel of purlin from bottom and at the top most panel of purlins.

Maximum force in the sag rod

$= \dfrac{5}{8} \times 123.18 \times \sin\ 18.435 \times 6 \times 8 = 1\ 169$ kg

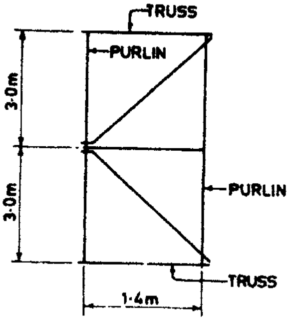
Maximum force in diagonal sag rod

$= \dfrac{1\ 169\ \sqrt{1.4^2 + 3^2}}{2 \times 1.4} = 1\ 382$ kg

Required net area of diagonal

sag rods $= \dfrac{1\ 382}{1\ 500} = 0.92\ \text{cm}^2$

Use 12 ϕ rods.



Girt Design

Span of girt

for vertical bending $= 3.0$ m

for horizontal bending $= 6.0$ m

Maximum spacing of girt $= 1.7$ m

Channel Girt with Sag Rod at the Centre

Vertical Bending

AC sheet weight $= 17 \times 1.7$ $= 28.9$ kg/m

Girt self-weight (say) $= 15.0$ kg/m

Total *DL* $= 43.9$ kg/m

Vertical BM, $M_{yy} = \dfrac{43.9 \times 3^2}{8}$ $= 49.4$ kg/m

Horizontal Bending

Wind load $= 0.7 \times 0.75 \times 100 \times 1.7$ $= 789.3$ kg/m

Horizontal BM $= \dfrac{89.3 \times 6^2}{8}$ $= 401.9$ kg.m

Trying ISMC 125 at 12.7 kg/m,

$f_{bc} = \left[\dfrac{949.4}{13.1} + \dfrac{401.9}{66.6}\right] \times 100 = 980\ \text{kg/cm}^2 < 1\ 650\ \text{kg/cm}^2$

(No increase in permissible stress is taken since wind load caused predominant stress.)

Tension in central straight sag rod/purlin $= \dfrac{5}{8} \times 43.9 \times 6$

$= 164.6$ kg

Maximum number of panels supported $= \dfrac{6.0}{1.7} = 3.52$ (say) 4

Maximum tension in strength sag rod $= 4 \times 164.6 = 658$ kg

Required net area of sag rod $= \dfrac{658}{1\ 500} = 0.44\ \text{cm}^2$

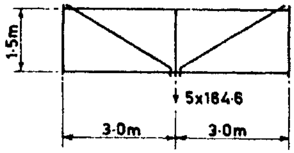
Use 12 ϕ rods.

No. of girts supported by diagonal sag rods (including eaves purlin) = 5

Actual spacing of girts = 6.0/4 = 1.5 m

Tension in diagonal sag rod

$$= \left[\frac{164.6 \times 5}{2 \times 1.5}\right] \sqrt{3^2 + 1.5^2} = 920 \text{ kg}$$



Net area of rod required

$$= \frac{920}{1\ 500} = 0.61 \text{ cm}^2$$

Use 12 ϕ rod.

6.3 Frame Members Desigi.

Column Section

Column forces (*see* page 22, Table 'Design Forces')

Maximum compression = 40.50 kN

Maximum tension/minimum compression = 0.0 kN

Moment = 87.21 kN.m

The section given in Table 61 is shown below:

$I_{xx} = 2.907 \times 10^8 \text{ mm}^4$

$I_{yy} = 0.996 \times 10^8 \text{ mm}^4$

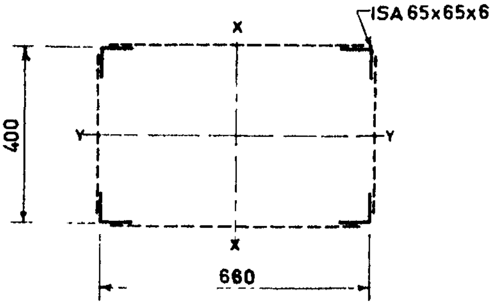
$A = 2\ 976 \text{ mm}^2$

$$r_{xx} = \sqrt{\frac{2.907 \times 10^8}{2\ 976}} = 312.5 \text{ mm}$$

$$r_{yy} = \sqrt{\frac{0.996 \times 10^8}{2\ 976}} = 182.9 \text{ mm}$$

$$(l_e/r)_x = \frac{3 \times 6\ 000}{312.5} = 57.6$$

$$(l_e/r)_y = \frac{0.75 \times 600}{182.9} = 24.6$$



Elastic critical stress, $f_{ex} = \dfrac{9.869\ 8 \times E}{(l_e/r)_y^2} = 3\ 343.4 \text{ N/mm}^2$

$$f_{ey} = \frac{9.869\ 6 \times E}{(l_e/r)_x^2} = 609.8 \text{ N/mm}^2$$

Allowable axial compressive stress (IS 800 : 1984), $F_a = \dfrac{0.6 \times 609.8 \times 250}{(609.8^{1.4} + 250^{1.4})^{1/1.4}} = 125.3 \text{ N/mm}^2$

Allowable bending compressive stress, $F_b = \dfrac{0.66 \times 609.8 \times 250}{(609.8^{1.4} + 250^{1.4})^{1/1.4}} = 137.61 \text{ N/mm}^2$

Actual axial compressive stress, $f_a = \dfrac{40\ 500}{2\ 976} = 13.61 \text{ N/mm}^2$

Actual bending stress, $f_b = \dfrac{M}{I_{xx}} \cdot y = \dfrac{87.21 \times 10^6}{2.907 \times 10^6} \times 330 = 99 \text{ N/mm}^2$

Check for combined stresses

$$\frac{f_a}{F_a} + \frac{f_b}{F_b\left(1 - \frac{f_a}{0.6 f_c}\right)} = \frac{13.61}{125.3} + \frac{99}{125.3\left[1 - \frac{13.61}{0.6 \times 3\,343.4}\right]} = 0.90 < 1.0$$

Therefore, it is OK.

Maximum compressive force in a leg $= \dfrac{40\,500}{4} + \dfrac{87.21 \times 10^6}{2 \times (660 - 2 \times 18.1)} = 80\,027$ N

Maximum compressive stress $= \dfrac{80\,027}{744} = 107.6$ N/mm²

l/r_{vv} of the corner leg $= \dfrac{520}{12.6} = 41.3$

Elastic critical stress, f_c $= \dfrac{9.869\,6 \times 2.05 \times 10^5}{(41.3)^2} = 1\,186.2$ N/mm²

Allowable axial compressive stress $= \dfrac{0.6 \times 1\,186.2 \times 250}{(1\,186.2^{1.4} + 250^{1.4})^{1/1.4}} = 138.9$ N/mm² > 107.6 N/mm²

Therefore, it is OK.

Maximum tension $= \dfrac{0.0}{7.4} + \dfrac{87.21 \times 10^6}{2 \times 623.8} = 69\,902$ N

Net effective area

$$A_1 = A_2 = \left(\frac{744}{2} - 0.6 \times 20\right) = 360$$

$$K = \frac{3A_1}{3A_1 + A_2} = 0.74$$

$$A_{net} = a + Kb = 360 + 0.74 \times 360 = 626.4 \text{ mm}^2$$

Actual tensile stress $= \dfrac{69\,902}{626.4} = 111.6$ N/mm² < 150 N/mm²

Therefore, it is OK.

Beam Section

Beam forces as given in Table 12 are:

Maximum compressive force	= 25.3 kN
Maximum tensile force	= 2.2 kN
Moment	= 87.6 kN.m

Section given in Table 61 is

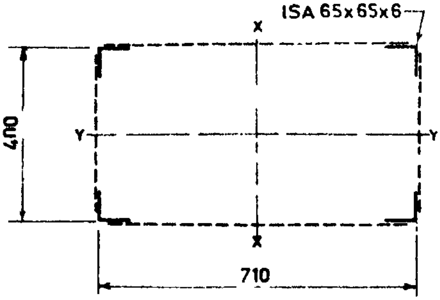
$I_{xx} = 3.389 \times 10^8$ mm⁴

$I_{yy} = 0.996 \times 10^8$ mm⁴

$A = 2\,976$ mm²

$$r_{xx} = \sqrt{\frac{3.389 \times 10^8}{2\,976}} = 337.0 \text{ mm}$$

$$r_{yy} = \sqrt{\frac{0.996 \times 10^8}{2\,976}} = 182.9 \text{ mm}$$



$$(l_e/r)_x = \frac{0.75 \times 9\ 490}{337} = 21.1$$

$$(l_e/r)_y = \frac{0.75 \times 9\ 490}{182.9} = 38.9$$

Elastic critical stress, f_{ey} $= \dfrac{9.869\ 6 \times E}{(l_e/r)_y^2} = 1\ 337\ \text{N/mm}^2$

f_{ex} $= \dfrac{9.869\ 6 \times E}{(l_e/r)_x^2} = 4\ 545\ \text{N/mm}^2$

Allowable axial compressive stress (IS 800 : 1984), $F_a = \dfrac{0.6 \times 1\ 337 \times 250}{(1\ 337^{1.4} + 250^{1.4})^{1/1.4}} = 140.5\ \text{N/mm}^2$

Allowable bending compressive stress, F_b $= \dfrac{0.66 \times 1\ 337 \times 250}{(1\ 337^{1.4} + 250^{1.4})^{1/1.4}} = 154.6\ \text{N/mm}^2$

Actual compressive stress, f_a $= \dfrac{25\ 300}{2\ 976} = 8.5\ \text{N/mm}^2$

Actual bending stress, f_b $= \dfrac{M}{I_{xx}} \cdot y = \dfrac{87.60 \times 10^6}{3.389 \times 10^8} \times 355 = 91.8\ \text{N/mm}^2$

Check for combined stresses

$$\frac{f_a}{F_a} + \frac{f_b}{F_b\left(1 - \dfrac{f_a}{0.6 f_e}\right)} = \frac{8.5}{140.5} + \frac{91.8}{140.5\left(1 - \dfrac{8.5}{0.6 \times 4\ 545}\right)} = 0.77 < 1.0$$

Maximum compressive force in an angle $= \dfrac{25\ 300}{4} + \dfrac{87.6 \times 10^6}{2 \times (710 - 2 \times 18.1)} = 71\ 329\ \text{N}$

Maximum compressive stress $= \dfrac{71\ 329}{744} = 95.9\ \text{N/mm}^2$

l/r_{vv} of the angle $= \dfrac{570}{12.6} = 45.2$

Elastic critical stress, f_e $= \dfrac{9.869\ 6 \times 2.05 \times 10^5}{(45.2)^2} = 990.3\ \text{N/mm}^2$

Allowable axial compressive stress $= \dfrac{0.6 \times 990.3 \times 250}{(990.3^{1.4} + 250^{1.4})^{1/1.4}} = 136.1\ \text{N/mm}^2 > 95.9$

Therefore, it is OK.

Maximum tension in the leg $= \dfrac{2\ 200}{4} + \dfrac{87.6 \times 10^6}{2 \times 673.8} = 65\ 554\ \text{N}$

Net effective area

$$A_1 = A_2 = \left(\frac{744}{2} - 0.6 \times 20\right) = 360$$

$$K = \frac{3A_1}{3A_1 + A_2} = 0.74$$

$$A_{net} = a + Kb = 360 + 0.74 \times 360 = 626.4$$

Actual tensile stress $= \dfrac{65\ 554}{626.4} = 104.7 < 150\ \text{N/mm}^2$

Therefore, it is OK.

Design of Lacing

Column section

a) On depth face

$(l/r)_{max}$ of the column = 57.6

$0.7 \times 57.6 = 40.3 < 50$

Therefore spacing of lacing $= 40.3 \times r_{vv} = 40.3 \times 12.6 = 507 = 510$ mm (say)

Horizontal distance between centroidal axes of the angles in D— direction,

$d = 660 - 2 \times 18.1 = 623.8$ mm

$$\tan^{-1}\left(\frac{623.8}{510 \times 0.5}\right) = 67.8 > 40^\circ$$
$$< 70^\circ$$

Traverse shear $= \frac{2.5}{100} \times 40\,500 = 1\,012.5$ N

Shear at the bottom = 14 540 N

Total shear = 15 550 N

Providing single lacing, Force in each lacing $= \frac{15\,550}{2} \times \text{cosec}\,(67.8^\circ)$

$= 8\,397.5$ N

Length of lacing bar/angle $= \sqrt{623.8^2 + 255^2} = 674$ mm

Try ISRO 18, $r = 0.45$, $\frac{l}{r}$ $= 149.8 > 145$

Try ISA 40 40 × 6, $r = 0.77$, $\frac{l}{r}$ $= 87.5$

Elastic critical stress, f_c $= \frac{9.869\,6 \times E}{(87.5)^2} = 264.3$ N/mm²

Allowable axial compressive stress $= \frac{0.6 \times 264.3 \times 250}{(264.3^{1.4} + 250^{1.4})^{1/1.4}} = 93.9$ N/mm²

Allowable load $= 93.9 \times 507 = 47\,607 > 15\,550$ N

Check for tension – The net effective area of the section is checked although welding is recommended for lacing to corner leg connection.

$$A_1 = (40 - 21.5 - 3) \times 6 = 117$$

$$A_2 = (40 - 3) \times 6 = 222$$

$$K = \frac{3A_1}{3A_1 + A_2} = 0.61$$

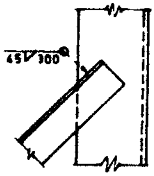
$$A_1 + KA_2 = 117 + 0.61 \times 222 = 252.4 \text{ mm}^2$$

Maximum tensile stress $= \frac{15\,550}{252.4} = 61.6 < 150$ N/mm²

Therefore, it is OK.

Strength of end welds (4.5 mm size) $= 4.5 \times 71 \times 300 = 95\,850 > 8\,900$ N

Therefore, it is OK.



b) *On breadth face*

Spacing = 510 mm

$$d = 400 - 2 \times 18.1 = 363.8 \text{ mm}$$

$$\tan^{-1}\left(\frac{363.8}{510 \times 0.5}\right) = 54.9^\circ > 40^\circ$$
$$< 70^\circ$$

Shear at a section $= \frac{2.5}{100} \times 40\ 500 = 1\ 012.5$ N

Axial force in the lacings $= \frac{1\ 012.5}{2} \times \text{cosec } 54.9 = 618$ N

Length of the lacing rod $= \sqrt{363.8^2 + 255^2} = 444$ mm

Try ISRO – 14, $r = 3.5$ mm, $\frac{l}{r} = \frac{444}{3.5} = 126.9 < 145$

Elastic critical stress, f_c $= \frac{9.869\ 6\ E}{(126.9)^2} = 125.6$ N/mm²

Allowable axial compressive stress $= \frac{0.6 \times 125.6 \times 250}{(125.6^{1.4} + 250^{1.4})^{1/1.4}} = 59.8$ N/mm²

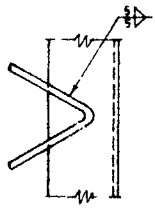
Allowable load $= 59.8 \times 153.9 = 9\ 203$ N > 618 N

Therefore, it is OK.

Strength of end welds (5 mm size)

$$= 5 \times 71 \times \frac{70}{2} \times 2 = 24\ 850 \text{ N} > 618 \text{ N}$$

Therefore, it is OK.



6.4 Column Base Plate for Hinged Type of Support

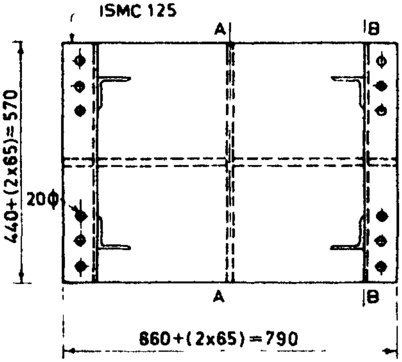
Column size : 660 mm × 400 mm

In this example, forces on foundation as in Table 36 are:

Dead load (*DL*)	= 29.23 kN downward
Live load (*LL*)	= 20.63 kN downward
Wind load (*WL*)	= 30.93 kN upward
DL + *LL*	= 29.23 + 20.63 = 49.86 kN
DL + *WL*	= 29.23 – 30.93 = 1.7 kN upward

DL + *LL* governs the design of the base plate.

Load due to column legs + lacing $= 4 \times 58 \times 6 + 650 = 22\ 420$ N
$= 2.25$ kN



Dead load of AC sheeting and girts $= 300 \times 6 \times 6 = 10\,800$ N
$= 10.8$ kN

Total axial force in columns $= 62.91$ kN

Try a base plate of size $790 \times 570 \times 20$ mm

$$W = \frac{62\,910}{790 \times 570} = 0.139 \text{ N/mm}^2$$

Moment at section AA, $m_a = \dfrac{0.139 \times (660 - 2 \times 65)^2}{8} = 4\,880$ N.mm

Moment at section BB, $m_b = \dfrac{W}{2} \times \left(A^2 - \dfrac{B^2}{4}\right) = \dfrac{0.139}{2} \times \left(65^2 - \dfrac{65^2}{4}\right) = 220$ N mm

Maximum moment $= 4\,880$ N mm

Thickness of the plate $= t = \sqrt{\dfrac{6 \times 4\,880}{189.0}} = 12.4$ mm < 20 mm

Therefore, it is OK.

Provide twelve 20 mm dia bolts for anchorage.

Horizontal Shear in Base Plate

From *Table 36*

Total horizontal shear $= 7.07 + 7.26 = 14.33$ kN

Bearing area of base key $= 570 \times 60 = 34\,200$ mm^2

Bearing shear on foundation concrete $= \dfrac{14\,330}{34\,200} = 0.42$ N/mm^2

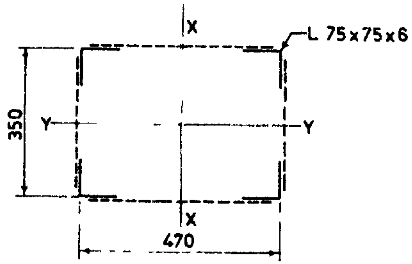
Allowable bearing stress $= 0.25 \times 15 = 3.75$ N/mm^2 > 0.42 N/mm^2

Therefore, it is OK.

6.5 Design Example of a Fixed Column Base Plate

Taking the same frame given in **5.4** with fixed base column and 200 kg/m^2 wind zone.

Column section from Table 61 is shown below:



Forces

From *Table 12*

Load	*Axial* (kN)	*Shear* (kN)	m (kN.m)
DL	−29.13	10.9	−27.75
LL	−20.63	11.42	−28.85
WL (200)	54.93	33.42	119.2

Self-weight of column + lacing = $68 \times 4 \times 6 + 600 = 2\,232$ N

DL of AC sheeting and girts = $300 \times 6 \times 6 = 1\,080$ N

DL + LL case

Total axial compression = $29.13 + 20.63 + 2.25 + 10.8 = 62.81$ kN

Shear = $10.90 + 11.42 = 22.32$ kN

Bending moment = $27.75 + 28.85 = 56.61$ kN.m

DL + WL case

Axial tension = $-29.13 - 2.25 - 10.0 + 54.93 = 12.75$ kN

Shear = $10.90 + 33.20 = 44.1$ kN

Bending moment = $119.22 - 27.75 = 91.47$ kN.m

Using M15 concrete,
allowable bearing pressure = $0.25 \times f_{ck} = 0.25 \times 15 = 3.75$ N/mm^2

Try a base plate of size $620 \times 500 \times 20$ mm

DL + LL case

Taking moments about tension bolts,

$$\frac{1}{2} \times 3.75 \times K \times 582.5^2 \times \left(1 - \frac{K}{3}\right) \times 500 -$$

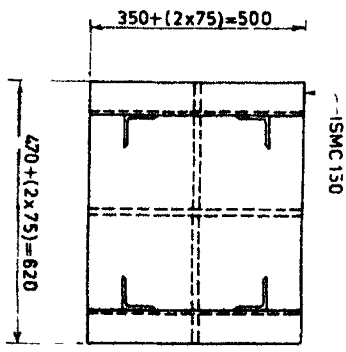
$$62\,810 \times 272.5 - 56.61 \times 10^6 = 0$$

$$K^2 - 3K + 0.70 = 0$$

$$K = 0.255$$

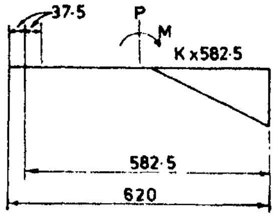
Force in bolts $= 0.255 \times 582.5 \times \dfrac{3.75}{2} \times 500 - 62\,810$

$= 76\,443$ N



DL + WL case

Taking moments about tension bolts,



$$\frac{1}{2} \times 3.75 \times K \times 582.5^2 \times \left(1 - \frac{K}{3}\right) \times 500 +$$

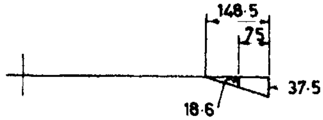
$$12\,750 \times 267.5 - 91.47 \times 10^6 = 0$$

$$K^2 - 3K + 0.83 = 0 \quad K = 0.308$$

$$\text{Force in bolts} = 0.300 \times 582.5 \times \frac{3.75}{2} \times 500 + 12\,750$$

$$= 1\,80\,947 \text{ N}$$

Maximum tension in bolts = 1 80 947 N



Maximum bending moment in base plate on tension side

1 80 947 × 37.5 = 67 85 513 N.mm

$$\text{On compression side} = 500 \times \left(1.86 \times 75 \times \frac{75}{2} + 1.89 \times \frac{75}{2} \times \frac{75 \times 2}{3}\right)$$

$$= 43\,87\,500 \text{ N.mm}$$

$$\text{Thickness of base plate, } t = \sqrt{\frac{67\,85\,513 \times 6}{400 \times 1.33 \times 189.0}} = 20.1 \text{ mm}$$

Therefore, it is OK.

$$\text{Providing 6 bolts on either side, force/bolt} = \frac{180\,947}{6} = 30\,158 \text{ N}$$

Capacity of 20 mm ϕ bolt = 29 400 × 1.25 = 36 750 N

Therefore provide twelve 20 mm dia bolts.

According to Table 76, twelve 24 mm dia bolts are required.

Due to standardization, sizes of the bolts recommended in Table 76 may be conservative for some cases as in the above example. If one desires more economical design for a particular case, the above design procedure can be adopted.

6.6 Design of Foundation

Typified design of foundation is not included in this report since the soil condition which varies from site to site would influence the design of foundation. A typical example of isolated footing design for assumed field condition is illustrated in this section. Limit state design in accordance with IS 456 : 1978 is used in this example. The fixed base portal foundation in Section 5.5 is designed here.

Assumptions

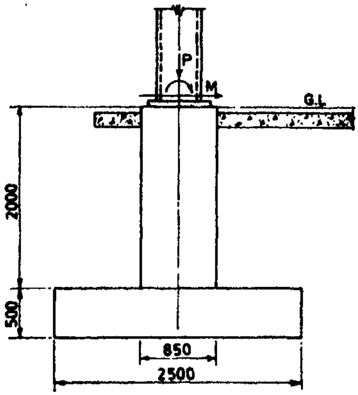
F_{ck} = 15 MPa

Allowable bearing pressure on soil = 150 kN/m²

Required depth of footing below grade = 2.5 m

Unit weight of soil back fill = 15 kN/m³

The design is illustrated for *DL + LL* case and has to be checked for *DL + WL* case. In this particular example, *DL + WL* case does not govern the design.



Forces on Foundation

	$DL + LL$	0.75 $(DL + WL)$
P (kN)	62.81	0
T (kN)	0	9.56
V (kN)	22.32	33.08
M (kN.m)	56.61	68.60

Development Length of Anchor Bolts

From the design of base plate (*see* **5.5**)

Total tension in 6 bolts $= 180.9$ kN (due to $DL + WL$)

Actual tension in each bolt $= \dfrac{180.9}{6} = 30.15$ kN

Net area of 24 mm ϕ bolt (net area taken as 0.75 times gross area) $= 339\ \text{mm}^2$

Stress in steel in limit state of collapse $= \dfrac{30\,150 \times 1.5}{339} = 133.4\ \text{N/mm}^2$

Development length required $= \dfrac{133.4 \times 24}{1.33 \times 1.0 \times 4} = 601$ mm

Use 600 mm embedment in concrete pedestal.

Design of Pedestal

Let the size of pedestal $= 850 \times 700$ mm

Self weight of pedestal $= \dfrac{850 \times 700 \times 2\,000}{10^9} \times 25\,000$

$= 29\,750\ \text{N} = 29.75$ kN

Total downward load $= 62.81 + 29.75 = 92.56$ kN

Moment at base of pedestal due to shear $= 2 \times 22.32 = 44.64$ kN.m

Total moment at base of pedestal $= 56.61 + 44.64 = 101.25$ kN.m

Design compression $= 1.5 \times 92.56 = 138.84$ kN

Design moment $= 1.5 \times 101.25 = 151.88$ kN.m

$f_{ck} = 15$ MPa

$$\frac{M_u}{f_{ck}bD^2} = \frac{151.88 \times 10^6}{15 \times 700 \times 850^2} = 0.020$$

$$\frac{P_u}{f_{ck}bD} = \frac{138.84 \times 10^3}{15 \times 700 \times 850} = 0.016$$

From chart 31 of SP 16 : 1980.

For Fe 415 and $\dfrac{d'}{D} = 0.05$

$$\frac{P}{f_{ck}} = 0.1$$

$$P = 1.5$$

Therefore, area of longitudinal steel $= \frac{1.5}{100} \times 850 \times 700 = 8\ 925\ \text{mm}^2$

Provide 12 bars of 32 mm ϕ, $A_t = 9\ 650\ \text{mm}^2$

Lateral Ties

Diameter = greater of:

a) 5 mm

b) 1/4 diameter of main bar = $1/4 \times 32 = 8$ mm

Therefore, provide 8 mm lateral ties

Spacing of ties = least of the following:

a) least dimension = 600 mm

b) 16 times diameter of main bar = $16 \times 32 = 512$ mm

c) 48 times diameter of ties = $48 \times 8 = 384$ mm

Provide 8 mm ϕ lateral ties at 380 mm c/c.

Reinforcement details are shown in the figure at the end of this section.

Design of Footing

Direct load from pedestal, W_1	= 92.56 kN
Safe bearing capacity of soil	= 150 kN/m^2
Unit weight of soil	= 15 kN/m^3
Try a footing of size = 2.0 m × 2.5 m × 0.5 m	
Weight of soil above footing, W_3	$= (2 \times 2.5 - 0.7 \times 0.85) \times 2 \times 15$ = 132.2 kN
Weight of footing, W_2	$= 2 \times 2.5 \times 0.5 \times 25 = 62.5$ kN
Load from pedestal, W_1	= 92.56 kN
Total vertical load	$= W_1 + W_2 + W_3 = 287.26$ kN
Overturning moment, M	$= 56.61 + 2.5 \times 22.32 - 11.1 = 112.41$ kN.m
Factor of safety against overturning	$= \frac{287.26 \times 1.25}{112.41} = 3.2 > 1.5$
Therefore, it is OK.	
Eccentricity of resultant vertical force, e	$= \frac{112.41}{287.26} = 0.39 \leqslant \frac{b}{6} = \frac{2.5}{6} = 0.42$ m

Therefore, base pressure distribution is trapezoidal as shown in the figure.

Maximum compressive stress $= \frac{P}{A}\left(1 + \frac{6e}{b}\right)$

$$= \frac{287.26}{2.0 \times 2.5}\left(1 + \frac{6 \times 0.39}{2.5}\right)$$

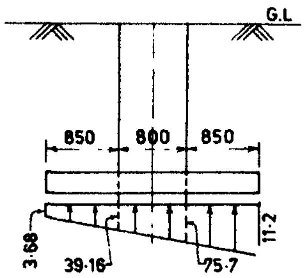
$$= 111.2 < 150\ \text{kN/m}^2$$

Therefore, it is OK.

Minimum pressure $= \frac{P}{A}\left(1 - \frac{6e}{b}\right) = 3.68\ \text{kN/m}^2$

Pressure at C $= 111.20 - \frac{111.20 - 3.68}{2.5} \times 0.825 = 75.71\ \text{kN/m}^2$

Pressure at B $= 3.68 + \frac{111.20 - 3.68}{2.5} \times 0.825 = 39.16\ \text{kN/m}^2$



Maximum Factored B.M. (Neglecting Weight of Soil)

$$\text{At section C} = 1.5 \times \left(111.20 - 75.71 \times \frac{0.825}{2} \times \frac{0.825 \times 2}{3} + \frac{75.71 \times 0.825^2}{2}\right)$$

$$= 50.73 \text{ kN.m/m width}$$

$$\text{At section B} = 1.5 \times \left(39.16 - 3.68 \times \frac{0.825}{2} \times \frac{0.825 \times 2}{3} + \frac{3.68 \times 0.825^2}{2}\right)$$

$$= 13.95 \text{ kN.m/m width}$$

Effective depth = 0.5 − 0.05 = 0.45 m

Refer Chapter 5 of SP 16 : 1980

Minimum tension reinforcement of 0.12 percent is sufficient.

$$\text{Area of steel} = 0.12 \times \frac{100}{100} \times 450 = 540 \text{ mm}^2/\text{m width}$$

Use 12 mm ϕ Fe 415 bars at 200 mm c/c top and bottom both ways.

Shear in footing would be small and hence not critical receiving shearing reinforcement.

For economy reasons, depth of footing, may be reduced to 200 mm at the free edge as shown in Fig. 11.

6.7 Bracing Design

Typical bracings arrangements are shown in Fig. 10. Among these Type (b) bracing detail design is illustrated here (*see* Fig. 12).

The wind force perpendicular to the ridge is carried, by the frame action and hence only nominal bracings are necessary in the gable end walls and at rafter level along the length of building.

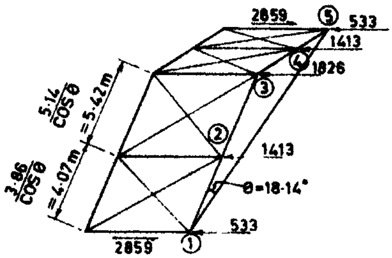
Gable End Wall Bracings

$$\text{Maximum length of bracing} = \sqrt{3^2 + \left(3 + \frac{3.86}{3}\right)^2} = 5.23 \text{ m} = 523 \text{ cm}$$

$$r_{min} \text{ required} = \frac{523}{350} = 1.5 \text{ cm}$$

Use ISA 5050 × 6

Rafter Level Bracings



Wind pressure on windward gable end = 0.7 × 1 000 = 700 N/m^2

Wind drag on roof = 0.025 × 1 000 = 25 N/m^2

Forces on Windward Gable End Truss

$$\text{At nodes 1, 5} = \frac{700 \times 3.86}{2 \times 2}\left(6 + \frac{3.86}{2 \times 3 \times 2}\right) + 25 \times \frac{4.07}{2} \times \frac{42}{22} = 5\,330 \text{ N}$$

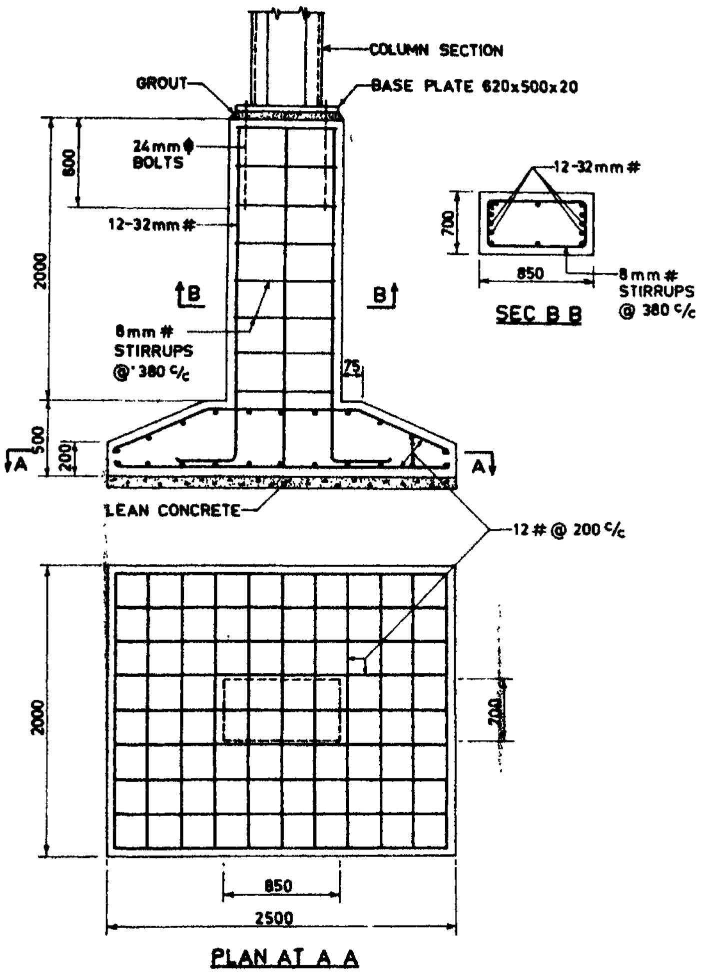

COLUMN SECTION
GROUT
BASE PLATE 620x500x20
24mm ϕ BOLTS
600
2000
12-32mm #
B
B
8mm # STIRRUPS @ 380 c/c
75
500
200
A
A
LEAN CONCRETE
12 # @ 200 c/c
12-32mm #
700
850
8mm # STIRRUPS @ 380 c/c
SEC B B
2000
700
850
2500
PLAN AT A A

FIG. 11

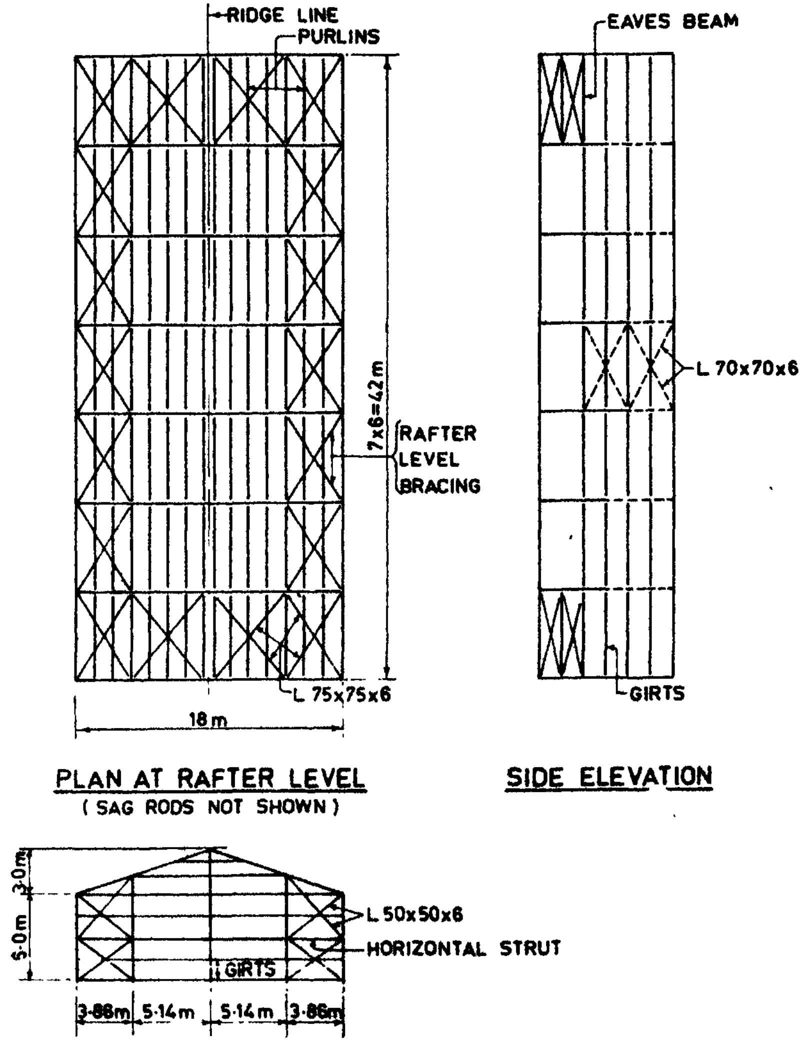

RIDGE LINE
PURLINS
EAVES BEAM
7x6=42m
RAFTER LEVEL BRACING
L 70x70x6
L 75x75x6
GIRTS
18 m
PLAN AT RAFTER LEVEL
(SAG RODS NOT SHOWN)
SIDE ELEVATION
3·0m
5·0m
L 50x50x6
HORIZONTAL STRUT
GIRTS
3·86m
5·14m
5·14m
3·86m

FIG. 12

At node 2, 4 $= 700 \times \left(\frac{3.86 + 5.14}{2 \times 2}\right)\left(6 + \frac{3 \times 3.86 + 5.14}{2 \times 2 \times 3}\right) + 25\left(\frac{4.07 + 5.42}{2}\right) \times \frac{42}{2}$

$= 14\ 130$ N

At node 3 $= 700 \times \frac{5.14}{2}\left(9 - \frac{5.14}{2 \times 3 \times 2}\right) + 25 \times 5.42 \times \frac{42}{2} = 18\ 260$ N

The reactions from columns and frames on the rafter bracing truss for equilibrium are shown in the figure.

Maximum bracing force $= \frac{(2\ 859 - 533) \times \sqrt{6^2 + 4.07^2}}{6} = 28\ 100$ N

Try ISA $75 \times 75 \times 6$

$l/r_{vv} = \sqrt{\frac{6^2 + 5.42^2}{2 \times 1.46}} \times 100 = 277$

$l/r_{xx} = \sqrt{\frac{6^2 + 5.42^2}{2.30}} \times 100 = 351$ which may be allowed.

Assuming 20 dia bolts,

Net effective area $= (4.33 - 2.15 \times 0.6) + \frac{4.33}{(1 + 0.35)\frac{4.33}{(4.33 - 2.15 \times 0.6)}} = 5.93\ \text{cm}^2$

Allowable tension $= 5.93 \times 100 \times 150 = 88\ 950\ \text{N} > 28\ 100$ N

Therefore, it is OK.

Wind pressure on leeward gable end $= 0.3 \times 1\ 000 = 300\ \text{N/m}^2$

Forces on Leeward Gable End Truss

At nodes 1, 5 $= \frac{300 \times 3.86}{2 \times 2}\left(6 + \frac{3.86}{2 \times 3 \times 2}\right) + \frac{25 \times 4.07}{2} \times \frac{42}{2} = 2\ 900$ N

At nodes 2, 4 $= 300 \times \left(\frac{3.86 + 5.14}{2 \times 2}\right) \times \left(6 + \frac{3 \times 3.86 + 5.14}{2 \times 2 \times 3}\right) + 25\left(\frac{4.07 + 5.42}{2}\right) \times \frac{42}{2} = 7\ 480$ N

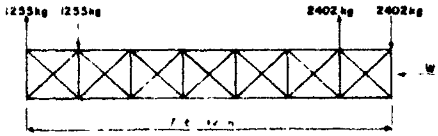
At node 3 $= 300 \times \frac{5.14}{2}\left(9 - \frac{5.14}{2 \times 3 \times 2}\right) + 25 \times 5.42 \times \frac{42}{2} = 9\ 450$ N

Since the rafter truss is not in one plane, the tipping effect of end gable load has to be resisted by eaves bracing system as shown

Forces on Eaves Truss Due to Tipping Effect

On the windward end $= \frac{(14\ 130 \times 4.07 + 18\ 260 \times 9.49/2)}{6} = 24\ 020$ N

On the leeward end $= \frac{(7\ 480 \times 4.07 + 9\ 450 \times 9.49/2)}{6} = 12\ 550$ N



Eaves Truss

Forces due to tipping effect will cause additional stresses on main rafters of portals.

Additional compressive stress in the $4 - 65 \times 65 \times 6$ rafter $= \dfrac{2\,402}{4 \times 744} = 8.0$ MPa

which is very small and can be neglected. The length of members of eaves truss is slightly less as compared to the length of memb rs between nodes 2 and 3 but for uniformity sake, use ISA $75 \times 75 \times 6$ as designed earlier.

Wind Perpendicular to End Gable

Wind columns in gable ends:

Wind pressure on end gable $= 0.7\ P$
$= 0.7 \times 100 = 700\ \text{N/m}^2$

Height of central column $= 6.0 + 3.0 = 9.0$ m

Maximum moment in the wind columns $= \dfrac{70 \times 5.14 \times 9^2}{8} = 36\,430$ N.m

Try ISMB 450

$$\frac{1}{r_{yy}} = \frac{900}{3.0} = 300$$

Therefore, it is OK.

$$D/T = \frac{450}{17.4} = 25.9$$

$$F_{bc} = 55 \times 1.33 = 73\ \text{MPa}$$

$$f_{bc} = \frac{36\,430 \times 100}{1\,350.7 \times 1\,000} = 27\ \text{MPa}$$

Therefore, it is OK.

Use IS MB 450 wind columns in gable ends.

Vertical Bracing on Longitudinal Wall

Wind force from windward side:

From end gable $= \dfrac{18}{2} \times \left(\dfrac{6+9}{2}\right) \times 0.7 \times 1\,000 = 23\,630$ N

From roof drag $= 25 \times 9.49 \times 21 = 4\,980$ N

Wall drag at eaves $= 25 \times 1.5 \times 21 = 790$ N

Wall drag at mid column $= 25 \times 3 \times 21 = 1\,580$ N

Total force at top of column on windward side $= 23\,630 + 4\,980 + 790 = 29\,400$ N

Wind force from leeward side:

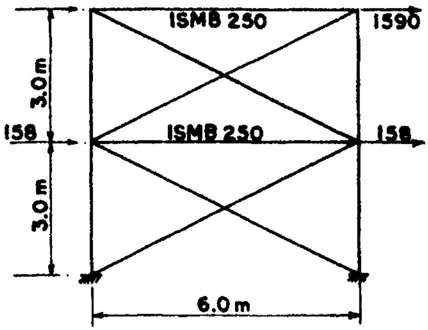
From end gable $= \dfrac{18}{2} \times \left(\dfrac{6+9}{2}\right) \times 0.3 \times 1\,000 \times \dfrac{1}{2} = 10\,130$ N

Roof drag $= 4\,980$ N

Wall drag at eaves $= 790$ N

Wall drag at mid column $= 1\,580$ N

Total force at top of column on leeward side $= 10\,130 + 4\,980 + 790 = 15\,900$ N



Try ISMB 250

$$(l/r)_{yy} = \frac{600}{2.65} = 226 < 250$$

Therefore, it is OK.

Allowable compression = 20.7 × 4 755
= 98 430 N > 29 400 N

Therefore, it is OK.

Length of bracing = $\sqrt{3^2 + 6^2} = 6.7$ m = 670 cm

Maximum bracing force

$$= 9(29\,400 + 15\,900 + 2 \times 1\,580) \times \frac{6.7}{6}$$
$$= 54\,110 \text{ N}$$

Try ISA 7 070 × 6

$$(l/r) = \frac{670}{2.14} = 313 < 350$$

Therefore, it is OK.

Assuming 20 dia bolts,

$$\text{Net effective area} = (4.03 - 2.15 \times 0.6) + \frac{3 \times 4.03}{3 \times 4.03 + 4.03} = 5.4 \text{ cm}^2$$

Allowable tension = 540 × 150 = 81 000 N < 54 110 N

Therefore, it is OK.

$$\text{Additional axial force in column} = 54\,110 \times \frac{3}{6.7} = 24\,230 \text{ N}$$

The column and foundation in the braced bay have to be checked for this additional force.

7 SUMMARY AND CONCLUSIONS

7.1 Analysis and design of lattice portal frames (single bay, without cranes) have been presented for five different spans, two different spacings, three different roof slopes, two three different column heights, three different basic wind pressures and five different earthquake zones. It has been found that the forces in members even due to the lowest basic wind pressure of 100 kg/m² are more than that due to the most severe earthquake zone forces.

In addition to analysis and design forces, foundation forces have also been given in tables for use in the design of foundations. A worked out example has also been given, both as an illustration of the design methodology and as a check on computer analysis, and design results presented. Unit weight of the frame members per square metre of the floor area covered is also presented along with the design results. The following observations may be made with regard to the unit weight:

a) Portals with fixed base tend to have less unit weight compared to the corresponding portals with hinged base.

b) Portals having longer spans have higher unit weight compared to shorter spans.

c) Generally portals having shallower roof slopes (1/5) have a lower unit weight, particularly in the case of portal frames with hinged base. However, in the case of portals with fixed base, the trend is not clear.

d) Although unit weight of frames alone is more in the case of 4.5 m spacing of frames as compared to 6 m spacing, this may not be still true if the weights of members spanning between frames (purlins and girts) are also considered.

e) In many cases, the lattice portal deflection limit (l/325) seems to be the governing consideration in the design of members, exceptions being normally found in the case of frames having longer span lengths and shorter column heights.

REFERENCES

IS 104 : 1979	Specification for ready mixed paint, brushing, zinc chrome, priming (*second revision*)
IS 123 : 1962	Specification for ready mixed paint, brushing, finishing, semigloss, for general purposes, to Indian Standard colours
IS 226 : 1975	Specification for structural steel (standard quality) (*fifth revision*)
IS 456 : 1978	Code of practice for plain and reinforced concrete (*third revision*)
IS 800 : 1984	Code of practice for use of structural steel in general building construction
IS 806 : 1968	Code of practice for use of steel tubes in general building construction.
IS 875 : 1964	Code of practice for structural safety of buildings: Loading standards
IS 1893 : 1984	Criteria for earthquake resistance design of structures (*fourth revision*)
IS 2062 : 1984	Specification for weldable structural steel (*third revision*)
IS 2074 : 1979	Specification for ready mixed paint, air-drying, red-oxide zinc chrome, priming (*first revision*)
IS 3007 (Part 1) : 1964	Code of practice for laying of asbestos cement sheets: Part 1 Corrugated sheets
IS 3757 : 1972	Specification for high strength structural bolts (*second revision*)
SP 16 : 1980	Design aids for reinforced concrete to IS 456 : 1978
	B. S. Sarma, V. Kalyanaraman and L. N. Ramamurthy. Optimum design of lattice portal frames. *Eng Opt.* 9 (1986). 273-284
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TABLE 1 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 9.0 m Column height = 4.5 m Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch: Moment under Compression	Haunch: Moment under Tension	Haunch: Shear under Compression	Haunch: Shear under Tension	Base/Crown: Moment under Compression	Base/Crown: Moment under Tension	Base/Crown: Shear under Compression	Base/Crown: Shear under Tension	Sway
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	21.0	0.0	17.3	0.0	3.8	0.0	0.0	0.0	3.8	0.0	0.99
		Beam	8.3	1.2	17.8	8.1	12.6	1.1	12.9	4.5	2.1	1.4	
	150	Column	21.0	1.6	17.3	16.1	3.8	2.3	0.0	0.0	5.6	4.8	1.30
		Beam	8.3	3.4	17.8	15.7	12.7	4.1	13.0	4.3	0.3	3.2	
	200	Column	21.4	5.2	20.9	23.6	3.9	3.6	0.0	0.0	7.4	6.9	1.31
		Beam	8.4	5.6	18.0	23.1	12.8	7.1	13.1	4.1	0.3	4.3	
1/4.0	100	Column	22.1	0.0	18.7	0.0	4.2	0.0	0.0	0.0	4.2	0.0	0.89
		Beam	7.8	1.3	19.2	8.4	14.1	1.8	15.0	3.6	1.9	1.3	
	150	Column	22.0	2.7	18.6	16.5	4.1	2.4	0.0	0.0	5.3	4.9	1.17
		Beam	7.8	3.4	19.2	16.1	14.1	5.3	15.0	2.7	2.7	2.0	
	200	Column	22.4	6.6	18.8	24.1	4.2	3.7	0.0	0.0	7.9	7.0	1.20
		Beam	7.9	5.4	19.4	23.7	14.2	8.6	15.1	2.8	0.7	3.7	
1/5.0	100	Column	22.7	0.0	19.6	0.0	4.3	0.0	0.0	0.0	4.3	0.0	0.85
		Beam	7.4	1.4	20.1	8.8	15.0	2.3	16.3	2.9	1.5	1.3	
	150	Column	22.7	3.4	19.6	17.1	4.3	2.5	0.0	0.0	5.0	5.0	1.12
		Beam	7.4	3.4	20.1	16.6	15.0	6.0	16.3	1.9	2.5	2.1	
	200	Column	23.0	7.6	19.7	24.8	4.4	3.8	0.0	0.0	6.2	7.9	1.16
		Beam	7.5	5.3	20.3	24.4	15.1	9.6	16.5	4.3	3.2	3.4	

Fixed Base

1 3.0	100	Column	21.1	0.0	16.0	0.0	6.0	0.0	10.8	0.0	6.0	0.0	0.48
		Beam	10.3	0.4	16.4	1.3	12.0	0.3	11.2	1.9	0.7	0.0	
	150	Column	21.1	0.0	16.1	0.0	6.0	0.0	10.9	0.0	6.0	0.0	0.60
		Beam	10.3	2.6	16.5	5.2	12.0	1.9	11.1	3.6	1.0	0.5	
	200	Column	21.1	2.3	16.1	9.3	6.0	3.7	15.0	14.7	8.1	7.0	0.73
		Beam	10.3	4.7	16.5	9.0	12.0	4.2	11.1	3.3	1.3	0.7	
1 4.0	100	Column	22.1	0.0	17.6	0.0	6.4	0.0	11.2	0.0	6.4	0.0	0.41
		Beam	10.0	0.7	17.9	2.0	13.5	0.5	13.7	3.2	0.4	0.3	
	150	Column	21.1	0.5	17.7	6.5	6.4	2.4	11.2	10.1	6.4	4.9	0.52
		Beam	10.0	2.9	18.0	6.2	13.5	3.1	13.6	2.3	0.6	0.5	
	200	Column	22.1	3.9	17.7	10.7	6.4	4.0	14.7	14.8	8.2	7.4	0.67
		Beam	10.0	5.0	18.1	10.5	13.5	5.8	13.5	2.8	0.1	0.8	
1 5.0	100	Column	22.8	0.0	18.6	0.0	6.7	0.0	11.4	0.0	6.7	0.0	0.38
		Beam	9.7	0.9	19.0	2.4	14.5	0.9	15.4	2.7	0.5	0.3	
	150	Column	22.7	1.3	18.7	7.3	6.7	2.6	11.4	10.3	6.7	5.2	0.50
		Beam	9.7	3.1	19.0	7.0	14.5	3.9	15.3	1.9	0.4	0.4	
	200	Column	22.7	5.0	18.7	11.8	6.7	4.3	11.4	15.1	6.7	7.6	0.64
		Beam	9.7	5.2	19.1	11.5	14.5	6.9	15.2	4.3	0.4	0.5	

NOTE - Wherever design is governed by *DL + WL* combination, the corresponding design forces have been multiplied by 1 1.33 to account for increased allowable stresses.

TABLE 2 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 9.0 m Column height = 4.5 m Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch				Base/Crown				Sway
					Moment under		Shear under		Moment under		Shear under		
					Compression	Tension	Compression	Tension	Compression	Tension	Compression	Tension	
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	27.2	0.0	21.8	0.0	4.8	0.0	0.0	0.0	4.8	0.0	1.15
		Beam	10.5	2.0	22.8	11.5	16.2	2.0	16.7	5.6	2.8	1.8	
	150	Column	27.5	2.6	22.2	22.2	4.9	3.3	0.0	0.0	7.7	6.6	1.30
		Beam	10.6	4.9	23.0	21.5	16.3	5.9	16.8	5.3	4.3	4.3	
	200	Column	28.0	7.3	27.2	32.1	4.9	4.9	0.0	0.0	9.7	9.4	1.26
		Beam	10.7	7.8	24.1	31.3	16.5	9.8	17.1	5.1	0.5	5.8	
1/4.0	100	Column	28.6	0.0	23.6	0.0	5.2	0.0	0.0	0.0	5.2	0.0	1.07
		Beam	9.9	2.1	24.6	11.9	18.1	2.9	19.3	4.2	2.3	1.7	
	150	Column	28.9	4.0	23.8	22.7	5.3	3.4	0.0	0.0	6.9	6.7	1.17
		Beam	10.0	4.8	24.8	22.0	18.2	7.4	19.5	3.1	3.7	3.6	
	200	Column	29.0	9.4	23.8	32.9	5.3	5.1	0.0	0.0	8.6	10.7	1.34
		Beam	10.0	7.5	24.9	32.1	18.3	12.0	19.6	4.4	0.9	4.9	
1/5.0	100	Column	29.5	0.0	24.8	0.0	5.5	0.0	0.0	0.0	5.5	0.0	1.02
		Beam	9.5	2.2	25.8	12.3	19.3	3.6	21.1	3.3	2.1	1.7	
	150	Column	29.4	5.2	24.7	23.6	5.5	3.6	0.0	0.0	6.5	6.9	1.37
		Beam	9.4	4.8	25.7	22.8	19.2	8.6	21.1	3.2	3.3	2.8	
	200	Column	29.9	10.8	24.9	33.9	5.5	5.3	0.0	0.0	8.1	10.8	1.29
		Beam	9.5	7.3	26.0	33.1	19.4	13.4	21.3	6.5	4.3	4.5	

Fixed Base

1 3.0	100	Column	27.1	0.0	20.1	0.0	7.4	0.0	13.4	0.0	7.4	0.0	0.58
		Beam	13.0	1.0	20.7	2.5	15.3	0.2	14.8	2.1	0.9	0.0	
	150	Column	27.2	0.0	20.2	0.0	7.5	0.0	14.0	0.0	7.6	0.0	0.73
		Beam	13.0	3.9	20.8	7.6	15.4	3.1	14.7	4.4	1.3	0.7	
	200	Column	27.2	3.8	20.2	13.2	7.5	5.1	17.1	19.9	7.9	9.6	0.91
		Beam	13.0	6.8	20.8	12.7	15.3	6.1	14.6	4.0	0.4	1.7	
1 4.0	100	Column	28.6	0.0	22.1	0.0	8.0	0.0	14.0	0.0	8.0	0.0	0.50
		Beam	12.6	1.4	22.7	3.3	17.4	1.1	18.1	3.9	0.5	0.5	
	150	Column	28.6	1.3	22.2	9.4	8.0	3.5	14.0	13.8	8.0	6.8	0.64
		Beam	12.6	4.2	22.8	9.0	17.4	4.7	17.9	2.6	0.8	0.6	
	200	Column	28.6	5.9	22.2	15.1	8.1	5.6	20.0	20.0	11.2	10.0	0.83
		Beam	12.6	7.1	22.9	14.6	17.4	8.3	17.9	4.4	0.2	1.0	
1 5.0	100	Column	29.4	0.0	23.4	0.0	8.3	0.0	14.2	0.0	8.3	0.0	0.46
		Beam	12.3	1.6	24.0	4.0	18.7	1.8	20.3	3.0	0.6	0.4	
	150	Column	29.5	2.4	23.5	10.4	8.4	3.8	14.2	14.0	8.4	7.1	0.62
		Beam	12.3	4.4	24.1	9.9	18.7	5.7	20.2	3.2	0.6	0.5	
	200	Column	29.5	7.3	23.6	16.4	8.4	5.9	20.1	20.3	11.4	10.4	0.79
		Beam	12.3	7.2	24.2	15.9	18.7	9.7	20.1	6.5	0.6	0.7	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1 1.33 to account for increased allowable stresses.

TABLE 3 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 9.0 m Column height = 4.5 m Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure (kg/m²)	Member	Compression (kN)	Tension (kN)	Haunch: Moment under Compression (kN.m)	Haunch: Moment under Tension (kN.m)	Haunch: Shear under Compression (kN)	Haunch: Shear under Tension (kN)	Base/Crown: Moment under Compression (kN.m)	Base/Crown: Moment under Tension (kN.m)	Base/Crown: Shear under Compression (kN)	Base/Crown: Shear under Tension (kN)	Sway (cm)
					Hinged Base								
1/3.0	100	Column	22.5	0.0	17.2	0.0	2.9	0.0	0.0	0.0	4.8	0.0	1.83
		Beam	7.4	2.1	18.1	15.5	13.0	2.5	14.1	5.3	0.6	3.7	
	150	Column	23.4	2.3	28.6	27.1	3.1	2.8	0.0	0.0	8.0	6.2	1.59
		Beam	7.5	4.4	29.2	26.4	13.3	6.1	14.5	5.4	5.5	5.6	
	200	Column	23.6	6.9	35.8	38.4	3.7	4.2	0.0	0.0	10.3	10.7	1.82
		Beam	7.6	6.9	36.5	37.7	13.3	9.9	14.6	5.3	7.3	7.6	
1/4.0	100	Column	23.5	0.0	19.5	0.0	3.1	0.0	0.0	0.0	5.3	0.0	1.69
		Beam	6.8	2.1	20.1	15.6	14.3	3.3	16.0	4.1	3.5	2.8	
	150	Column	24.0	3.6	22.6	27.4	3.1	2.9	0.0	0.0	7.7	6.2	1.72
		Beam	6.9	4.2	22.0	26.7	14.5	7.4	16.2	3.4	0.9	5.1	
	200	Column	24.4	8.3	32.8	38.6	3.2	4.2	0.0	0.0	9.6	10.6	1.82
		Beam	6.9	6.4	31.6	37.9	14.7	11.5	16.4	2.7	1.0	6.9	
1/5.0	100	Column	24.2	0.0	19.4	0.0	3.2	0.0	0.0	0.0	5.2	0.0	1.64
		Beam	6.3	2.0	20.2	15.9	15.2	3.8	17.2	3.3	3.3	2.8	
	150	Column	24.5	4.4	25.2	27.9	3.3	3.0	0.0	0.0	7.2	6.3	1.82
		Beam	6.4	4.0	22.1	27.2	15.3	8.2	17.4	2.1	4.9	4.3	
	200	Column	25:1	9.2	31.5	39.1	3.3	4.3	0.0	0.0	9.3	10.6	1.78
		Beam	6.5	6.0	32.2	38.4	15.6	12.5	17.7	3.9	6.2	6.6	

Fixed Base

1/3	100	Column	22.5	0.0	16.4	0.0	4.5	0.0	14.8	0.0	6.1	0.0	0.83
		Beam	8.9	0.8	17.0	3.3	12.5	0.1	12.9	4.6	1.1	0.5	
	150	Column	22.5	0.0	16.5	0.0	4.5	0.0	19.4	0.0	7.9	0.0	1.08
		Beam	8.9	3.0	17.0	8.3	12.4	2.5	12.8	4.3	1.7	0.7	
	200	Column	22.5	2.2	16.5	13.6	4.5	4.1	25.7	24.1	10.4	8.5	1.34
		Beam	8.9	5.2	17.0	13.2	12.4	5.0	12.7	4.1	0.1	2.2	
1/4.0	100	Column	23.5	0.0	17.8	0.0	4.8	0.0	11.3	0.0	4.8	0.0	0.75
		Beam	8.4	1.1	18.4	3.9	13.9	0.8	15.1	3.7	0.8	0.5	
	150	Column	23.5	0.1	17.9	9.6	4.8	2.7	18.4	16.9	7.6	6.1	0.98
		Beam	8.4	3.2	18.5	9.2	13.9	3.7	15.1	2.8	1.2	0.6	
	200	Column	23.5	3.7	18.0	14.9	4.8	4.2	26.6	23.9	11.1	8.7	1.24
		Beam	8.4	5.2	18.5	14.5	13.9	6.7	15.0	2.8	1.7	0.8	
1/5.0	100	Column	24.1	0.0	18.7	0.0	4.9	0.0	11.4	0.0	4.9	0.0	0.71
		Beam	8.0	1.2	19.2	4.4	14.8	1.3	16.6	3.0	0.8	0.4	
	150	Column	24.1	0.9	18.8	10.4	5.0	2.9	18.9	17.1	8.0	6.3	0.95
		Beam	8.0	3.2	19.3	10.0	14.8	4.5	16.5	1.8	1.0	0.6	
	200	Column	24.2	4.8	18.8	16.0	5.0	4.4	26.5	24.0	11.2	8.9	1.21
		Beam	8.0	5.2	19.4	15.5	14.8	7.8	16.4	4.3	1.5	0.9	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 4 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 9.0 m Column height = 6.0 m Frame spacing = 6.0 m

ROOF SLOPE	BASIC WIND PRESSURE	MEMBER	COMPRESSION	TENSION	HAUNCH				BASE/CROWN				SWAY
					Moment under		Shear under		Moment under		Shear under		
					Compression	Tension	Compression	Tension	Compression	Tension	Compression	Tension	
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
Hinged Base													
1/3.0	100	Column	29.4	0.0	27.2	0.0	3.6	0.0	0.0	0.0	7.4	0.0	1.84
		Beam	9.4	3.1	23.2	21.2	16.7	3.9	18.3	6.5	0.8	4.9	
	150	Column	30.1	3.9	37.1	37.1	3.9	4.0	0.0	0.0	10.5	8.4	1.80
		Beam	9.5	6.3	30.6	35.9	17.0	8.7	18.6	6.6	0.9	7.5	
	200	Column	31.1	9.4	47.0	51.9	4.9	5.7	0.0	0.0	13.6	14.4	1.69
		Beam	9.7	9.4	48.3	50.6	17.3	13.6	19.0	6.6	9.7	10.1	
1/4.0	100	Column	30.8	0.0	25.2	0.0	3.9	0.0	0.0	0.0	7.0	0.0	1.70
		Beam	8.7	3.0	26.3	21.3	18.5	4.8	20.8	5.0	4.6	3.7	
	150	Column	31.4	5.3	34.1	37.3	4.0	4.0	0.0	0.0	9.8	8.5	1.80
		Beam	8.8	5.9	29.8	36.1	18.8	10.3	21.1	4.0	1.2	6.8	
	200	Column	31.9	11.5	23.9	52.2	4.0	5.7	0.0	0.0	4.0	14.3	1.84
		Beam	8.9	8.8	42.6	51.0	19.0	15.8	21.3	3.8	1.2	9.2	
1/5.0	100	Column	31.7	0.0	24.6	0.0	4.1	0.0	0.0	0.0	6.5	0.0	1.65
		Beam	8.1	2.9	26.1	21.7	19.7	5.5	22.4	3.9	4.2	3.7	
	150	Column	32.2	6.3	32.7	38.0	4.1	4.1	0.0	0.0	9.5	8.6	1.75
		Beam	8.2	5.6	33.9	36.8	19.9	11.4	22.6	2.7	6.3	6.5	
	200	Column	32.8	12.8	41.2	53.0	4.2	5.9	0.0	0.0	12.3	14.3	1.79
		Beam	8.3	8.3	42.5	51.7	20.1	17.2	22.9	5.9	8.3	8.8	

Fixed Base

1:3.0	100	Column	29.0	0.0	20.5	0.0	5.6	0.0	15.9	0.0	6.5	0.0	1.01
		Beam	11.2	1.6	21.4	5.2	15.9	0.6	16.9	5.7	1.5	0.6	
	150	Column	29.0	0.0	20.5	0.0	5.6	0.0	26.2	0.0	10.8	0.0	1.32
		Beam	11.2	4.4	21.5	11.8	15.9	3.9	16.8	5.4	2.3	0.9	
	200	Column	29.0	3.7	20.6	19.2	5.6	5.6	36.6	32.3	15.1	11.6	1.65
		Beam	11.2	7.3	21.6	18.4	15.9	7.2	16.7	5.0	0.2	3.0	
1:4.0	100	Column	30.4	0.0	22.3	0.0	6.0	0.0	15.5	0.0	6.5	0.0	0.91
		Beam	10.6	4.8	23.3	6.0	17.9	1.6	19.9	4.5	1.1	0.6	
	150	Column	30.4	0.8	22.4	13.8	6.0	3.9	23.9	22.9	10.0	8.3	1.22
		Beam	10.6	4.6	23.3	13.0	17.9	5.6	19.7	3.2	1.7	0.8	
	200	Column	30.3	5.8	22.4	20.9	6.0	5.8	35.8	32.1	15.0	11.8	1.54
		Beam	10.6	7.3	23.4	20.1	17.9	9.5	19.6	4.5	0.7	2.3	
1:5.0	100	Column	31.3	0.0	23.4	0.0	6.2	0.0	15.6	0.0	6.6	0.0	0.87
		Beam	10.1	2.0	24.4	6.6	19.1	2.3	21.9	3.5	1.0	0.5	
	150	Column	31.3	1.9	23.5	14.7	6.2	4.1	25.6	23.0	10.8	8.5	1.18
		Beam	10.2	4.6	24.5	14.0	19.1	6.6	21.7	3.1	1.4	0.8	
	200	Column	31.3	7.1	23.6	22.1	6.2	6.1	35.7	32.2	15.1	12.0	1.49
		Beam	10.2	7.3	24.6	21.4	19.1	10.9	21.6	6.6	2.0	1.0	

NOTE – Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 5 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 12.0 m Column height = 4.5 m Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch				Base/Crown				Sway
					Moment under		Shear under		Moment under		Shear under		
					Compression	Tension	Compression	Tension	Compression	Tension	Compression	Tension	
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	26.3	0.0	30.3	0.0	6.7	0.0	0.0	0.0	6.7	0.0	1.01
		Beam	12.5	0.9	30.8	7.3	16.2	0.5	20.2	3.3	1.7	0.8	
	150	Column	26.2	1.6	30.2	17.5	6.7	2.6	0.0	0.0	6.7	5.1	1.29
		Beam	12.5	3.8	30.8	17.0	16.2	3.9	20.2	6.2	2.5	1.2	
	200	Column	26.6	5.8	30.5	26.9	6.8	4.3	0.0	0.0	7.7	7.7	1.30
		Beam	12.6	6.6	31.1	26.5	16.4	7.2	20.5	5.8	0.1	3.3	
1/4.0	100	Column	27.7	0.0	33.0	0.0	7.3	0.0	0.0	0.0	7.3	0.0	0.86
		Beam	12.1	1.2	33.5	8.1	18.2	1.4	24.1	5.5	1.2	0.6	
	150	Column	27.6	3.1	32.9	18.6	7.3	2.9	0.0	0.0	7.3	5.4	1.11
		Beam	12.1	4.0	33.5	18.2	18.2	5.4	24.1	3.8	1.8	1.0	
	200	Column	28.0	7.8	33.2	28.4	7.4	4.6	0.0	0.0	7.4	8.0	1.15
		Beam	12.2	6.7	33.8	28.0	18.3	9.3	24.3	5.1	0.5	2.5	
1/5.0	100	Column	28.6	0.0	34.7	0.0	7.7	0.0	0.0	0.0	7.7	0.0	0.80
		Beam	11.8	1.4	35.3	8.7	19.5	2.0	26.7	4.4	0.9	0.6	
	150	Column	28.5	4.1	34.7	19.7	7.7	3.1	0.0	0.0	7.7	5.6	1.05
		Beam	11.7	4.1	35.2	19.2	19.4	6.4	26.7	3.6	1.5	1.0	
	200	Column	28.5	9.4	34.6	30.1	7.7	5.0	0.0	0.0	7.7	8.4	1.31
		Beam	11.7	6.8	35.3	29.6	19.4	10.8	26.8	7.8	0.8	2.1	

Fixed Base

1/3.0	100	Column	26.3	0.0	27.2	0.0	10.3	0.0	19.4	0.0	10.3	0.0	0.50
		Beam	15.9	0.1	27.5	0.6	15.1	0.5	16.2	2.7	1.2	0.2	
	150	Column	26.3	0.0	27.2	0.0	10.4	0.0	19.4	0.0	10.4	0.0	0.57
		Beam	15.9	3.2	27.6	6.3	15.1	2.2	16.1	0.9	1.2	0.5	
	200	Column	26.3	3.7	27.3	12.2	10.4	4.8	19.4	17.0	10.4	8.2	0.69
		Beam	16.0	6.3	27.7	11.9	15.1	4.9	16.0	4.4	1.2	0.9	
1/4.0	100	Column	27.7	0.0	30.3	0.0	11.2	0.0	20.3	0.0	11.2	0.0	0.40
		Beam	15.9	0.7	30.7	1.8	17.2	0.4	21.0	1.5	0.5	0.3	
	150	Column	27.6	1.5	30.4	8.5	11.3	3.2	20.3	11.3	11.3	5.7	0.46
		Beam	15.9	3.9	30.8	8.2	17.2	3.8	20.9	3.2	0.5	0.6	
	200	Column	27.7	5.9	30.5	15.0	11.3	5.5	20.3	17.5	11.3	8.9	0.62
		Beam	15.9	7.1	30.8	14.7	17.2	7.1	20.8	4.6	0.5	0.9	
1/5.0	100	Column	28.5	0.0	32.3	0.0	11.8	0.0	20.6	0.0	11.8	0.0	0.35
		Beam	15.7	1.1	32.7	2.2	18.6	0.5	24.3	0.5	0.3	0.4	
	150	Column	28.5	2.6	32.5	9.9	11.8	3.5	20.7	11.7	11.8	6.1	0.44
		Beam	15.8	4.3	32.8	2.3	18.6	2.5	24.2	3.3	0.0	0.6	
	200	Column	28.6	7.3	32.6	16.9	11.8	6.1	20.7	18.0	11.8	9.4	0.58
		Beam	15.8	7.5	32.9	6.9	18.6	5.5	24.1	7.2	0.0	0.9	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 6 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 12.0 m Column height = 4.5 m Frame spacing = 6.0 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch: Moment under Compression	Haunch: Moment under Tension	Haunch: Shear under Compression	Haunch: Shear under Tension	Base Crown: Moment under Compression	Base Crown: Moment under Tension	Base Crown: Shear under Compression	Base Crown: Shear under Tension	Sway
	(kg/m^2)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
Hinged Base													
1/3.0	100	Column	33.9	0.0	38.2	0.0	8.5	0.0	0.0	0.0	8.5	0.0	1.21
		Beam	15.9	1.8	39.2	11.0	20.7	1.4	26.1	3.5	2.2	1.0	
	150	Column	34.2	2.8	38.4	24.5	8.5	3.8	0.0	0.0	8.5	7.1	1.25
		Beam	16.0	5.5	39.5	23.7	20.9	5.8	26.3	7.6	3.5	3.3	
	200	Column	34.9	8.3	38.9	37.0	8.6	6.0	0.0	0.0	10.5	10.5	1.24
		Beam	16.2	9.2	40.0	36.2	21.2	10.2	26.7	7.1	0.1	4.4	
1/4.0	100	Column	35.7	0.0	41.8	0.0	9.3	0.0	0.0	0.0	9.3	0.0	1.04
		Beam	15.4	2.1	42.8	12.0	23.3	2.6	31.1	6.4	1.5	0.9	
	150	Column	35.7	5.0	41.8	26.1	9.3	4.1	0.0	0.0	9.3	7.5	1.35
		Beam	15.4	5.8	42.8	25.3	23.3	7.9	31.2	4.3	2.4	1.4	
	200	Column	36.3	11.2	42.1	39.3	9.4	6.5	0.0	0.0	9.4	11.0	1.28
		Beam	15.5	9.4	43.2	38.4	23.6	13.1	31.5	7.9	3.4	3.3	
1/5.0	100	Column	36.9	0.0	44.1	0.0	9.8	0.0	0.0	0.0	9.8	0.0	0.96
		Beam	15.0	2.3	45.1	12.9	25.0	3.4	34.6	4.9	1.2	0.8	
	150	Column	36.8	6.4	44.0	27.6	9.8	4.5	0.0	0.0	9.8	7.8	1.28
		Beam	15.0	5.9	45.1	26.8	25.0	9.3	34.6	5.9	2.0	1.4	
	200	Column	37.3	13.1	44.2	41.3	9.8	6.9	0.0	0.0	9.8	11.4	1.32
		Beam	15.1	9.5	45.4	40.4	25.1	15.0	34.9	11.5	2.7	2.8	

Fixed Base

1/3.0	100	Column	34.2	0.0	34.2	0.0	13.0	0.0	24.1	0.0	13.0	0.0	0.58
		Beam	20.1	0.8	34.9	2.0	19.3	0.0	21.5	3.0	1.5	0.3	
	150	Column	33.8	0.6	34.2	10.0	13.0	3.9	24.1	15.2	13.0	7.3	0.68
		Beam	20.1	5.0	34.9	9.5	19.3	3.6	21.4	6.0	1.5	0.8	
	200	Column	33.8	5.9	34.3	17.6	13.0	6.8	24.1	23.2	13.0	11.3	0.86
		Beam	20.1	9.1	35.0	17.1	19.3	7.3	21.3	5.4	1.5	1.3	
1/4.0	100	Column	36.1	0.0	38.9	0.0	14.4	0.0	25.9	0.0	14.4	0.0	0.43
		Beam	20.4	1.5	39.5	3.5	22.1	1.3	26.7	1.1	0.7	0.5	
	150	Column	36.1	2.6	38.6	12.6	14.3	4.6	25.6	15.8	14.3	8.0	0.55
		Beam	20.2	5.8	39.3	12.1	22.1	5.7	27.1	3.5	0.6	0.8	
	200	Column	36.0	8.5	38.5	21.2	14.2	7.8	25.4	23.9	14.2	12.3	0.76
		Beam	20.2	10.0	39.2	20.7	22.1	10.2	27.3	7.3	0.6	1.1	
1/5.0	100	Column	37.4	0.0	42.3	0.0	15.4	0.0	27.1	0.0	15.4	0.0	0.35
		Beam	20.5	2.0	42.9	1.7	23.8	0.1	29.9	4.2	0.0	0.6	
	150	Column	37.3	4.0	41.8	14.5	15.2	5.2	26.5	16.5	15.2	8.6	0.50
		Beam	20.3	6.3	42.4	4.4	23.9	4.0	30.8	5.3	0.0	0.9	
	200	Column	37.3	10.3	41.6	23.8	15.1	8.5	26.3	24.7	15.1	13.0	0.68
		Beam	20.2	10.6	42.3	10.4	23.9	8.0	31.1	10.6	0.0	1.1	

NOTE Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 7 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 12.0 m Column height = 6.0 m Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch				Base/Crown				Sway
					Moment under		Shear under		Moment under		Shear under		
					Compression	Tension	Compression	Tension	Compression	Tension	Compression	Tension	
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	27.7	0.0	30.6	0.0	5.1	0.0	0.0	0.0	5.1	0.0	1.79
		Beam	11.0	1.7	31.5	14.6	16.7	1.6	22.8	7.9	2.8	1.8	
	150	Column	28.3	1.9	31.0	28.5	5.2	3.1	0.0	0.0	7.9	6.4	1.80
		Beam	11.1	4.5	31.9	27.8	17.0	5.4	23.1	7.7	4.3	4.3	
	200	Column	29.0	6.6	37.5	41.6	5.3	4.7	0.0	0.0	9.9	9.2	1.75
		Beam	11.3	7.4	38.3	40.8	17.3	9.3	23.5	7.5	5.7	5.8	
1/4.0	100	Column	29.1	0.0	33.1	0.0	5.5	0.0	0.0	0.0	5.5	0.0	1.61
		Beam	10.3	1.8	34.0	15.2	18.6	2.5	26.3	6.2	2.3	1.7	
	150	Column	29.4	3.6	33.3	29.4	5.5	3.2	0.0	0.0	7.1	6.6	1.76
		Beam	10.4	4.5	34.2	28.7	18.7	7.0	26.5	4.8	3.7	2.7	
	200	Column	30.1	8.7	33.7	42.7	5.6	4.9	0.0	0.0	8.8	9.3	1.72
		Beam	10.6	7.2	34.7	42.0	19.0	11.4	26.9	4.9	4.8	4.9	
1/5.0	100	Column	30.0	0.0	34.7	0.0	5.8	0.0	0.0	0.0	5.8	0.0	1.54
		Beam	9.9	1.9	35.6	15.8	19.8	3.1	28.7	5.0	2.1	1.7	
	150	Column	30.3	4.5	34.9	30.3	5.8	3.4	0.0	0.0	6.7	6.7	1.69
		Beam	9.9	4.5	35.8	29.6	20.0	8.0	28.9	3.3	3.3	2.8	
	200	Column	31.0	9.9	35.4	43.9	5.9	5.1	0.0	0.0	8.4	10.6	1.65
		Beam	10.1	7.0	36.4	43.2	20.3	12.8	29.4	7.5	4.3	4.5	

Fixed Base

1 3.0	100	Column	27.7	0.0	28.4	0.0	7.9	0.0	19.1	0.0	7.9	0.0	0.79
		Beam	13.6	0.6	28.9	2.5	15.8	0.3	19.7	3.3	0.9	0.0	
	150	Column	27.7	0.0	28.4	0.0	7.9	0.0	19.1	0.0	7.9	0.0	0.99
		Beam	13.6	3.5	29.0	9.4	15.8	2.7	19.5	6.1	1.3	0.6	
	200	Column	27.6	3.4	28.4	16.7	7.9	4.9	26.8	26.3	10.9	9.4	1.20
		Beam	13.6	6.4	29.0	16.3	15.8	5.7	19.4	5.6	0.5	1.7	
1/4.0	100	Column	29.1	0.0	31.2	0.0	8.5	0.0	19.8	0.0	8.5	0.0	0.68
		Beam	13.2	4.0	34.7	3.7	17.9	0.7	24.1	5.6	0.5	0.4	
	150	Column	29.1	0.9	31.3	11.6	8.5	3.3	19.9	18.0	8.5	6.6	0.85
		Beam	13.3	3.9	31.9	11.2	17.9	4.3	24.0	4.0	0.8	0.6	
	200	Column	29.1	5.5	31.4	19.2	8.5	5.4	26.3	26.4	11.0	9.8	1.10
		Beam	13.3	6.8	32.0	18.8	17.9	7.8	23.9	5.1	0.2	1.0	
1/5.0	100	Column	30.0	0.0	33.0	0.0	8.8	0.0	20.1	0.0	8.8	0.0	0.62
		Beam	12.9	1.3	33.5	4.5	19.2	1.3	27.1	4.6	0.6	0.4	
	150	Column	30.0	2.0	33.0	13.0	8.9	3.6	20.1	18.4	8.9	6.9	0.82
		Beam	12.9	4.1	33.6	12.6	19.2	5.3	26.9	3.5	0.6	0.5	
	200	Column	29.9	6.9	33.1	21.1	8.9	5.8	26.5	26.9	11.2	10.2	1.05
		Beam	12.9	7.0	33.7	20.7	19.2	9.3	26.8	7.7	0.6	0.7	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1 1.33 to account for increased allowable stresses.

TABLE 8 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 12.0 m Column height = 6.0 m Frame spacing = 6.0 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch				Base/Crown				Sway
					Moment under		Shear under		Moment under		Shear under		
					Compression	Tension	Compression	Tension	Compression	Tension	Compression	Tension	
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	36.1	0.0	38.8	0.0	6.5	0.0	0.0	0.0	6.5	0.0	1.79
		Beam	14.0	2.7	40.4	20.5	21.5	2.7	29.5	9.8	3.7	2.4	
	150	Column	37.0	3.1	39.5	39.1	6.6	4.3	0.0	0.0	10.1	8.8	1.74
		Beam	14.3	6.4	41.2	37.9	22.0	7.8	30.1	9.6	0.6	5.7	
	200	Column	38.1	9.2	43.7	56.5	6.7	6.4	0.0	0.0	14.2	12.4	1.62
		Beam	14.5	10.2	42.4	55.2	22.4	12.8	30.7	9.4	0.6	7.7	
1/4.0	100	Column	37.9	0.0	42.1	0.0	7.0	0.0	0.0	0.0	7.0	0.0	1.61
		Beam	13.2	2.8	43.7	21.2	24.0	3.9	34.2	7.5	3.1	2.3	
	150	Column	38.6	5.2	42.6	40.3	7.1	4.5	0.0	0.0	9.2	8.9	1.68
		Beam	13.4	6.4	44.2	39.0	24.3	9.9	34.6	5.6	4.9	4.8	
	200	Column	39.2	12.2	43.0	58.2	7.2	6.7	0.0	0.0	11.6	14.2	1.73
		Beam	13.5	9.9	44.7	56.8	24.6	15.8	35.1	7.5	6.4	6.5	
1/5.0	100	Column	39.1	0.0	44.2	0.0	7.4	0.0	0.0	0.0	7.4	0.0	1.54
		Beam	12.6	2.9	45.8	22.0	25.6	4.8	37.3	5.8	2.8	2.3	
	150	Column	39.8	6.5	44.7	41.5	7.5	4.7	0.0	0.0	8.8	9.1	1.62
		Beam	12.8	6.3	46.4	40.2	25.9	11.2	37.8	5.3	4.4	3.7	
	200	Column	40.5	13.9	45.2	59.8	7.5	7.0	0.0	0.0	10.9	14.3	1.66
		Beam	12.9	9.7	46.9	58.5	26.2	17.6	38.3	11.1	5.7	6.0	

			Fixed Base										
1:3.0	100	Column	35.7	0.0	35.5	0.0	9.9	0.0	23.7	0.0	9.9	0.0	0.95
		Beam	17.2	1.4	36.5	4.6	20.3	0.3	26.0	3.6	1.2	0.0	
	150	Column	35.7	0.0	35.6	0.0	9.9	0.0	25.5	0.0	10.3	0.0	1.19
		Beam	17.2	5.3	36.7	13.7	20.3	4.3	25.8	7.6	1.8	0.9	
	200	Column	35.7	5.4	35.7	23.7	9.9	6.9	30.3	35.6	10.5	12.9	1.49
		Beam	17.2	9.1	36.8	22.9	20.3	8.2	25.7	6.9	2.5	2.3	
1:4.0	100	Column	37.5	0.0	39.1	0.0	10.6	0.0	24.6	0.0	10.6	0.0	0.81
		Beam	16.7	1.9	40.1	6.2	23.0	1.7	31.8	6.6	0.7	0.6	
	150	Column	37.5	2.1	39.2	17.0	10.7	4.7	24.7	24.7	10.7	9.2	1.06
		Beam	16.7	5.8	40.3	16.2	23.0	6.4	31.6	4.4	1.2	0.8	
	200	Column	37.5	8.3	39.3	27.0	10.7	7.5	35.8	35.7	15.1	13.4	1.36
		Beam	16.7	9.6	40.4	26.2	23.0	11.2	31.4	8.0	0.3	1.4	
1:5.0	100	Column	38.7	0.0	41.4	0.0	11.1	0.0	25.0	0.0	11.1	0.0	0.75
		Beam	16.2	2.2	42.4	7.3	24.7	2.5	35.7	5.2	0.8	0.5	
	150	Column	38.8	3.5	41.6	18.7	11.1	5.1	25.1	25.1	11.1	9.5	1.02
		Beam	16.3	6.0	42.6	17.9	24.7	7.8	35.5	5.9	0.8	0.7	
	200	Column	38.7	10.2	41.7	29.4	11.1	8.0	35.9	36.2	15.3	13.9	1.30
		Beam	16.3	9.7	42.8	28.6	24.7	13.1	35.3	11.7	0.8	1.0	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 9 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 12.0 m Column height = 9.0 m Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch				Base/Crown				Sway
					Moment under		Shear under		Moment under		Shear under		
					Compression	Tension	Compression	Tension	Compression	Tension	Compression	Tension	
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	33.6	1.0	45.2	51.6	3.6	3.5	0.0	0.0	10.2	8.0	2.64
		Beam	9.9	8.6	63.3	71.9	18.3	12.8	27.1	10.7	1.0	11.3	
	150	Column	35.8	8.5	81.1	82.9	5.7	5.9	0.0	0.0	15.8	12.6	2.53
		Beam	10.2	14.6	104.9	113.8	19.0	22.5	28.2	11.3	16.1	17.1	
	200	Column	37.4	16.5	34.4	114.3	3.8	8.2	0.0	0.0	3.8	21.7	2.63
		Beam	12.3	20.7	135.7	155.9	19.6	32.2	29.0	11.8	21.4	22.9	
1/4.0	100	Column	34.9	2.2	44.1	51.7	3.8	3.5	0.0	0.0	10.1	8.0	2.47
		Beam	9.0	7.9	61.7	71.9	20.1	14.7	30.3	6.6	1.4	10.4	
	150	Column	36.4	10.8	35.3	83.2	3.9	5.9	0.0	0.0	3.9	15.8	2.63
		Beam	9.2	13.3	37.1	114.0	20.6	25.5	31.1	7.6	1.4	15.9	
	200	Column	38.7	18.8	36.5	114.3	4.1	8.2	0.0	0.0	4.1	21.4	2.47
		Beam	9.5	18.6	125.7	155.7	21.3	36.1	32.2	13.3	19.6	21.3	
1/5.0	100	Column	35.8	3.0	52.3	52.3	4.0	3.6	0.0	0.0	10.1	8.1	2.41
		Beam	8.3	7.4	61.6	72.7	21.2	16.0	32.5	4.1	1.7	10.0	
	150	Column	37.3	12.0	72.8	84.1	4.7	6.0	0.0	0.0	14.5	15.8	2.57
		Beam	8.5	12.4	98.6	115.2	21.8	27.4	33.3	11.4	1.7	15.3	
	200	Column	39.5	20.4	93.6	115.5	5.9	8.4	0.0	0.0	19.0	21.4	2.41
		Beam	8.8	17.3	39.9	157.4	22.5	38.7	34.4	18.4	1.8	20.6	

Fixed Base

1 3.0	100	Column	30.5	0.0	29.2	0.0	5.3	0.0	38.7	0.0	10.5	0.0	2.25
		Beam	11.1	6.0	30.3	23.8	16.7	5.9	23.7	8.1	3.4	1.4	
	150	Column	30.9	2.8	30.2	28.2	5.5	5.8	62.6	53.9	16.8	12.5	2.64
		Beam	11.3	11.1	31.1	40.6	16.6	11.9	22.2	7.1	0.3	4.9	
	200	Column	31.7	8.0	30.1	40.4	5.7	8.4	78.0	75.2	20.5	17.3	2.53
		Beam	11.6	16.2	32.3	56.9	16.7	17.7	21.6	6.8	5.7	6.3	
1 4.0	100	Column	31.9	0.0	31.6	0.0	5.6	0.0	37.8	0.0	10.5	0.0	2.07
		Beam	10.4	6.1	32.6	25.8	18.6	7.9	27.5	4.5	2.7	1.5	
	150	Column	32.2	4.9	32.8	30.7	5.8	6.0	61.1	53.3	16.8	12.7	2.46
		Beam	10.6	11.0	33.9	43.9	18.5	15.0	25.9	9.2	0.8	4.0	
	200	Column	32.7	11.0	34.0	43.7	6.1	8.7	61.5	75.3	13.5	17.7	2.60
		Beam	10.9	15.9	41.3	61.4	18.5	21.8	24.2	14.4	0.7	5.1	
1 5.0	100	Column	32.8	0.0	33.1	0.0	5.8	0.0	37.7	0.0	10.5	0.0	2.00
		Beam	9.9	6.0	34.2	27.3	19.8	9.2	30.0	5.7	2.4	1.6	
	150	Column	33.2	6.3	34.5	32.6	6.1	6.2	60.8	53.4	16.8	12.9	2.39
		Beam	10.1	10.8	35.6	46.4	19.8	16.9	28.4	12.9	1.1	3.6	
	200	Column	33.6	12.9	35.9	46.4	6.3	9.1	21.1	85.2	6.3	23.2	2.52
		Beam	10.4	15.6	43.2	65.0	19.7	24.5	26.6	19.3	1.1	4.6	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1 1.33 to account for increased allowable stresses.

TABLE 10 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 12.0 m Column height = 9.0 m Frame spacing = 6.0 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch				Base/Crown				Sway
					Moment under		Shear under		Moment under		Shear under		
					Compression	Tension	Compression	Tension	Compression	Tension	Compression	Tension	
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	43.9	2.0	75.5	70.4	5.4	4.8	0.0	0.0	14.4	10.8	2.54
		Beam	12.7	11.8	97.8	96.7	23.6	17.7	35.2	13.5	14.5	15.1	
	150	Column	46.1	12.6	106.3	112.4	7.3	8.0	0.0	0.0	20.8	21.5	2.59
		Beam	13.0	19.9	138.7	152.8	24.3	30.7	36.2	13.9	21.5	22.8	
	200	Column	48.4	23.3	43.1	154.7	4.8	11.2	0.0	0.0	4.8	29.2	2.59
		Beam	16.0	28.1	180.2	209.4	25.1	43.8	37.3	14.5	28.6	30.7	
1/4.0	100	Column	44.9	4.1	70.0	70.7	4.8	4.9	0.0	0.0	13.6	10.8	2.66
		Beam	11.4	10.9	90.7	97.0	25.7	20.4	39.0	7.5	13.4	13.9	
	150	Column	48.0	14.8	44.8	112.2	5.0	8.0	0.0	0.0	5.0	21.2	2.43
		Beam	11.8	18.0	48.1	152.5	26.8	34.5	40.6	11.1	1.9	21.2	
	200	Column	50.2	26.1	127.3	154.0	8.2	11.2	0.0	0.0	25.8	28.8	2.43
		Beam	12.2	25.2	166.6	208.5	27.5	48.8	41.7	19.1	26.1	28.4	
1/5.0	100	Column	46.1	5.2	67.9	71.6	5.0	5.0	0.0	0.0	13.3	10.9	2.59
		Beam	10.6	10.2	83.3	98.1	27.3	22.0	41.8	6.8	2.2	13.4	
	150	Column	49.2	16.4	46.8	113.4	5.2	8.1	0.0	0.0	5.2	21.2	2.38
		Beam	11.0	16.7	132.1	154.2	28.3	37.1	43.4	16.3	2.2	20.5	
	200	Column	51.4	28.2	123.0	155.6	7.7	11.3	0.0	0.0	25.1	28.8	2.37
		Beam	11.3	23.4	51.4	210.6	29.1	52.3	44.6	26.1	2.3	27.5	

Fixed Base

1/3.0	100	Column	39.7	0.0	37.6	0.0	6.8	0.0	52.9	0.0	14.3	0.0	2.40
		Beam	14.3	8.5	39.5	32.3	21.3	8.5	29.3	9.5	0.5	4.4	
	150	Column	40.3	4.1	39.2	37.8	7.2	8.0	86.2	74.5	22.8	16.9	2.60
		Beam	14.6	15.3	41.2	53.6	21.1	16.2	26.6	7.9	0.3	6.1	
	200	Column	41.3	11.1	40.1	53.9	7.3	11.5	119.1	103.2	31.2	23.4	2.56
		Beam	14.8	22.1	42.2	75.1	21.3	23.9	26.2	9.5	0.3	8.0	
1/4.0	100	Column	41.2	0.0	39.4	0.0	7.0	0.0	51.1	0.0	14.3	0.0	2.54
		Beam	13.2	8.5	41.3	35.8	23.9	11.3	36.1	5.7	3.7	2.1	
	150	Column	12.0	7.1	42.6	41.8	7.6	8.3	83.5	72.9	22.7	17.2	2.55
		Beam	13.8	15.1	44.6	58.9	23.7	20.4	31.9	12.9	1.0	5.1	
	200	Column	43.2	14.9	43.9	59.1	7.9	11.9	115.9	101.8	31.1	23.8	2.37
		Beam	14.1	21.6	46.0	82.1	23.8	29.5	30.7	19.7	5.4	6.6	
1/5.0	100	Column	42.4	0.3	41.4	26.1	7.2	4.8	50.9	44.3	14.3	10.8	2.47
		Beam	12.5	8.4	43.3	37.7	25.5	13.0	39.5	9.0	3.3	2.3	
	150	Column	43.2	9.0	44.9	44.5	7.9	8.6	70.0	73.2	18.7	17.5	2.48
		Beam	13.1	14.8	46.9	62.5	25.3	23.2	34.9	17.8	1.4	4.6	
	200	Column	44.5	17.4	45.8	63.3	8.1	12.3	26.8	114.6	8.1	31.3	2.64
		Beam	13.3	21.2	47.9	87.7	25.4	33.3	34.2	26.7	1.4	6.1	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 11 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 18.0 m Column height = 6.0 m Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch: Moment under Compression	Haunch: Moment under Tension	Haunch: Shear under Compression	Haunch: Shear under Tension	Base/Crown: Moment under Compression	Base/Crown: Moment under Tension	Base/Crown: Shear under Compression	Base/Crown: Shear under Tension	Sway
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	38.6	0.0	67.8	0.0	11.3	0.0	0.0	0.0	11.3	0.0	1.56
		Beam	19.9	1.0	68.7	12.1	24.0	0.3	42.5	6.9	2.1	0.8	
	150	Column	38.9	2.0	68.0	32.1	11.3	3.7	0.0	0.0	11.3	7.0	1.81
		Beam	20.0	5.3	69.0	31.4	24.1	5.1	42.8	13.1	3.0	1.0	
	200	Column	39.8	7.8	69.2	50.7	11.5	6.2	0.0	0.0	11.5	10.7	1.73
		Beam	20.3	9.3	70.2	49.9	24.5	9.6	43.6	12.4	0.5	3.9	
1/4.0	100	Column	40.1	0.0	73.4	0.0	12.2	0.0	0.0	0.0	12.2	0.0	1.56
		Beam	19.3	1.7	74.3	14.5	26.7	1.9	51.0	11.2	1.3	0.6	
	150	Column	40.7	4.5	74.0	35.2	12.3	4.2	0.0	0.0	12.3	7.5	1.64
		Beam	19.4	5.8	75.0	34.5	26.9	7.4	51.5	8.1	2.0	0.9	
	200	Column	41.5	11.1	75.1	54.8	12.5	6.9	0.0	0.0	12.5	11.4	1.63
		Beam	19.7	9.8	76.1	54.0	27.4	12.8	52.4	11.0	0.3	2.7	
1/5.0	100	Column	42.0	0.0	77.8	0.0	13.0	0.0	0.0	0.0	13.0	0.0	1.42
		Beam	19.0	2.0	78.7	16.0	28.6	2.8	56.8	9.0	0.9	0.6	
	150	Column	42.0	6.0	78.2	37.6	13.0	4.6	0.0	0.0	13.0	7.9	1.54
		Beam	19.1	6.1	79.2	36.9	28.9	8.9	57.7	7.9	1.5	0.9	
	200	Column	42.3	13.5	78.5	58.7	13.1	7.6	0.0	0.0	13.1	12.0	1.78
		Beam	19.2	10.2	79.6	58.0	29.0	15.1	58.1	16.9	0.9	2.2	

							Fixed Base						
1 3.0	100	Column	38.8	0.0	60.5	0.0	17.6	0.0	44.9	0.0	17.6	0.0	0.76
		Beam	25.8	0.0	61.2	0.0	21.7	0.0	30.0	5.2	2.5	0.4	
	150	Column	38.7	0.0	60.1	0.0	17.4	0.0	44.1	0.0	17.4	0.0	0.87
		Beam	25.6	4.9	60.7	12.4	21.8	3.3	30.9	1.8	2.5	1.1	
	200	Column	38.7	5.8	59.9	24.9	17.3	7.4	43.8	32.9	17.3	11.9	1.06
		Beam	25.5	9.8	60.6	24.4	21.8	7.2	31.3	8.5	2.4	1.7	
1 4.0	100	Column	41.0	0.0	69.1	0.0	19.5	0.0	48.1	0.0	19.5	0.0	−0.66
		Beam	26.4	0.2	69.7	3.0	25.0	0.7	39.5	2.6	1.4	0.6	
	150	Column	40.9	2.4	68.7	17.6	19.4	4.9	47.5	22.1	19.4	8.3	0.61
		Beam	26.2	6.1	69.3	17.1	25.0	5.6	40.0	6.0	1.4	1.2	
	200	Column	40.9	9.0	68.8	31.5	19.4	8.9	47.5	35.1	19.4	13.3	0.85
		Beam	26.2	11.3	69.5	31.0	25.0	10.4	39.9	9.1	1.4	1.7	
1 5.0	100	Column	42.4	0.0	74.8	0.0	20.8	0.0	49.7	0.0	20.8	0.0	−0.56
		Beam	26.6	1.7	75.5	3.0	27.1	0.3	46.0	0.8	0.6	0.5	
	150	Column	42.3	4.0	74.6	20.9	20.6	5.7	49.2	23.3	20.6	9.0	0.54
		Beam	26.5	6.9	75.3	8.2	27.1	4.1	46.6	6.7	0.6	0.8	
	200	Column	42.3	11.1	74.4	36.3	20.5	9.9	48.9	36.4	20.5	14.4	0.77
		Beam	26.4	12.2	75.1	19.3	27.2	8.5	47.0	14.4	0.6	1.2	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 12 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 18.0 m Column height = 6.0 m Frame spacing = 6.0 m

Roof Slope	Basic Wind Pressure (kg/m²)	Member	Compression (kN)	Tension (kN)	Haunch: Moment under Compression (kN.m)	Haunch: Moment under Tension (kN.m)	Haunch: Shear under Compression (kN)	Haunch: Shear under Tension (kN)	Base/Crown: Moment under Compression (kN.m)	Base/Crown: Moment under Tension (kN.m)	Base/Crown: Shear under Compression (kN)	Base/Crown: Shear under Tension (kN)	Sway (cm)
					Hinged Base								
1/3.0	100	Column	49.9	0.0	86.0	0.0	14.3	0.0	0.0	0.0	14.3	0.0	1.71
		Beam	25.3	2.2	87.6	18.9	30.7	1.4	55.0	7.4	2.7	1.0	
	150	Column	50.6	3.6	86.9	45.2	14.5	5.3	0.0	0.0	14.5	9.8	1.73
		Beam	25.6	7.7	88.7	43.9	31.1	7.6	55.8	16.1	4.0	1.4	
	200	Column	52.0	11.2	88 7	69.8	14.8	8.6	0.0	0.0	14.8	14.6	1.60
		Beam	26.2	13.1	90.5	68.4	31.7	13.6	57.0	15.3	0.6	5.2	
1/4.0	100	Column	52.7	0.0	93.9	0.0	15.7	0.0	0.0	0.0	15.7	0.0	1.55
		Beam	24.8	2.9	95.6	21.5	34.5	3.4	66.4	13.4	1.7	0.9	
	150	Column	52.6	7.3	94.3	49.7	15.7	6.0	0.0	0.0	15.7	10.5	1.83
		Beam	24.9	8.5	96.1	48.3	34.7	10.8	66.9	9.0	2.7	1.2	
	200	Column	53.4	16.3	95.2	76.2	15.9	9.7	0.0	0.0	15.9	15.7	1.84
		Beam	25.1	13.9	97.0	74.8	35.0	18.2	67.7	17.1	4.0	3.6	
1/5.0	100	Column	54.3	0.0	101.8	0.0	17.0	0.0	0.0	0.0	17.0	0.0	1.51
		Beam	24.6	3.4	103.5	24.2	36.7	4.8	70.0	9.6	1.3	0.7	
	150	Column	54.3	9.3	99.6	53.1	16.6	6.6	0.0	0.0	16.6	11.1	1.72
		Beam	24.4	8.8	101.3	51.8	37.1	12.9	74.8	12.8	2.1	1.2	
	200	Column	55.2	19.0	100.6	80.7	16.8	10.5	0.0	0.0	16.8	16.4	1.73
		Beam	24.6	14.1	102.5	79.3	37.6	20.9	75.8	24.6	1.3	2.9	

Fixed Base

1/3.0	100	Column	49.9	0.0	77.6	0.0	22.6	0.0	57.8	0.0	22.6	0.0	0.78
		Beam	33.0	1.0	78.7	2.7	27.7	0.1	37.2	5.5	3.3	0.6	
	150	Column	49.8	1.3	77.2	19.7	22.4	6.0	57.0	29.6	22.4	10.5	0.88
		Beam	32.8	7.7	78.4	18.9	27.7	5.3	37.8	1.2	3.2	1.6	
	200	Column	49.8	9.1	77.1	35.8	22.3	10.7	56.6	46.3	22.3	16.7	1.14
		Beam	32.7	14.2	78.3	34.9	27.7	10.5	38.3	9.6	3.2	2.4	
1/4.0	100	Column	53.4	0.0	89.2	0.0	25.2	0.0	61.9	0.0	25.2	0.0	−0.58
		Beam	34.0	2.1	90.3	6.1	32.2	1.7	50.6	2.2	1.8	0.9	
	150	Column	53.2	4.2	88.7	25.8	24.9	7.2	61.0	31.0	24.9	11.7	0.58
		Beam	33.8	9.0	89.8	24.9	32.2	8.2	51.4	6.6	1.8	1.6	
	200	Column	53.2	13.0	88.3	44.3	24.8	12.4	60.4	47.9	24.8	18.4	0.83
		Beam	33.6	15.8	89.5	43.4	32.3	14.7	52.1	13.7	1.8	2.3	
1/5.0	100	Column	55.1	0.0	96.3	0.0	26.6	0.0	63.4	0.0	26.6	0.0	0.51
		Beam	34.2	3.1	97.4	1.8	35.0	0.4	59.8	0.4	0.7	0.7	
	150	Column	54.9	6.5	96.0	30.6	26.5	8.3	62.8	32.6	26.5	12.8	0.56
		Beam	34.0	10.2	97.2	13.4	35.0	6.4	60.0	10.6	0.7	1.1	
	200	Column	54.8	16.0	95.9	51.2	26.4	13.9	62.5	50.2	26.4	19.9	0.79
		Beam	33.9	17.2	97.1	28.6	35.0	12.3	60.0	20.8	0.7	1.6	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 13 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 18.0 m Column height = 9.0 m Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch				Base/Crown				Sway
					Moment under		Shear under		Moment under		Shear under		
					Compression	Tension	Compression	Tension	Compression	Tension	Compression	Tension	
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
Hinged Base													
1/3.0	100	Column	44.6	0.0	72.7	0.0	8.1	0.0	0.0	0.0	11.0	0.0	2.54
		Beam	17.3	8.9	80.7	77.7	26.3	10.9	53.3	18.0	7.7	7.6	
	150	Column	46.6	7.5	74.8	90.9	8.3	6.7	0.0	0.0	15.5	13.5	2.66
		Beam	17.8	16.4	100.9	130.0	27.1	21.1	55.0	17.3	0.7	11.6	
	200	Column	49.2	15.8	108.1	129.3	8.6	9.9	0.0	0.0	19.2	18.8	2.49
		Beam	18.4	23.8	134.6	181.8	28.1	31.2	57.1	16.9	15.1	15.5	
1/4.0	100	Column	45.8	1.3	77.4	54.2	8.6	3.8	0.0	0.0	9.4	8.3	2.66
		Beam	16.1	8.8	79.2	80.4	28.8	13.8	60.8	9.9	1.4	6.5	
	150	Column	47.6	11.1	79.2	94.0	8.8	7.1	0.0	0.0	13.5	13.8	2.70
		Beam	16.5	15.9	100.5	133.8	29.6	25.6	62.4	20.2	1.4	9.9	
	200	Column	49.5	20.9	92.9	133.6	9.0	10.4	0.0	0.0	17.1	21.6	2.71
		Beam	16.9	22.9	83.2	187.1	30.3	37.3	64.0	33.8	1.4	13.4	
1/5.0	100	Column	47.0	2.7	80.8	56.3	9.0	4.0	0.0	0.0	9.5	8.5	2.55
		Beam	15.3	8.7	82.6	83.1	30.6	15.7	66.0	11.9	5.9	5.0	
	150	Column	49.0	13.0	83.0	96.8	9.2	7.4	0.0	0.0	12.8	14.1	2.60
		Beam	15.7	15.4	86.5	137.6	31.4	28.4	67.9	28.2	8.4	9.2	
	200	Column	50.8	23.4	86.6	137.4	9.4	10.8	0.0	0.0	16.1	21.7	2.61
		Beam	16.1	22.1	86.9	192.2	32.2	41.1	69.6	44.8	1.9	12.5	

Fixed Base

1 3.0	100	Column	41.0	0.0	63.4	0.0	11.8	0.0	42.6	0.0	11.8	0.0	1.98
		Beam	20.3	7.8	64.6	30.2	23.5	6.7	43.8	13.0	2.3	1.2	
	150	Column	41.4	5.0	65.3	37.2	12.2	7.5	61.5	60.6	16.4	14.2	2.25
		Beam	20.7	15.6	66.5	57.0	23.4	14.4	40.8	10.5	0.8	3.2	
	200	Column	41.8	12.6	67.0	56.7	12.6	11.7	89.9	88.8	23.4	20.6	2.44
		Beam	21.1	23.6	68.3	83.1	23.3	21.8	37.6	14.4	1.0	3.8	
1, 4.0	100	Column	43.0	0.0	69.7	0.0	12.7	0.0	44.2	0.0	12.7	0.0	1.70
		Beam	19.7	8.4	70.9	35.3	26.6	9.6	53.5	8.4	1.4	1.1	
	150	Column	43.1	8.6	70.0	43.7	12.7	8.1	59.5	59.7	16.6	14.8	2.37
		Beam	19.7	16.1	71.2	65.5	26.6	19.1	53.3	22.0	0.2	2.1	
	200	Column	43.5	17.3	72.9	66.3	13.3	12.6	56.9	87.5	13.3	21.6	2.47
		Beam	20.3	24.1	74.2	96.0	26.5	28.3	48.8	32.4	0.1	2.5	
1 5.0	100	Column	45.1	0.4	74.3	23.6	13.3	4.3	45.2	35.4	13.3	8.8	1.54
		Beam	19.3	8.7	75.5	38.9	28.6	11.4	59.6	13.4	0.9	0.9	
	150	Column	44.4	10.8	73.9	48.0	13.2	8.7	59.8	60.7	16.9	15.4	2.26
		Beam	19.2	16.3	75.2	71.3	28.5	22.1	59.8	30.5	0.9	1.5	
	200	Column	45.4	19.8	75.9	72.4	13.6	13.2	46.3	87.1	13.6	24.1	2.46
		Beam	19.6	24.1	77.2	104.0	28.5	32.5	57.4	45.4	0.8	2.0	

NOTE — Wherever design is governed by *DL* + *WL* combination, the corresponding design forces have been multiplied by 1 1.33 to account for increased allowable stresses.

TABLE 14 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 18.0 m Column height = 9.0 m Frame spacing = 6.0 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch: Moment under Compression	Haunch: Moment under Tension	Haunch: Shear under Compression	Haunch: Shear under Tension	Base/Crown: Moment under Compression	Base/Crown: Moment under Tension	Base/Crown: Shear under Compression	Base/Crown: Shear under Tension	Sway
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	57.3	0.0	91.7	0.0	10.2	0.0	0.0	0.0	14.3	0.0	2.71
		Beam	22.0	12.6	104.7	106.4	33.6	15.6	68.7	21.8	10.2	10.2	
	150	Column	60.9	10.9	113.4	123.9	10.6	9.3	0.0	0.0	19.8	18.2	2.44
		Beam	22.9	22.4	141.1	175.2	35.1	29.0	71.7	21.4	15.2	15.5	
	200	Column	63.7	22.6	140.8	175.5	10.9	13.5	0.0	0.0	25.3	25.5	2.44
		Beam	23.6	32.4	177.0	244.7	36.2	42.5	74.0	23.0	20.1	20.7	
1/4.0	100	Column	59.1	3.2	98.0	75.6	10.9	5.4	0.0	0.0	12.9	11.4	2.75
		Beam	20.5	12.4	101.3	109.8	37.0	19.5	78.5	11.4	8.6	8.7	
	150	Column	61.9	16.0	101.0	128.1	11.2	9.8	0.0	0.0	17.7	18.7	2.65
		Beam	21.1	21.7	121.5	180.4	38.2	35.0	81.1	29.4	12.6	13.3	
	200	Column	63.6	29.6	102.6	181.7	11.4	14.2	0.0	0.0	11.4	29.2	2.76
		Beam	21.5	31.2	106.2	252.2	38.8	51.0	82.5	48.3	1.9	17.9	
1/5.0	100	Column	60.9	5.0	102.9	78.1	11.4	5.7	0.0	0.0	12.2	11.7	2.64
		Beam	19.5	12.1	106.1	113.1	39.4	21.9	85.7	18.3	7.7	8.0	
	150	Column	63.6	18.7	105.6	132.2	11.7	10.2	0.0	0.0	16.7	21.2	2.55
		Beam	20.1	21.0	138.3	185.7	40.5	38.9	88.1	40.5	2.5	12.3	
	200	Column	65.3	33.0	107.5	186.7	11.9	14.8	0.0	0.0	11.9	29.4	2.66
		Beam	20.4	30.1	138.9	258.9	41.3	56.0	89.8	63.2	14.6	16.7	

Fixed Base

1:3.0	100	Column	53.4	0.0	80.5	0.0	14.9	0.0	54.0	0.0	14.9	0.0	2.22
		Beam	25.8	11.3	82.7	42.8	30.0	9.9	55.7	15.3	0.9	3.0	
	150	Column	53.1	8.3	82.7	52.7	15.4	10.6	84.2	82.6	22.4	19.5	2.62
		Beam	26.2	21.8	84.9	78.6	29.9	20.2	52.2	13.0	1.0	4.2	
	200	Column	54.3	18.0	84.9	78.8	15.9	16.0	120.8	118.8	31.8	27.9	2.49
		Beam	26.8	32.2	87.2	113.7	30.0	30.1	49.8	21.8	1.1	5.2	
1/4.0	100	Column	56.4	0.0	90.5	0.0	16.4	0.0	57.5	0.0	16.4	0.0	1.78
		Beam	25.5	12.0	92.7	49.4	34.1	13.7	66.5	12.9	0.2	1.8	
	150	Column	55.7	12.8	90.5	61.3	16.4	11.5	82.1	82.2	22.7	20.4	2.54
		Beam	25.4	22.4	92.7	90.1	34.0	26.4	66.1	30.6	0.2	2.7	
	200	Column	57.5	23.6	92.9	90.9	16.9	17.1	116.4	116.7	32.1	29.0	2.43
		Beam	26.0	32.6	95.2	129.9	34.3	38.6	64.8	46.2	0.2	3.5	
1/5.0	100	Column	58.3	1.8	96.8	34.5	17.3	6.4	59.0	49.6	17.3	12.3	1.63
		Beam	25.0	12.4	98.9	54.6	36.6	16.3	73.8	19.5	1.1	1.2	
	150	Column	57.5	15.6	96.1	67.0	17.2	12.2	82.3	83.3	23.1	21.2	2.42
		Beam	24.8	22.6	98.4	97.8	36.6	30.4	74.6	41.8	1.1	2.0	
	200	Column	59.2	27.5	96.5	98.5	17.2	17.9	58.3	116.0	17.2	32.5	2.39
		Beam	25.0	32.4	98.8	140.0	37.1	44.2	76.5	64.1	1.1	2.8	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 15 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 18.0 m   Column height = 12.0 m   Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch: Moment under Compression	Haunch: Moment under Tension	Haunch: Shear under Compression	Haunch: Shear under Tension	Base/Crown: Moment under Compression	Base/Crown: Moment under Tension	Base/Crown: Shear under Compression	Base/Crown: Shear under Tension	Sway
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
						Hinged Base							
1/3.0	100	Column	51.3	0.0	108.3	0.0	6.3	0.0	0.0	0.0	14.8	0.0	3.39
		Beam	16.0	10.9	136.2	127.9	28.1	15.3	60.9	23.6	13.1	13.4	
	150	Column	54.0	8.6	126.9	148.4	6.5	7.9	0.0	0.0	21.0	16.8	3.65
		Beam	16.5	19.4	189.4	206.5	29.0	28.3	62.8	24.1	19.4	20.3	
	200	Column	59.2	17.1	190.8	205.0	9.9	11.1	0.0	0.0	27.4	23.0	3.25
		Beam	17.6	27.4	244.5	283.1	30.8	40.5	66.8	26.0	25.7	27.3	
1/4.0	100	Column	52.2	0.8	99.4	91.1	6.7	4.6	0.0	0.0	13.8	10.6	3.47
		Beam	14.5	10.4	106.8	129.4	30.5	18.4	67.5	14.3	1.9	12.2	
	150	Column	55.5	11.6	124.1	149.4	6.9	8.0	0.0	0.0	20.8	16.9	3.53
		Beam	15.0	17.9	173.9	207.6	31.7	32.6	70.2	16.4	2.0	18.5	
	200	Column	58.7	22.5	85.9	207.6	7.2	11.3	0.0	0.0	7.2	28.4	3.52
		Beam	15.6	25.4	221.6	285.9	32.8	46.8	72.7	29.4	23.0	24.9	
1/5.0	100	Column	53.5	2.1	95.9	92.8	6.9	4.7	0.0	0.0	13.4	10.7	3.37
		Beam	13.5	9.9	120.1	131.5	32.2	20.2	72.5	8.9	11.2	10.4	
	150	Column	56.7	13.6	130.8	152.0	7.2	8.2	0.0	0.0	19.0	20.8	3.44
		Beam	14.0	16.9	174.4	211.0	33.3	35.5	75.0	25.0	2.5	17.7	
	200	Column	59.8	25.1	89.0	211.1	7.4	11.6	0.0	0.0	7.4	28.4	3.43
		Beam	14.5	23.9	212.2	290.5	34.5	50.7	77.6	40.9	21.7	23.9	

Fixed Base

1/3.0	100	Column	44.3	0.0	66.9	0.0	9.2	0.0	68.6	0.0	13.8	0.0	3.07
		Beam	17.8	8.5	68.9	43.7	24.4	8.0	47.3	15.4	3.8	1.6	
	150	Column	45.0	3.8	69.2	51.7	9.6	8.2	113.7	101.0	22.4	7.2	3.44
		Beam	18.2	16.2	71.2	76.1	24.3	16.3	44.0	13.0	0.0	5.4	
	200	Column	46.6	10.9	71.1	75.0	9.9	12.2	159.8	142.7	31.0	24.1	3.22
		Beam	18.6	23.7	73.2	107.5	24.4	24.3	42.4	14.4	0.1	6.8	
1/4.0	100	Column	45.9	0.0	70.6	0.0	9.4	0.0	66.3	0.0	13.8	0.0	3.19
		Beam	16.6	8.8	72.6	49.7	27.4	11.1	59.1	8.6	3.0	1.4	
	150	Column	47.0	7.1	75.7	58.2	10.2	8.7	111.0	100.1	22.4	17.7	3.19
		Beam	17.3	16.3	77.8	84.9	27.2	20.9	52.2	19.9	0.8	4.2	
	200	Column	48.6	15.4	77.1	85.1	10.5	12.9	155.4	140.8	31.1	24.8	3.44
		Beam	17.6	23.7	79.3	120.9	27.2	30.8	50.6	31.5	0.8	5.4	
1/5.0	100	Column	47.2	0.0	74.3	0.0	9.8	0.0	66.2	0.0	13.9	0.0	3.06
		Beam	15.9	8.8	76.3	53.2	29.3	13.0	65.1	13.5	2.6	1.5	
	150	Column	47.8	9.7	78.0	63.8	10.3	9.1	109.3	99.2	22.6	18.1	3.46
		Beam	16.4	16.1	80.1	92.1	29.1	24.2	59.9	29.1	1.4	3.8	
	200	Column	50.1	18.1	81.3	91.8	10.8	13.4	48.5	153.5	10.8	31.3	3.25
		Beam	16.9	23.4	83.4	129.9	29.3	34.9	57.2	42.7	1.4	4.8	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 16 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 18.0 m   Column height = 12.0 m   Frame spacing = 6.0 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch				Base/Crown				Sway
					Moment under		Shear under		Moment under		Shear under		
					Compression	Tension	Compression	Tension	Compression	Tension	Compression	Tension	
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	65.9	0.0	140.2	0.0	7.9	0.0	0.0	0.0	19.4	0.0	3.45
		Beam	20.3	15.4	178.4	173.5	35.9	21.7	78.1	28.9	17.4	17.9	
	150	Column	71.8	11.6	171.4	200.0	8.4	10.7	0.0	0.0	28.2	22.6	3.21
		Beam	21.5	26.2	106.3	276.3	38.0	38.2	82.7	31.0	1.9	27.1	
	200	Column	75.4	25.5	104.0	277.9	8.7	15.2	0.0	0.0	8.7	38.5	3.32
		Beam	22.2	37.4	109.8	380.9	39.3	55.4	85.5	31.6	1.9	36.4	
1/4.0	100	Column	68.6	1.8	102.2	124.3	8.5	6.4	0.0	0.0	17.8	14.3	3.20
		Beam	18.7	14.2	144.2	174.1	39.6	25.3	88.3	17.3	2.6	16.2	
	150	Column	71.8	17.2	177.7	202.9	8.9	10.9	0.0	0.0	25.9	22.9	3.46
		Beam	19.2	24.4	228.1	279.4	40.7	44.6	90.6	24.9	23.2	24.8	
	200	Column	78.0	30.2	110.5	279.1	9.2	15.3	0.0	0.0	9.2	38.1	3.10
		Beam	20.2	34.2	116.3	382.3	42.9	63.0	95.6	41.2	2.8	33.3	
1/[illegible].0	100	Column	68.2	5.2	104.4	128.2	8.7	6.7	0.0	0.0	17.9	14.7	3.69
		Beam	17.1	13.8	146.2	178.8	41.1	28.4	92.9	15.5	3.1	15.5	
	150	Column	73.5	19.6	109.2	206.1	9.1	11.2	0.0	0.0	9.1	28.0	3.37
		Beam	17.9	23.0	234.9	283.6	43.0	48.4	97.3	36.2	3.2	23.7	
	200	Column	76.1	36.2	111.5	285.9	9.3	15.9	0.0	0.0	9.3	38.[illegible]	3.59
		Beam	18.3	32.6	117.3	390.5	44.0	69.1	99.4	58.7	3.3	32.0	

Fixed Base

1/3.0	100	Column	57.0	0.0	84.7	0.0	11.6	0.0	93.6	0.0	18.8	0.0	3.51
		Beam	22.6	12.2	88.2	60.8	31.2	11.7	60.6	18.5	0.2	5.1	
	150	Column	58.4	6.4	87.2	72.9	12.0	11.4	152.6	135.2	30.3	23.3	3.52
		Beam	23.1	22.3	90.8	104.9	31.2	22.8	57.9	15.9	0.1	7.3	
	200	Column	59.8	16.5	89.7	104.1	12.4	16.6	214.5	190.9	41.8	32.5	3.56
		Beam	23.5	32.4	93.5	146.9	31.3	33.5	55.1	21.6	0.0	9.2	
1/4.0	100	Column	59.6	0.0	91.5	0.0	12.2	0.0	91.0	0.0	18.8	0.0	3.38
		Beam	21.4	12.4	94.9	68.2	35.1	15.7	73.6	12.9	4.0	1.8	
	150	Column	60.9	10.7	97.5	80.1	13.2	12.1	151.6	136.7	30.4	24.0	3.41
		Beam	22.3	22.4	101.1	114.8	34.8	28.8	65.3	28.0	1.0	5.4	
	200	Column	63.5	21.6	98.4	116.7	13.3	17.4	208.0	187.9	41.8	33.3	3.24
		Beam	22.5	32.1	102.2	163.7	35.3	42.0	66.4	44.4	1.1	7.3	
1/5.0	100	Column	61.4	1.1	96.6	49.2	12.8	6.9	90.8	81.7	19.0	14.9	3.27
		Beam	20.5	12.4	100.0	73.1	35.5	18.3	81.2	20.0	3.4	2.0	
	150	Column	62.1	14.0	101.4	87.5	13.5	12.7	149.5	135.8	30.6	24.6	3.60
		Beam	21.2	22.2	105.1	124.6	37.3	33.1	74.4	39.8	1.8	4.9	
	200	Column	64.9	25.9	101.9	126.3	13.5	18.0	59.9	203.1	13.5	42.0	3.36
		Beam	21.4	31.5	105.7	176.5	38.0	47.8	77.5	61.5	1.9	6.9	

NOTE — Wherever design is governed by *DL* + *WL* combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses

TABLE 17 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 24.0 m   Column height = 9.0 m   Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch: Moment under Compression	Haunch: Moment under Tension	Haunch: Shear under Compression	Haunch: Shear under Tension	Base/Crown: Moment under Compression	Base/Crown: Moment under Tension	Base/Crown: Shear under Compression	Base/Crown: Shear under Tension	Sway
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	56.3	0.0	129.2	0.0	14.4	0.0	0.0	0.0	14.4	0.0	2.57
		Beam	26.6	9.7	131.1	84.5	34.3	10.2	84.5	27.0	6.1	2.7	
	150	Column	58.5	7.7	132.6	100.6	14.7	7.8	0.0	0.0	14.7	14.5	2.63
		Beam	27.3	19.4	134.5	151.0	35.2	21.7	86.9	24.8	0.2	8.8	
	200	Column	61.7	17.4	137.9	148.3	15.3	12.0	0.0	0.0	21.0	20.9	2.47
		Beam	28.4	28.8	140.0	215.9	36.7	32.8	90.6	25.8	0.2	11.7	
1/4.0	100	Column	57.3	1.4	136.5	58.0	15.2	4.2	0.0	0.0	15.2	8.7	2.56
		Beam	25.0	10.6	138.4	92.7	37.3	14.5	97.8	13.8	0.9	4.4	
	150	Column	59.5	13.0	140.0	109.3	15.6	8.8	0.0	0.0	15.6	15.5	2.58
		Beam	25.6	20.0	142.0	161.8	38.3	28.0	100.5	35.3	0.9	6.7	
	200	Column	61.6	24.7	143.6	160.5	16.0	13.4	0.0	0.0	16.0	22.3	2.61
		Beam	26.3	29.4	145.6	230.9	39.3	41.4	103.2	58.0	0.9	9.0	
1/5.0	100	Column	58.3	3.8	142.5	62.7	15.8	4.7	0.0	0.0	15.8	9.2	2.68
		Beam	24.0	10.9	144.3	98.7	39.5	17.2	107.5	22.0	3.7	2.6	
	150	Column	60.3	16.4	145.5	116.4	16.2	9.6	0.0	0.0	16.2	16.3	2.77
		Beam	24.6	20.1	147.4	171.0	40.4	32.0	110.0	50.1	1.7	5.8	
	200	Column	62.4	29.0	149.0	169.6	16.6	14.4	0.0	0.0	16.6	23.3	2.73
		Beam	25.2	29.3	151.0	242.8	41.4	46.8	112.8	78.1	1.7	7.8	

Fixed Base

1 3.0	100	Column	53.3	0.0	112.5	0.0	21.6	0.0	82.2	0.0	21.6	0.0	1.54
		Beam	32.8	9.9	113.8	36.8	29.9	7.3	57.5	17.0	2.8	1.6	
	150	Column	53.2	6.8	112.5	47.9	21.6	9.7	81.8	69.6	21.6	16.4	1.98
		Beam	32.7	21.2	113.8	77.4	29.9	16.9	57.8	14.2	2.7	2.9	
	200	Column	52.5	17.7	112.6	78.3	21.6	15.7	89.3	103.4	23.4	24.7	2.62
		Beam	32.7	32.5	114.0	117.9	29.9	26.3	57.6	21.8	2.7	4.3	
1 4.0	100	Column	55.8	0.0	125.6	0.0	23.5	0.0	85.5	0.0	23.5	0.0	1.10
		Beam	32.7	11.7	126.9	48.1	33.9	11.3	74.9	12.0	1.3	1.6	
	150	Column	55.7	11.5	125.5	60.7	23.4	11.5	85.2	72.6	23.4	18.2	1.63
		Beam	32.6	23.3	126.9	94.8	33.9	23.1	74.8	31.5	1.3	2.7	
	200	Column	54.5	24.2	123.8	95.9	23.0	17.9	83.2	105.8	23.0	26.9	2.49
		Beam	32.2	34.7	125.2	141.4	33.9	35.0	76.8	52.9	1.2	3.6	
1 5.0	100	Column	58.1	1.1	135.6	30.3	24.8	5.5	87.7	39.7	24.8	10.0	0.88
		Beam	32.7	12.4	136.9	22.3	36.9	8.4	87.8	19.9	0.2	1.5	
	150	Column	57.8	14.0	135.1	69.0	24.7	12.6	87.1	74.6	24.7	19.3	1.39
		Beam	32.5	24.3	136.5	57.5	36.8	19.1	87.4	45.3	0.2	2.3	
	200	Column	56.2	28.0	132.4	107.4	24.1	19.5	84.5	108.3	24.1	28.4	2.31
		Beam	31.9	35.9	133.8	90.9	36.6	29.9	89.4	73.2	0.1	3.1	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 18 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 24.0 m Column height = 9.0 m Frame spacing = 6.0 m

Roof Slope	Basic Wind Pressure (kg/m²)	Member	Compression (kN)	Tension (kN)	Haunch: Moment under Compression (kN.m)	Haunch: Moment under Tension (kN.m)	Haunch: Shear under Compression (kN)	Haunch: Shear under Tension (kN)	Base/Crown: Moment under Compression (kN.m)	Base/Crown: Moment under Tension (kN.m)	Base/Crown: Shear under Compression (kN)	Base/Crown: Shear under Tension (kN)	Sway (cm)
Hinged Base													
1/3.0	100	Column	72.1	0.0	163.3	0.0	18.1	0.0	0.0	0.0	18.1	0.0	2.73
		Beam	33.7	14.1	166.7	118.1	43.8	15.1	108.8	32.5	0.2	7.8	
	150	Column	76.4	11.5	170.1	138.3	18.9	10.9	0.0	0.0	18.9	19.8	2.41
		Beam	35.1	26.7	173.6	204.7	45.6	30.0	113.6	30.7	12.3	11.7	
	200	Column	79.6	25.2	175.3	203.2	19.5	16.6	0.0	0.0	22.4	28.5	2.41
		Beam	36.2	39.5	179.0	292.3	47.1	45.1	117.3	38.7	16.5	15.5	
1/4.0	100	Column	73.9	3.7	173.7	82.8	19.3	6.2	0.0	0.0	19.3	12.2	2.63
		Beam	31.9	15.1	177.1	128.2	47.9	20.7	126.6	20.9	1.2	5.8	
	150	Column	77.1	19.0	178.7	150.7	19.9	12.3	0.0	0.0	20.6	21.2	2.54
		Beam	32.8	27.5	182.2	219.9	49.4	38.6	130.5	51.2	1.2	8.9	
	200	Column	79.2	35.2	182.1	219.8	20.2	18.5	0.0	0.0	20.2	30.4	2.66
		Beam	33.4	40.2	185.8	312.7	50.3	56.8	133.2	82.6	1.2	12.0	
1/5.0	100	Column	76.3	6.1	183.2	87.8	20.4	6.8	0.0	0.0	20.4	12.7	2.46
		Beam	31.0	15.2	186.6	135.0	51.3	23.9	140.6	32.6	2.2	4.9	
	150	Column	78.4	23.3	186.3	159.7	20.7	13.3	0.0	0.0	20.7	22.2	2.66
		Beam	31.6	27.6	189.9	231.6	52.3	43.9	143.3	71.0	2.2	7.7	
	200	Column	81.6	39.8	191.6	230.1	21.3	19.6	0.0	0.0	21.3	31.5	2.52
		Beam	32.5	39.7	195.2	326.6	53.8	63.5	147.6	108.4	2.3	10.5	

Fixed Base

1/30	100	Column	68.8	0.0	143.6	0.0	27.5	0.0	103.8	0.0	27.5	0.0	1.50
		Beam	41.8	14.4	145.9	53.1	38.5	10.9	75.6	20.8	3.4	2.2	
	150	Column	68.8	10.7	143.7	68.2	27.5	13.7	103.5	95.2	27.5	22.6	1.98
		Beam	41.8	29.4	146.1	107.0	38.5	23.6	75.5	17.1	3.4	4.0	
	200	Column	68.2	25.0	143.6	108.8	27.4	21.6	121.6	139.4	32.0	33.5	2.61
		Beam	41.7	44.3	146.1	161.0	38.5	36.3	76.0	32.7	3.4	5.7	
1/40	100	Column	72.6	0.8	161.2	38.3	30.0	7.2	108.6	53.4	30.0	13.2	1.04
		Beam	41.9	16.5	163.5	67.6	43.9	16.1	98.4	18.8	1.6	2.2	
	150	Column	72.2	16.8	160.6	85.3	29.8	16.0	107.8	98.7	29.8	24.9	1.60
		Beam	41.7	31.9	163.0	130.1	43.8	31.9	98.1	45.5	1.6	3.5	
	200	Column	72.7	32.3	159.0	130.4	29.4	24.1	105.3	140.6	29.4	36.1	2.01
		Beam	41.3	46.6	161.5	190.1	44.3	47.6	103.7	75.5	1.4	4.6	
1/50	100	Column	75.2	3.1	173.3	45.1	31.6	8.2	110.9	55.5	31.6	14.2	0.89
		Beam	41.7	17.6	175.6	33.6	47.7	12.4	115.1	30.2	0.2	2.0	
	150	Column	72.9	21.8	172.5	98.1	31.4	17.9	110.4	103.1	31.4	26.8	1.82
		Beam	41.4	33.8	174.9	83.0	47.0	27.1	110.9	64.0	0.3	3.0	
	200	Column	73.6	38.3	171.5	147.5	31.1	26.7	108.7	146.6	31.1	38.6	2.14
		Beam	41.2	48.8	174.0	125.7	47.4	40.9	115.1	100.0	0.2	4.0	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses

TABLE 19 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 24.0 m   Column height = 12.0 m   Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch				Base/Crown				Sway
					Moment under		Shear under		Moment under		Shear under		
					Compression	Tension	Compression	Tension	Compression	Tension	Compression	Tension	
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	53.4	0.0	136.6	0.0	11.4	0.0	0.0	0.0	12.1	0.0	3.32
		Beam	24.3	10.9	148.6	133.0	36.9	13.2	99.3	35.5	10.3	10.2	
	150	Column	66.5	6.7	140.8	156.0	11.7	8.5	0.0	0.0	20.2	17.5	3.53
		Beam	25.1	20.9	173.9	225.7	38.0	26.7	102.5	34.5	0.9	15.4	
	200	Column	69.5	18.2	197.4	224.6	12.1	12.8	0.0	0.0	26.0	24.7	3.63
		Beam	25.9	30.8	244.5	318.2	39.3	40.1	105.9	33.7	20.2	20.7	
1/4.0	100	Column	64.2	0.0	142.9	0.0	11.9	0.0	0.0	0.0	13.6	0.0	3.29
		Beam	22.2	11.2	145.9	139.3	39.7	17.4	111.2	20.3	8.7	8.6	
	150	Column	67.9	11.5	148.0	162.1	12.3	9.0	0.0	0.0	18.4	18.0	3.32
		Beam	23.0	20.4	173.8	233.1	41.2	32.7	115.3	32.0	1.9	13.2	
	200	Column	71.5	23.7	172.1	231.4	12.8	13.3	0.0	0.0	28.3	25.2	3.32
		Beam	23.8	29.6	156.7	326.7	42.7	48.0	119.7	54.9	2.0	17.8	
1/5.0	100	Column	64.8	2.0	147.7	97.4	12.3	5.1	0.0	0.0	12.8	11.1	3.51
		Beam	20.9	11.2	150.7	145.2	41.7	20.2	119.7	18.9	7.8	6.6	
	150	Column	69.6	14.1	154.6	167.2	12.9	9.5	0.0	0.0	20.4	18.4	3.20
		Beam	21.9	19.8	176.2	239.9	43.7	36.4	125.4	46.0	2.6	12.2	
	200	Column	73.3	27.1	160.1	238.2	13.3	13.9	0.0	0.0	21.9	28.5	3.20
		Beam	22.6	28.6	251.0	335.9	45.2	53.0	129.9	74.2	2.7	16.5	

Fixed Base

1/3.0	100	Column	56.0	0.0	116.2	0.0	16.2	0.0	78.8	0.0	16.2	0.0	2.95
		Beam	27.7	10.2	118.3	51.9	31.6	8.6	74.7	22.6	3.0	1.5	
	150	Column	55.4	6.4	118.0	64.8	16.6	9.9	110.0	108.2	21.8	18.9	3.46
		Beam	27.9	20.7	120.2	99.9	31.4	18.9	70.8	18.4	1.2	4.1	
	200	Column	57.0	15.9	121.3	99.0	17.1	15.4	159.1	156.9	31.1	27.3	3.30
		Beam	28.6	31.1	123.5	146.0	31.6	28.7	67.8	24.9	1.3	5.1	
1/4.0	100	Column	58.4	0.0	127.8	0.0	17.5	0.0	82.0	0.0	17.5	0.0	2.37
		Beam	26.8	11.3	129.9	62.4	35.2	12.7	88.6	14.0	1.7	1.4	
	150	Column	57.5	11.4	127.8	77.5	17.5	11.0	82.4	108.4	17.5	20.0	3.36
		Beam	26.8	21.7	130.0	116.6	35.2	25.3	88.8	36.8	0.1	2.5	
	200	Column	59.5	22.1	129.8	117.1	17.7	16.6	153.1	153.9	31.5	28.5	3.41
		Beam	27.2	31.9	132.1	169.8	35.6	37.6	88.8	58.2	0.1	3.4	
1/5.0	100	Column	59.2	1.2	134.8	42.2	18.1	5.9	82.6	64.2	18.1	11.8	2.24
		Beam	26.0	11.8	136.9	69.7	37.8	15.3	100.5	23.2	1.1	1.1	
	150	Column	59.2	14.3	135.3	85.7	18.2	11.8	108.2	110.1	22.7	20.8	3.20
		Beam	26.1	22.0	137.5	127.7	37.8	29.3	100.1	51.5	1.0	1.9	
	200	Column	61.4	25.7	136.4	127.6	18.3	17.5	93.1	154.1	18.3	32.0	3.17
		Beam	26.3	31.9	138.6	183.9	38.4	43.0	102.9	79.9	1.1	2.6	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 28 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 24.0 m Column height = 12.0 m Frame spacing = 6.0 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch: Moment under Compression	Haunch: Moment under Tension	Haunch: Shear under Compression	Haunch: Shear under Tension	Base/Crown: Moment under Compression	Base/Crown: Moment under Tension	Base/Crown: Shear under Compression	Base/Crown: Shear under Tension	Sway
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	81.3	0.0	172.3	0.0	14.4	0.0	0.0	0.0	19.6	0.0	3.37
		Beam	30.8	15.6	192.4	182.8	47.1	19.1	127.7	43.3	13.7	13.6	
	150	Column	85.0	11.7	206.8	215.0	14.8	12.0	0.0	0.0	26.8	23.9	3.58
		Beam	31.7	29.0	255.8	306.7	48.5	37.3	131.6	41.6	20.3	20.6	
	200	Column	92.2	24.6	259.4	302.9	15.7	17.3	0.0	0.0	34.4	33.2	3.19
		Beam	33.6	41.6	323.5	426.3	51.4	54.3	139.6	42.9	26.9	27.5	
1/4.0	100	Column	81.7	2.1	179.6	131.0	15.0	6.9	0.0	0.0	17.4	14.9	3.59
		Beam	28.1	16.0	185.0	192.0	50.5	25.1	142.4	21.8	11.5	11.5	
	150	Column	88.0	17.3	188.7	221.7	15.7	12.5	0.0	0.0	24.1	24.4	3.25
		Beam	29.5	28.0	221.8	315.0	53.1	45.0	149.8	47.2	16.8	17.6	
	200	Column	90.9	34.9	192.9	315.9	16.1	18.4	0.0	0.0	16.1	38.3	3.48
		Beam	30.2	40.6	273.9	441.5	54.4	65.9	153.4	79.7	22.2	23.8	
1/5.0	100	Column	84.1	4.4	188.2	135.4	15.7	7.3	0.0	0.0	17.0	15.3	3.43
		Beam	26.8	15.7	193.7	198.0	53.8	28.3	155.2	29.7	3.2	10.6	
	150	Column	90.3	20.7	197.4	228.5	16.4	13.1	0.0	0.0	27.7	25.0	3.13
		Beam	28.1	27.2	239.5	324.1	56.4	50.0	163.0	66.3	3.4	16.3	
	200	Column	93.2	39.4	205.5	325.0	16.8	19.1	0.0	0.0	28.6	38.6	3.35
		Beam	28.7	39.1	207.5	453.7	57.7	72.7	166.6	105.9	3.5	22.1	

Fixed Base

1/3.0	100	Column	70.8	0.0	146.6	0.0	20.4	0.0	98.8	0.0	20.4	0.0	3.42
		Beam	35.0	14.8	150.4	74.2	40.3	12.8	96.7	27.2	4.0	2.1	
	150	Column	72.2	9.9	150.5	91.2	21.1	13.8	149.1	146.0	29.6	25.7	3.45
		Beam	35.7	28.5	154.4	137.2	40.5	26.3	93.1	22.4	1.4	5.5	
	200	Column	74.4	22.4	153.9	137.6	21.6	21.0	214.4	210.3	42.1	36.9	3.50
		Beam	36.4	42.4	158.0	199.5	40.6	39.6	89.2	37.4	1.6	6.8	
1, 4.0	100	Column	73.9	1.0	160.4	54.9	21.8	7.8	101.6	86.1	21.8	15.7	2.92
		Beam	33.8	16.1	164.2	88.2	45.3	18.4	117.7	23.2	2.6	2.3	
	150	Column	75.7	15.9	163.3	108.2	22.2	15.3	106.6	146.8	22.2	27.2	3.28
		Beam	34.3	29.8	167.2	159.5	45.4	35.0	115.3	52.9	0.3	3.5	
	200	Column	77.8	30.6	167.0	160.6	22.8	2.7	132.3	207.6	22.8	38.6	3.04
		Beam	35.0	43.4	171.1	230.0	46.0	51 2	114.5	80.8	0.2	4.5	
1/5.0	100	Column	76.4	3.4	172.4	61.6	23.1	8.5	105.0	88.5	23.1	16.5	2.61
		Beam	33.3	16.7	176.1	97.5	48.6	21.8	129.5	34.8	1.4	1.5	
	150	Column	78.5	19.3	174.2	118.3	23.3	16.3	146.8	148.6	30.8	28.2	2.94
		Beam	33.6	30.1	178.1	173.4	49.0	40.2	130.5	72.1	1.4	2.5	
	200	Column	79.9	35.9	172.5	173.6	23.0	23.6	121.0	204.7	23.0	43.1	3.13
		Beam	33.5	42.8	176.6	247.2	49.9	58.6	138.1	113.9	1.5	3.7	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 21 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 30.0 m   Column height = 9.0 m   Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch: Moment under Compression	Haunch: Moment under Tension	Haunch: Shear under Compression	Haunch: Shear under Tension	Base/Crown: Moment under Compression	Base/Crown: Moment under Tension	Base/Crown: Shear under Compression	Base/Crown: Shear under Tension	Sway
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
						Hinged Base							
1/3.0	100	Column	67.4	0.0	197.2	0.0	21.9	0.0	0.0	0.0	21.9	0.0	2.67
		Beam	36.9	11.2	199.1	94.6	41.4	10.6	116.0	35.7	4.9	1.6	
	150	Column	69.9	9.2	202.4	113.9	22.5	9.3	0.0	0.0	22.5	16.0	2.66
		Beam	37.9	23.5	204.5	178.3	42.6	23.5	119.4	32.2	1.6	7.0	
	200	Column	73.4	20.6	210.1	173.8	23.3	14.8	0.0	0.0	23.3	23.8	2.51
		Beam	39.3	35.5	212.2	260.2	44.2	36.0	124.2	36.6	1.6	9.2	
1/4.0	100	Column	69.4	1.6	212.8	61.6	23.6	4.6	0.0	0.0	23.6	9.1	2.52
		Beam	35.8	12.7	214.7	107.0	45.9	15.5	140.2	19.3	3.0	1.6	
	150	Column	72.0	15.3	218.2	127.4	24.2	10.8	0.0	0.0	24.2	17.5	2.52
		Beam	36.8	24.9	220.3	196.1	47.1	30.8	144.1	50.7	0.0	4.5	
	200	Column	74.3	29.3	223.2	193.7	24.8	17.0	0.0	0.0	24.8	26.0	2.58
		Beam	37.6	37.3	225.3	285.6	48.2	46.3	147.7	83.7	0.0	6.0	
1/5.0	100	Column	71.2	4.2	224.8	71.7	25.0	5.7	0.0	0.0	25.0	10.2	2.37
		Beam	35.1	13.9	226.7	120.2	48.1	19.1	149.2	31.9	1.0	2.1	
	150	Column	72.3	20.1	225.1	141.2	25.0	12.3	0.0	0.0	25.0	19.0	2.66
		Beam	35.4	26.1	227.2	213.4	49.3	36.3	158.8	74.7	1.1	3.4	
	200	Column	74.7	35.0	230.7	210.5	25.6	18.9	0.0	0.0	25.6	27.9	2.65
		Beam	36.3	38.3	232.8	307.2	50.6	53.4	163.0	115.8	1.2	4.6	

Fixed Base

1/3.0	100	Column	65.4	0.0	169.0	0.0	33.2	0.0	129.7	0.0	33.2	0.0	1.29
		Beam	46.9	12.2	170.4	45.1	35.9	8.1	70.9	2.8	5.3	2.8	
	150	Column	65.0	8.8	168.4	60.6	33.0	12.3	128.8	80.5	33.0	19.0	1.45
		Beam	46.7	27.6	169.8	101.6	35.7	19.3	70.8	17.9	5.3	5.2	
	200	Column	63.0	23.1	165.5	104.5	32.3	20.9	125.3	124.2	32.3	29.9	2.67
		Beam	45.8	43.2	167.0	159.5	35.4	30.9	71.8	25.0	5.2	7.6	
1/4.0	100	Column	69.7	0.0	194.9	0.0	37.1	0.0	138.9	0.0	37.1	0.0	−1.03
		Beam	48.7	14.6	196.2	60.7	41.8	12.5	101.1	13.6	3.3	2.9	
	150	Column	69.3	13.8	194.3	78.8	36.9	14.8	137.9	84.9	36.9	21.5	1.11
		Beam	48.5	30.8	195.8	127.6	41.7	26.5	100.7	39.4	3.3	4.9	
	200	Column	69.2	28.4	193.9	128.5	36.7	24.1	136.7	129.1	36.7	33.1	1.55
		Beam	48.3	46.8	195.3	193.8	41.7	40.4	101.9	65.9	3.3	6.9	
1/5.0	100	Column	72.1	1.3	210.8	37.1	39.2	6.7	142.1	42.9	39.2	11.1	0.82
		Beam	49.1	16.6	212.1	40.4	45.5	10.2	122.0	26.0	1.8	1.6	
	150	Column	71.7	17.3	210.0	92.9	39.0	16.9	140.8	89.2	39.0	23.6	0.93
		Beam	48.8	33.5	211.5	98.5	45.3	23.5	121.5	60.9	1.8	2.6	
	200	Column	72.0	32.7	211.7	148.6	39.3	27.1	142.1	135.8	39.3	36.1	1.18
		Beam	49.1	50.5	213.2	157.6	45.3	36.5	119.2	93.3	1.8	3.7	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 22 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 30.0 m Column height = 9.0 m Frame spacing = 6.0 m

Roof Slope	Basic Wind Pressure (kg/m²)	Member	Compression (kN)	Tension (kN)	Haunch: Moment under Compression (kN.m)	Haunch: Moment under Tension (kN.m)	Haunch: Shear under Compression (kN)	Haunch: Shear under Tension (kN)	Base/Crown: Moment under Compression (kN.m)	Base/Crown: Moment under Tension (kN.m)	Base/Crown: Shear under Compression (kN)	Base/Crown: Shear under Tension (kN)	Sway (cm)
					Hinged Base								
1/3.0	100	Column	87.4	0.0	252.4	0.0	28.0	0.0	0.0	0.0	28.0	0.0	2.53
		Beam	47.4	16.2	255.9	132.3	53.4	15.5	151.1	44.1	6.4	2.2	
	150	Column	91.2	13.8	260.3	157.9	28.9	13.1	0.0	0.0	28.9	22.0	2.43
		Beam	48.9	32.5	263.9	242.9	55.2	32.5	156.3	39.7	2.0	9.3	
	200	Column	94.7	29.9	267.8	239.7	29.8	20.7	0.0	0.0	29.8	32.6	2.46
		Beam	50.3	48.8	271.5	353.8	56.8	49.7	161.2	54.8	2.1	12.2	
1/4.0	100	Column	89.6	4.3	271.4	90.2	30.2	7.0	0.0	0.0	30.2	13.0	2.57
		Beam	45.8	18.2	274.8	149.9	59.0	22.3	181.7	29.7	0.1	4.0	
	150	Column	92.0	23.4	276.4	179.5	30.7	15.5	0.0	0.0	30.7	24.4	2.75
		Beam	46.7	34.8	280.1	270.0	60.2	43.2	185.7	74.9	0.1	6.0	
	200	Column	95.6	41.6	284.6	266.2	31.6	23.6	0.0	0.0	31.6	35.5	2.63
		Beam	48.1	51.0	288.4	387.7	62.0	63.6	191.6	118.7	0.1	8.0	
1/5.0	100	Column	92.1	7.7	290.7	103.6	32.3	8.5	0.0	0.0	32.3	14.5	2.38
		Beam	45.4	19.8	294.2	167.8	62.0	27.1	190.1	47.0	1.3	2.9	
	150	Column	94.2	28.4	289.8	194.4	32.2	17.1	0.0	0.0	32.2	26.1	2.56
		Beam	45.6	35.7	293.4	289.7	64.0	49.8	207.7	105.2	1.5	4.5	
	200	Column	97.7	48.2	297.3	286.3	33.0	25.9	0.0	0.0	33.0	37.8	2.44
		Beam	46.8	51.9	301.1	414.0	65.7	72.6	213.5	160.6	1.5	6.2	
					Fixed Base								
1/3.0	100	Column	84.4	0.0	216.1	0.0	42.2	0.0	163.7	0.0	42.2	0.0	1.19
		Beam	59.9	17.9	218.5	66.1	46.2	12.1	93.8	0.5	6.7	3.8	
	150	Column	84.2	13.6	216.0	86.7	42.1	17.4	162.9	110.4	42.1	26.4	1.44
		Beam	59.8	38.2	218.5	140.9	46.2	27.0	93.8	21.7	6.7	7.0	
	200	Column	81.6	32.7	211.6	145.4	41.1	28.8	157.8	167.7	41.1	40.8	2.65
		Beam	58.5	58.9	214.3	218.2	45.7	42.6	95.6	38.7	6.5	10.1	
1/4.0	100	Column	90.2	0.7	249.8	44.7	47.3	8.3	175.7	56.9	47.3	14.3	0.93
		Beam	62.2	20.9	252.2	87.1	54.0	18.0	132.9	22.3	4.2	3.9	
	150	Column	89.9	20.3	249.5	111.2	47.1	20.8	174.6	116.0	47.1	29.7	1.09
		Beam	62.1	42.3	252.1	175.6	54.0	36.7	132.9	57.5	4.2	6.5	
	200	Column	86.7	42.1	245.4	181.3	46.3	33.9	171.3	177.6	46.3	45.8	2.11
		Beam	61.0	64.7	248.0	267.9	52.9	56.1	129.3	93.6	4.1	9.3	
1/5.0	100	Column	94.2	3.3	270.9	55.1	50.1	9.8	179.7	60.3	50.1	15.8	0.70
		Beam	62.9	23.2	273.3	58.3	59.2	14.9	162.9	39.4	2.1	2.1	
	150	Column	89.1	27.9	261.6	134.1	48.2	24.2	172.1	123.7	48.2	33.1	1.42
		Beam	60.6	46.6	264.2	139.3	57.5	33.7	160.1	91.8	2.0	3.5	
	200	Column	90.1	48.0	263.9	205.7	48.5	37.1	172.9	182.0	48.5	49.0	1.60
		Beam	61.1	68.2	266.6	213.6	57.9	51.0	160.9	138.8	2.0	4.9	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 23 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 30.0 m Column height = 12.0 m Frame spacing = 4.5 m

Roof Slope	Basic Wind Pressure (kg/m²)	Member	Compression (kN)	Tension (kN)	Haunch: Moment under Compression (kN.m)	Haunch: Moment under Tension (kN.m)	Haunch: Shear under Compression (kN)	Haunch: Shear under Tension (kN)	Base/Crown: Moment under Compression (kN.m)	Base/Crown: Moment under Tension (kN.m)	Base/Crown: Shear under Compression (kN)	Base/Crown: Shear under Tension (kN)	Sway (cm)
					Hinged Base								
1/3.0	100	Column	74.9	0.0	210.5	0.0	17.5	0.0	0.0	0.0	17.5	0.0	3.35
		Beam	33.4	11.7	213.6	141.4	44.7	12.6	140.3	47.4	8.3	4.3	
	150	Column	78.3	6.9	217.2	167.4	18.1	9.5	0.0	0.0	19.8	18.4	3.51
		Beam	34.5	23.7	220.5	251.8	46.2	27.2	145.0	44.9	12.9	12.4	
	200	Column	81.8	19.7	224.2	248.7	18.7	14.8	0.0	0.0	24.3	26.7	3.59
		Beam	35.6	35.6	245.8	361.8	47.7	41.8	149.9	42.5	17.7	16.6	
1/4.0	100	Column	75.4	0.0	221.5	0.0	18.5	0.0	0.0	0.0	18.5	0.0	3.56
		Beam	31.1	12.7	224.6	153.7	48.4	17.9	160.7	26.4	6.4	4.0	
	150	Column	81.0	12.3	233.1	176.9	19.4	10.3	0.0	0.0	19.4	19.2	3.19
		Beam	32.8	23.8	236.4	264.4	51.0	34.2	169.4	48.3	1.5	9.7	
	200	Column	84.9	26.3	240.8	260.9	20.1	15.8	0.0	0.0	20.3	27.7	3.21
		Beam	33.9	35.2	244.2	378.1	52.7	51.2	175.2	83.0	1.5	13.2	
1/5.0	100	Cloumn	77.1	2.3	230.6	103.2	19.2	5.6	0.0	0.0	19.2	11.6	3.34
		Beam	29.8	13.1	233.7	162.9	51.2	21.2	175.8	30.3	5.5	4.1	
	150	Column	79.8	18.2	235.8	192.1	19.7	11.5	0.0	0.0	19.7	20.5	3.63
		Beam	30.5	24.5	239.1	282.6	52.4	40.2	180.0	74.4	2.4	8.6	
	200	Column	83.2	33.6	242.8	279.5	20.2	17.3	0.0	0.0	20.2	29.3	3.64
		Beam	31.4	35.7	246.3	400.9	54.0	58.9	185.6	117.6	2.5	11.7	

Fixed Base

1/3.0	100	Column	67.9	0.0	178.6	0.0	25.6	0.0	128.2	0.0	25.6	0.0	2.18
		Beam	39.6	12.3	180.9	60.9	38.0	9.3	96.0	28.5	3.0	1.7	
	150	Column	67.9	7.8	178.6	79.0	25.5	12.0	127.5	118.4	25.5	20.9	2.78
		Beam	39.6	26.0	180.9	126.7	38.1	21.4	96.9	24.1	2.9	3.2	
	200	Column	67.3	21.3	178.2	128.1	25.4	19.1	155.9	172.4	30.9	31.0	3.56
		Beam	39.5	39.5	180.7	192.2	38.4	33.5	99.9	38.3	2.9	4.4	
1/4.0	100	Column	69.2	0.1	195.9	42.9	27.2	6.1	130.2	65.8	27.2	12.0	2.22
		Beam	38.8	14.2	198.1	78.7	43.0	14.4	126.1	20.1	1.3	1.7	
	150	Column	71.6	13.1	200.7	97.1	27.9	13.7	133.9	121.4	27.9	22.7	2.34
		Beam	39.6	28.0	203.0	151.7	43.5	28.9	124.2	50.0	1.2	2.8	
	200	Column	70.0	29.3	196.1	153.4	27.1	21.4	128.9	174.7	27.1	33.3	3.64
		Beam	38.8	41.6	198.5	226.2	43.6	44.1	130.5	87.2	1.0	3.6	
1/5.0	100	Column	74.2	0.4	214.1	49.1	29.2	6.8	136.4	67.7	29.2	12.7	1.30
		Beam	39.2	14.9	216.3	30.2	46.9	10.1	143.2	31.4	0.1	2.1	
	150	Column	73.7	16.8	213.1	111.2	29.0	15.2	135.2	125.4	29.0	24.2	2.04
		Beam	38.9	29.2	215.4	83.9	46.7	23.5	142.5	72.6	0.1	3.0	
	200	Column	73.6	32.7	213.4	172.2	29.0	23.6	135.0	182.1	29.0	35.5	2.72
		Beam	39.0	43.3	215.8	136.6	46.7	33.6	142.6	113.1	0.1	4.0	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1/1.33 to account for increased allowable stresses.

TABLE 24 ANALYSIS RESULTS OF LATTICE PORTAL FRAMES

Span = 30.0 m   Column height = 12.0 m   Frame spacing = 6.0 m

Roof Slope	Basic Wind Pressure	Member	Compression	Tension	Haunch				Base/Crown				Sway
					Moment under		Shear under		Moment under		Shear under		
					Compression	Tension	Compression	Tension	Compression	Tension	Compression	Tension	
	(kg/m²)		(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(kN.m)	(kN.m)	(kN)	(kN)	(cm)
					Hinged Base								
1/3.0	100	Column	96.0	0.0	266.5	0.0	22.2	0.0	0.0	0.0	22.2	0.0	3.38
		Beam	42.5	17.0	272.1	196.9	57.2	18.6	180.7	57.6	11.5	11.0	
	150	Column	100.3	12.3	275.1	232.8	22.9	13.4	0.0	0.0	25.6	25.4	3.54
		Beam	43.9	33.0	281.0	343.9	59.1	38.2	187.0	54.1	17.2	16.6	
	200	Column	108.3	26.9	290.7	336.3	24.2	20.1	0.0	0.0	32.0	36.0	3.15
		Beam	46.4	48.2	340.1	485.6	62.5	56.6	197.9	54.0	0.1	22.1	
1/4.0	100	Column	97.9	1.4	283.7	135.6	23.6	7.3	0.0	0.0	23.6	15.3	3.47
		Beam	40.0	18.0	289.3	211.1	62.6	25.4	209.3	30.2	1.9	8.5	
	150	Column	104.7	18.9	297.1	244.8	24.8	14.4	0.0	0.0	24.8	26.4	3.13
		Beam	41.9	32.9	303.0	359.8	65.6	47.4	219.6	71.5	2.0	13.0	
	200	Column	108.0	39.0	303.8	358.9	25.3	22.0	0.0	0.0	26.1	37.9	3.36
		Beam	42.9	48.4	309.9	513.5	67.2	70.6	224.9	120.2	17.2	17.6	
1/5.0	100	Cloumn	98.6	6.2	291.9	148.0	24.3	8.4	0.0	0.0	24.3	16.3	3.59
		Beam	37.9	18.7	297.5	226.2	65.4	30.4	226.2	48.4	3.0	7.4	
	150	Column	103.5	26.4	301.9	263.7	25.2	16.0	0.0	0.0	27.6	27.9	3.55
		Beam	39.2	33.6	307.8	382.9	67.7	55.2	234.4	106.0	3.1	11.5	
	200	Column	110.0	45.6	314.8	377.4	26.2	23.5	0.0	0.0	26.2	39.4	3.20
		Beam	40.9	48.1	321.0	537.5	70.7	79.5	244.7	162.2	3.3	15.6	

Fixed Base

1/3.0	100	Column	87.7	0.0	227.6	0.0	32.4	0.0	161.5	0.0	32.4	0.0	2.11
		Beam	50.5	17.8	231.6	87.8	48.9	13.9	126.0	35.0	3.7	2.4	
	150	Column	85.3	14.3	224.3	114.6	31.8	17.1	157.7	161.8	31.8	29.0	3.45
		Beam	49.8	36.4	228.4	177.3	48.6	30.5	127.8	31.1	3.5	4.2	
	200	Column	88.5	29.3	229.5	177.2	32.6	26.4	214.2	235.2	42.3	42.3	3.24
		Beam	50.8	54.2	233.8	261.8	49.2	46.0	126.0	53.8	3.7	6.1	
1/4.0	100	Column	93.4	0.0	257.4	0.0	35.7	0.0	170.5	0.0	35.7	0.0	1.53
		Beam	50.9	19.6	261.4	107.7	56.4	19.9	163.6	28.8	1.4	2.3	
	150	Column	92.9	19.4	256.5	136.4	35.5	19.2	169.2	164.9	35.5	31.1	2.27
		Beam	50.6	38.4	260.7	208.3	56.2	40.0	162.9	72.5	1.4	3.7	
	200	Column	93.9	38.6	255.0	208.2	35.1	28.9	166.1	233.6	35.1	44.8	2.79
		Beam	50.4	56.0	259.3	304.1	57.1	59.6	172.7	120.6	1.2	4.7	
1/5.0	100	Column	96.0	2.7	273.3	73.2	37.1	10.0	172.2	94.4	37.1	17.9	1.30
		Beam	50.0	21.1	277.3	46.5	60.5	15.1	187.6	47.9	0.3	2.7	
	150	Column	92.2	26.9	266.2	157.4	36.0	21.3	166.4	170.3	36.0	33.3	2.89
		Beam	48.7	40.3	270.4	117.0	59.6	33.4	188.5	107.8	0.3	4.0	
	200	Column	92.7	47.8	266.9	237.6	36.1	32.2	166.2	243.8	36.1	48.1	3.46
		Beam	48.8	58.7	271.2	184.6	59.8	50.9	189.3	164.0	0.4	5.3	

NOTE — Wherever design is governed by $DL + WL$ combination, the corresponding design forces have been multiplied by 1 1.33 to account for increased allowable stresses.

TABLE 25 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 9.0 m   Column Height = 4.5 m   Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−13.31	1.97	0.0
		LL	−7.73	1.87	0.0
		WL	13.71	8.40	0.0
1/3.0	150	*DL*	−13.30	1.97	−0.0
		LL	−7.73	1.87	0.0
		WL	20.97	12.59	0.1
1/3.0	200	*DL*	−13.63	2.01	0.0
		LL	−7.73	1.87	0.0
		WL	27.42	16.79	0.1
1/4.0	100	*DL*	−13.22	1.97	0.0
		LL	−8.91	2.19	0.0
		WL	14.87	8.34	0.0
1/4.0	150	*DL*	−13.14	1.96	0.0
		LL	−8.91	2.18	0.0
		WL	22.30	12.51	0.0
1/4.0	200	*DL*	−13.46	1.99	0.0
		LL	−8.91	2.18	0.0
		WL	29.74	16.68	0.1
1/5.0	100	*DL*	−13.11	1.96	0.0
		LL	−9.63	2.38	0.0
		WL	15.68	8.39	0.0
1/5.0	150	*DL*	−13.09	1.96	0.0
		LL	−9.63	2.38	0.0
		WL	23.53	12.59	0.0
1/5.0	200	*DL*	−13.41	2.00	0.0
		LL	−9.63	2.38	0.0
		WL	31.37	16.78	0.0

(*Continued*)

TABLE 25 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 9.0 m Column Height = 4.5 m Frame Spacing = 4.5 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−13.33	3.09	−560.2
		LL	−7.73	2.88	−520.7
		WL	10.93	9.28	1702.0
1/3.0	150	*DL*	−13.32	3.10	−563.2
		LL	−7.73	2.89	−522.5
		WL	16.38	13.93	2559.3
1/3.0	200	*DL*	−13.34	3.11	−564.1
		LL	−7.73	2.89	−523.6
		WL	21.83	18.58	3418.6
1/4.0	100	*DL*	−13.18	3.06	−535.4
		LL	−8.91	3.34	−583.8
		WL	12.28	9.35	1671.0
1/4.0	150	*DL*	−13.17	3.07	−538.2
		LL	−8.91	3.36	−585.9
		WL	18.42	14.03	2511.3
1/4.0	200	*DL*	−13.19	3.08	−538.9
		LL	−8.91	3.36	−587.1
		WL	24.55	18.72	3352.3
1/5.0	100	*DL*	−13.14	3.05	−520.0
		LL	−9.63	3.62	−617.2
		WL	13.17	9.47	1679.5
1/5.0	150	*DL*	−13.07	3.04	−519.5
		LL	−9.63	3.64	−619.3
		WL	19.75	14.22	2524.1
1/5.0	200	*DL*	−13.09	3.05	−520.1
		LL	−9.63	3.65	−620.6
		WL	26.33	18.97	3369.2

TABLE 26 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 9.0 m Column Height = 4.5 m Frame Spacing = 6.0 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−16.90	2.36	0.0
		LL	−10.31	2.48	0.0
		WL	18.29	11.19	0.0
1/3.0	150	*DL*	−17.14	2.38	0.0
		LL	−10.31	2.48	0.0
		WL	27.42	16.78	0.0
1/3.0	200	*DL*	−17.64	2.44	0.0
		LL	−10.31	2.48	0.0
		WL	36.57	22.37	0.1
1/4.0	100	*DL*	−16.71	2.35	0.0
		LL	−11.87	2.90	0.0
		WL	19.83	11.11	0.0
1/4.0	150	*DL*	−17.01	2.38	0.0
		LL	−11.87	2.89	0.0
		WL	29.73	16.66	0.0
1/4.0	200	*DL*	−17.17	2.40	0.0
		LL	−11.87	2.89	0.0
		WL	39.65	22.22	0.1
1/5.0	100	*DL*	−16.65	2.35	0.0
		LL	−12.84	3.16	0.0
		WL	20.91	11.18	0.0
1/5.0	150	*DL*	−16.55	2.33	0.0
		LL	−12.84	3.16	0.0
		WL	31.37	16.76	0.1
1/5.0	200	*DL*	−17.03	2.38	0.0
		LL	−12.84	3.16	0.0
		WL	41.83	22.35	0.1

(Continued)

TABLE 26 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 9.0 m | Column Height = 4.5 m | Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−16.83	3.67	−663.3
		LL	−10.31	3.77	−678.0
		WL	14.60	12.33	2248.0
1/3.0	150	*DL*	−16.86	3.69	−665.9
		LL	−10.31	3.78	−680.3
		WL	21.88	18.51	3380.3
1/3.0	200	*DL*	−16.87	3.69	−666.3
		LL	−10.31	3.79	−681.7
		WL	29.16	24.69	4515.0
1/4.0	100	*DL*	−16.71	3.65	−636.6
		LL	−11.87	4.37	−759.6
		WL	16.40	12.41	2197.7
1/4.0	150	*DL*	−16.68	3.65	−635.6
		LL	−11.87	4.39	−762.2
		WL	24.59	18.63	3302.2
1/4.0	200	*DL*	−16.69	3.65	−635.9
		LL	−11.87	4.40	−763.8
		WL	32.77	24.86	4408.3
1/5.0	100	*DL*	−16.60	3.62	−614.7
		LL	−12.84	4.73	−802.8
		WL	17.58	12.56	2208.6
1/5.0	150	*DL*	−16.62	3.63	−616.7
		LL	−12.84	4.75	−805.4
		WL	26.36	18.86	3318.4
1/5.0	200	*DL*	−14.63	3.63	−617.0
		LL	−12.84	4.77	−807.1
		WL	35.14	25.17	4429.9

TABLE 27 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 9.0 m | Column Height = 6.0 m | Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−14.76	1.46	−0.0
		LL	−7.73	1.42	−0.0
		WL	16.66	10.55	0.0
1/3.0	150	*DL*	−15.64	1.52	0.0
		LL	−7.74	1.42	0.0
		WL	24.98	15.82	0.1
1/3.0	200	*DL*	−15.84	1.53	0.0
		LL	−7.74	1.42	−0.0
		WL	33.31	21.10	0.2
1/4.0	100	*DL*	−14.59	1.44	−0.0
		LL	−8.91	1.65	−0.0
		WL	17.72	10.42	0.0
1/4.0	150	*DL*	−15.13	1.48	−0.0
		LL	−8.91	1.65	−0.0
		WL	26.58	15.63	0.1
1/4.0	200	*DL*	−15.52	1.51	0.0
		LL	−8.91	1.65	0.0
		WL	35.44	20.84	0.2
1/5.0	100	*DL*	−14.54	1.44	−0.0
		LL	−9.63	1.79	−0.0
		WL	18.50	10.43	0.0
1/5.0	150	*DL*	−14.89	1.46	0.0
		LL	−9.63	1.79	−0.0
		WL	27.75	15.64	0.2
1/5.0	200	*DL*	−15.47	1.51	0.0
		LL	−9.64	1.79	−0.0
		WL	37.01	20.85	0.2

(*Continued*)

TABLE 27 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 9.0 m | Column Height = 6.0 m | Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−14.74	2.31	−541.7
		LL	−7.73	2.18	−509.0
		WL	11.76	11.42	2772.5
1/3.0	150	*DL*	−14.72	2.31	−540.4
		LL	−7.73	2.19	−511.0
		WL	17.62	17.15	4168.9
1/3.0	200	*DL*	−14.74	3.31	−540.8
		LL	−7.73	2.19	−512.3
		WL	23.48	22.87	5568.4
1/4.0	100	*DL*	−14.59	2.27	−514.7
		LL	−8.91	2.51	−568.1
		WL	13.08	11.38	2698.4
1/4.0	150	*DL*	−14.62	2.28	−516.9
		LL	−8.91	2.52	−570.3
		WL	19.60	17.08	4057.2
1/4.0	200	*DL*	−14.64	2.28	−517.2
		LL	−8.91	2.53	−571.8
		WL	26.12	22.79	5419.4
1/5.0	100	*DL*	−14.49	2.24	−496.2
		LL	−9.63	2.71	−600.3
		WL	13.95	11.43	2680.6
1/5.0	150	*DL*	−14.52	2.24	−498.1
		LL	−9.63	2.72	−602.6
		WL	20.92	17.16	4030.6
1/5.0	200	*DL*	−14.54	2.25	−498.3
		LL	−9.63	2.73	−604.2
		WL	27.88	22.89	5383.1

TABLE 28 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 9.0 m | Column Height = 6.0 m | Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)	Axial (kN)	Shear (kN)	Moment (kN.m)
		Hinged Base		
1/3.0	100 *DL*	−19.05	1.74	0.0
	LL	−10.31	1.88	0.0
	WL	22.20	14.06	0.1
1/3.0	150 *DL*	−19.82	1.80	0.0
	LL	−10.32	1.88	0.0
	WL	33.31	21.09	0.1
1/3.0	200 *DL*	−20.77	1.87	0.0
	LL	−10.32	1.88	0.0
	WL	44.41	28.11	0.1
1/4.0	100 *DL*	−18.92	1.73	−0.0
	LL	−11.87	2.18	0.0
	WL	23.62	13.88	0.1
1/4.0	150 *DL*	−19.48	1.77	0.0
	LL	−11.88	2.18	0.0
	WL	35.44	20.83	0.2
1/4.0	200 *DL*	−20.05	1.81	0.0
	LL	−11.88	2.18	0.0
	WL	47.25	27.77	0.2
1/5.0	100 *DL*	−18.86	1.73	−0.0
	LL	−12.84	2.37	0.0
	WL	24.67	13.89	0.1
1/5.0	150 *DL*	−19.34	1.75	−0.0
	LL	−12.85	2.37	0.0
	WL	37.02	20.84	0.2
1/5.0	200 *DL*	−19.99	1.81	0.0
	LL	−12.85	2.37	0.0
	WL	49.35	27.78	0.2

(*Continued*)

TABLE 28 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 9.0 m | Column Height = 6.0 m | Frame Spacing = 6.0 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−18.68	2.72	−635.4
		LL	−10.31	2.85	−662.5
		WL	15.72	15.19	3666.8
1/3.0	150	*DL*	−18.70	2.73	−637.1
		LL	−10.31	2.86	−665.1
		WL	23.56	22.50	5513.5
1/3.0	200	*DL*	−18.66	2.73	−636.9
		LL	−10.31	2.87	−666.8
		WL	31.39	30.42	7364.4
1/4.0	100	*DL*	−18.56	2.68	−606.7
		LL	−11.87	3.28	−739.1
		WL	17.47	15.12	3568.8
1/4.0	150	*DL*	−18.52	2.67	−604.6
		LL	−11.87	3.30	−742.1
		WL	26.19	22.70	5366.4
1/4.0	200	*DL*	−18.47	2.67	−604.3
		LL	−11.87	3.31	−744.0
		WL	34.90	30.29	7168.4
1/5.0	100	*DL*	−18.44	2.64	−584.9
		LL	−12.84	3.54	−780.9
		WL	18.64	15.18	3545.9
1/5.0	150	*DL*	−18.46	2.65	−586.4
		LL	−12.84	3.56	−784.1
		WL	27.94	22.80	5331.5
1/5.0	200	*DL*	−18.42	2.65	−586.0
		LL	−12.84	3.57	−786.1
		WL	37.24	30.42	7120.8

TABLE 29 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 12.0 m | Column Height = 4.5 m | Frame Spacing = 4.5 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−16.00	3.46	0.0
		LL	10.31	3.27	0.0
		WL	16.07	9.20	0.0
1/3.0	150	*DL*	−15.93	3.44	0.0
		LL	·10.31	3.27	0.0
		WL	24.10	13.79	0.0
1/3.0	200	*DL*	−16.32	3.52	0.0
		LL	−10.31	3.26	0.0
		WL	32.14	18.39	0.0
1/4.0	100	*DL*	−15.79	3.47	0.0
		LL	−11.88	3.85	0.0
		WL	17.70	9.47	0.0
1/4.0	150	*DL*	−15.72	3.46	0.0
		LL	−11.87	3.85	0.0
		WL	26.55	14.20	0.1
1/4.0	200	*DL*	−16.10	3.53	0.0
		LL	−11.87	3.85	0.0
		WL	35.40	18.92	0.1
1/5.0	100	*DL*	−15.73	3.50	0.0
		LL	−12.84	4.22	0.0
		WL	18.82	9.77	0.0
1/5.0	150	*DL*	−15.66	3.48	0.0
		LL	−12.84	4.22	0.0
		WL	28.23	14.64	0.0
1/5.0	200	*DL*	−15.66	3.48	0.0
		LL	−12.84	4.22	0.0
		WL	37.64	19.51	0.1

(Continued)

TABLE 29 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 12.0 m | Column Height = 4.5 m | Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−15.97	5.34	−1000.8
		LL	−10.31	5.00	−934.8
		WL	13.94	10.81	2171.7
1/3.0	150	*DL*	−15.95	5.34	−1000.6
		LL	−10.31	5.01	−937.1
		WL	20.91	16.23	3262.0
1/3.0	200	*DL*	−15.97	5.35	−1002.4
		LL	−10.31	5.02	−938.5
		WL	27.87	21.65	4353.5
1/4.0	100	*DL*	−15.78	5.36	−967.3
		LL	−11.87	5.88	−1059.1
		WL	15.79	11.47	2197.9
1/4.0	150	*DL*	−15.76	5.36	−966
		LL	−11.87	5.90	−1061
		WL	23.68	17.22	330[illegible]
1/4.0	200	*DL*	−15.78	5.37	−96
		LL	−11.87	5.91	−1063.
		WL	31.56	22.98	4404.0
1/5.0	100	*DL*	−15.67	5.35	−938.1
		LL	−12.84	6.42	−1123.8
		WL	16.99	11.95	2227.1
1/5.0	150	*DL*	−15.70	5.38	−942.2
		LL	−12.84	6.43	−1125.9
		WL	25.47	17.94	3343.7
1/5.0	200	*DL*	−15.72	5.39	−943.6
		LL	−12.84	6.45	−1127.6
		WL	33.96	23.95	4461.6

TABLE 30 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 12.0 m   Column Height = 4.5 m   Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−20.11	4.16	0.0
		LL	−13.75	4.34	0.0
		WL	21.42	12.25	0.1
1/3.0	150	*DL*	−20.41	4.21	0.0
		LL	−13.75	4.33	0.0
		WL	32.13	18.37	0.1
1/3.0	200	*DL*	−21.10	4.32	0.0
		LL	−13.75	4.33	0.0
		WL	42.85	24.49	0.1
1/4.0	100	*DL*	−19.87	4.17	0.0
		LL	−15.83	5.11	0.0
		WL	23.60	12.59	0.1
1/4.0	150	*DL*	−19.86	4.18	0.0
		LL	−15.83	5.10	0.0
		WL	35.41	18.88	0.0
1/4 0	200	*DL*	−20.43	4.25	0.0
		LL	−15.63	5.10	0.0
		WL	47.20	25.15	0.1
1/5.0	100	*DL*	−19.79	4.20	0.0
		LL	−17.12	5.60	0.0
		WL	25.09	12.99	0.0
1/5.0	150	*DL*	−19.70	4.18	0.0
		LL	−17.12	5.59	0.0
		WL	37.64	19.47	0.1
1/5.0	200	*DL*	−20.16	4.24	0.0
		LL	−17.12	5.59	0.0
		WL	50.19	25.94	0.1

(*Continued*)

TABLE 30 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 12.0 m　　Column Height = 4.5 m　　Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−20.44	6.40	−1192.5
		LL	−13.75	6.57	−1220.0
		WL	18.61	14.30	2853.9
1/3.0	150	*DL*	−20.07	6.39	−1189.1
		LL	−13.75	6.58	−1220.5
		WL	27.91	21.45	4280.8
1/3.0	200	*DL*	−20.09	6.40	−1190.2
		LL	−13.75	6.59	−1222.1
		WL	37.20	28.61	5712.0
1/4.0	100	*DL*	−20.30	6.54	−1178.7
		LL	−15.83	7.86	−1413.4
		WL	21.05	15.30	2930.3
1/4.0	150	*DL*	−20.22	6.47	−1161.7
		LL	−15.83	7.80	−1398.2
		WL	31.58	22.84	4362.6
1/4.0	200	*DL*	−20.19	6.43	−1152.2
		LL	−15.83	7.76	−1387.7
		WL	42.11	30.36	5786.5
1/5.0	100	*DL*	−20.27	6.66	−1171.2
		LL	−17.13	8.75	−1535.9
		WL	22.63	16.13	3016.6
1/5.0	150	*DL*	−20.20	6.56	−1147.2
		LL	−17.12	8.61	−1502.8
		WL	33.96	23.95	4457.9
1/5.0	200	*DL*	−20.16	6.52	−1137.4
		LL	−17.12	8.56	−1491.3
		WL	45.28	31.83	5912.3

TABLE 31 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 12.0 m   Column Height = 6.0 m   Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−17.42	2.61	0.0
		LL	−10.31	2.50	0.0
		WL	18.29	11.20	0.1
1/3.0	150	*DL*	−17.98	2.67	0.0
		LL	−10.31	2.50	0.0
		WL	27.43	16.80	0.1
1/3.0	200	*DL*	−18.68	2.75	0.0
		LL	−10.31	2.50	0.0
		WL	36.57	22.40	0.2
1/4.0	100	*DL*	−17.20	2.59	0.0
		LL	−11.87	2.92	0.0
		WL	19.83	11.13	0.0
1/4.0	150	*DL*	−17.53	2.63	0.0
		LL	−11.87	2.92	0.0
		WL	29.74	16.69	0.1
1/4.0	200	*DL*	−18.20	2.71	0.0
		LL	−11.87	2.92	0.0
		WL	39.65	22.25	0.1
1/5.0	100	*DL*	−17.14	2.60	0.0
		LL	−12.84	3.19	0.0
		WL	20.92	11.20	0.0
1/5.0	150	*DL*	−17.46	2.63	0.0
		LL	−12.84	3.19	0.0
		WL	31.37	16.79	0.1
1/5.0	200	*DL*	−18.13	2.71	0.0
		LL	−12.84	3.18	0.0
		WL	41.83	22.39	0.1

(Continued)

TABLE 31 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 12.0 m　　Column Height = 6.0 m　　Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)	AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
		Fixed Base		
1/3.0	100 *DL*	−17.41	4.07	−983.1
	LL	−10.31	3.84	−926.2
	WL	14.57	12.37	3028.8
1/3.0	150 *DL*	−17.37	4.06	−981.7
	LL	−10.31	3.85	−929.1
	WL	21.84	18.58	4554.9
1/3.0	200 *DL*	−17.33	4.07	−982.8
	LL	−10.31	3.86	−930.9
	WL	29.10	24.78	6083.3
1/4.0	100 *DL*	−17.21	4.03	−939.1
	LL	−11.87	4.46	−1038.3
	WL	16.37	12.47	2971.4
1/4.0	150 *DL*	−17.24	4.05	−943.5
	LL	−11.87	4.48	−1041.6
	WL	24.55	18.72	4464.5
1/4.0	200 *DL*	−17.20	4.05	−944.5
	LL	−11.88	4.49	−1043.7
	WL	32.73	24.98	5959.7
1/5.0	100 *DL*	−17.15	4.01	−912.2
	LL	−12.84	4.84	−1097.7
	WL	17.56	12.63	2986.6
1/5.0	150 *DL*	−17.11	4.01	−910.4
	LL	−12.84	4.85	−1101.0
	WL	26.33	18.97	4487.7
1/5.0	200 *DL*	−17.07	4.01	−911.0
	LL	−12.84	4.87	−1102.9
	WL	35.10	25.30	5989.3

TABLE 32 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 12.0 m | Column Height = 6.0 m | Frame Spacing = 6.0 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Hinged Base		
1/3.0	100	DL	−22.35	3.16	0.0
		LL	−13.75	3.32	0.0
		WL	24.38	14.92	0.2
1/3.0	150	DL	−23.26	3.27	0.0
		LL	−13.75	3.31	0.0
		WL	36.57	22.38	0.2
1/3.0	200	DL	−24.36	3.40	0.0
		LL	−13.76	3.31	0.0
		WL	48.76	29.84	0.1
1/4.0	100	DL	−22.09	3.14	0.0
		LL	−15.83	3.87	0.0
		WL	26.44	14.82	0.1
1/4.0	150	DL	−22.74	3.22	0.0
		LL	−15.83	3.87	0.0
		WL	39.65	22.23	0.1
1/4.0	200	DL	−23.40	3.30	0.0
		LL	−15.83	3.87	0.0
		WL	52.86	29.64	0.1
1/5.0	100	DL	−22.01	3.15	0.0
		LL	−17.12	4.22	0.0
		WL	27.89	14.91	0.0
1/5.0	150	DL	−22.66	3.23	0.0
		LL	−17.12	4.22	0.0
		WL	41.82	22.36	0.1
1/5.0	200	DL	−23.32	3.30	0.0
		LL	−17.13	4.22	0.0
		WL	55.78	29.82	0.2

(*Continued*)

TABLE 32 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 12.0 m Column Height = 6.0 m Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN m)
			Fixed Base		
1/3.0	100	*DL*	−21.93	4.83	−1161.8
		LL	−13.75	5.03	−1205.8
		WL	19.46	16.44	4001.2
1/3.0	150	*DL*	−21.95	4.85	−1165.7
		LL	−13.75	5.05	−1209.3
		WL	29.17	24.68	6015.6
1/3.0	200	*DL*	−21.91	4.85	−1166.0
		LL	−13.75	5.06	−1211.5
		WL	38.87	32.93	8034.3
1/4.0	100	*DL*	−21.70	4.78	−1108.8
		LL	−15.83	5.84	−1350.9
		WL	21.86	16.55	3907.6
1/4.0	150	*DL*	−21.72	4.79	−1112.2
		LL	−15.83	5.86	−1354.9
		WL	32.77	24.85	5872.2
1/4.0	200	*DL*	−21.67	4.80	−1112.3
		LL	−15.83	5.87	−1357.4
		WL	43.69	33.15	7842.6
1/5.0	100	*DL*	−21.62	4.75	−1075.9
		LL	−17.12	6.32	−1427.5
		WL	23.44	16.75	3926.6
1/5.0	150	*DL*	−21.64	4.77	−1079.2
		LL	−17.12	6.34	−1431.7
		WL	35.14	25.16	5898.6
1/5.0	200	*DL*	−21.59	4.77	−1079.2
		LL	−17.12	6.36	−1434.3
		WL	46.85	33.57	7872.8

TABLE 33 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 12.0 m | Column Height = 9.0 m | Frame Spacing = 4.5 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−23.25	1.90	0.0
		LL	−10.32	1.69	0.0
		WL	24.58	15.55	0.2
1/3.0	150	*DL*	−25.50	2.03	0.0
		LL	−10.32	1.69	−0.0
		WL	36.87	23.32	0.2
1/3.0	200	*DL*	−27.11	2.14	0.0
		LL	−10.32	1.69	−0.0
		WL	49.16	31.10	0.4
1/4.0	100	*DL*	−22.99	1.87	0.0
		LL	−11.88	1.96	0.0
		WL	25.94	15.35	0.2
1/4.0	150	*DL*	−24.56	1.96	0.0
		LL	−11.88	1.96	0.0
		WL	38.91	23.02	0.2
1/4.0	200	*DL*	−26.79	2.10	0.0
		LL	−11.87	1.96	0.0
		WL	51.86	30.69	0.5
1/5.0	100	*DL*	−22.91	1.86	0.0
		LL	−12.85	2.13	0.0
		WL	26.96	15.34	0.2
1/5.0	150	*DL*	−24.48	1.96	0.0
		LL	−12.85	2.13	0.0
		WL	40.45	23.00	0.3
1/5.0	200	*DL*	−26.70	2.10	0.0
		LL	−12.84	2.12	0.0
		WL	53.92	30.66	0.2

(Continued)

TABLE 33 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 12.0 m — Column Height = 9.0 m — Frame Spacing = 4.5 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−20.23	2.68	−929.7
		LL	−10.31	2.59	−895.8
		WL	16.34	16.74	6087.6
1/3.0	150	*DL*	−20.58	2.79	−975.0
		LL	−10.31	2.70	−939.0
		WL	24.28	25.24	9320.7
1/3.0	200	*DL*	−21.42	2.90	−1022.1
		LL	−10.31	2.76	−966.0
		WL	32.15	33.75	12601.4
1/4.0	100	*DL*	−20.02	2.62	−881.8
		LL	−11.88	2.98	−999.2
		WL	18.08	16.63	5925.9
1/4.0	150	*DL*	−20.37	2.73	−924.3
		LL	−11.87	3.10	−1047.5
		WL	26.91	25.10	9068.1
1/4.0	200	*DL*	−20.81	2.84	−971.5
		LL	−11.87	3.24	−1103.1
		WL	35.52	33.69	12399.0
1/5.0	100	*DL*	−19.96	2.60	−856.1
		LL	−12.84	3.21	−1056.3
		WL	19.24	16.66	5881.9
1/5.0	150	*DL*	−20.31	2.71	−897.0
		LL	−12.84	3.35	−1107.1
		WL	28.66	25.17	9001.2
1/5.0	200	*DL*	−20.75	2.82	−941.4
		LL	−12.84	3.50	−1164.5
		WL	37.88	33.81	12300.9

TABLE 34 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 12.0 m | Column Height = 9.0 m | Frame Spacing = 6.0 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−30.13	2.29	0.0
		LL	−13.75	2.24	0.0
		WL	32.77	20.72	0.3
1/3.0	150	*DL*	−32.38	2.41	0.0
		LL	−13.76	2.24	0.0
		WL	49.16	31.08	0.4
1/3.0	200	*DL*	−34.63	2.55	0.0
		LL	−13 75	2.24	0.0
		WL	65.63	41.50	0.4
1/4.0	100	*DL*	−29.07	2.20	0.0
		LL	−15.84	2.59	0.0
		WL	34.58	20.45	0.2
1/4.0	150	*DL*	−32.15	2.39	0.0
		LL	−15.83	2.59	0.0
		WL	51.86	30.67	0 5
1/4.0	200	*DL*	−34.38	2.53	0.0
		LL	−15.83	2.59	0.0
		WL	69.15	40.90	0.4
1/5.0	100	*DL*	−28.97	2.20	0.0
		LL	−17.13	2.82	0.0
		WL	35.95	20.43	0.3
1/5.0	150	*DL*	−32.04	2.38	0.0
		LL	−17.12	2.82	0.0
		WL	53.92	30.64	0.4
1/5.0	200	*DL*	−34.26	2.52	0.0
		LL	−17.12	2.81	0.0
		WL	71.89	40.85	0.4

(*Continued*)

TABLE 34 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 12.0 m | Column Height = 9.0 m | Frame Spacing = 6.0 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−25.94	3.28	−1141.2
		LL	−13.75	3.52	−1219.0
		WL	21.68	22.37	8195.6
1/3.0	150	*DL*	−26.55	3.44	−1215.8
		LL	−13.75	3.72	−1307.0
		WL	32.01	33.81	12713.8
1/3.0	200	*DL*	−27.59	3.56	−1266.1
		LL	−13.75	3.78	−1332.1
		WL	42.43	45.18	17140.7
1/4.0	100	*DL*	−25.37	3.08	−1033.0
		LL	−15.83	3.89	−1299.7
		WL	24.16	22.11	7841.9
1/4.0	150	*DL*	−26.21	3.35	−1141.0
		LL	−15.83	4.24	−1435.7
		WL	35.67	33.59	12271.5
1/4.0	200	*DL*	−27.33	3.49	−1195.7
		LL	−15.83	4.36	−1482.8
		WL	47.20	44.99	16654.6
1/5.0	100	*DL*	−25.29	3.05	−1002.1
		LL	−17.12	4.91	−1373.9
		WL	25.70	22.15	7784.6
1/5.0	150	*DL*	−26.04	3.30	−1097.6
		LL	−17.12	4.59	−1516.5
		WL	38.02	33.70	12176.6
1/5.0	200	*DL*	−27.33	3.40	−1132.3
		LL	−17.12	4.66	−1545.3
		WL	50.49	45.08	16413.2

TABLE 35 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 18.0 m Column Height = 6.0 m Frame Spacing = 4.5 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−23.15	5.83	0.0
		LL	−15.47	5.47	0.0
		WL	23.20	13.56	0.1
1/3.0	150	*DL*	−23.46	5.88	0.0
		LL	−15.47	5.46	0.0
		WL	34.80	20.32	0.1
1/3.0	200	*DL*	−24.36	6.07	0.0
		LL	−15.47	5.46	0.0
		WL	46.40	27.07	0.1
1/4.0	100	*DL*	−22.30	5.76	0.0
		LL	−17.81	6.48	0.0
		WL	25.70	14.16	0.1
1/4.0	150	*DL*	−22.86	5.86	0.0
		LL	−17.81	6.47	0.0
		WL	38.55	21.22	0.1
1/4.0	200	*DL*	−23.73	6.05	0.0
		LL	−17.81	6.46	0.0
		WL	51.40	28.27	0.1
1/5.0	100	*DL*	−22.72	5.83	0.0
		LL	−19.27	7.14	0.0
		WL	27.40	14.72	0.0
1/5.0	150	*DL*	−22.76	5.92	0.0
		LL	−19.26	7.11	0.0
		WL	41.09	22.03	0.1
1/5.0	200	*DL*	−23.06	5.99	0.0
		LL	−19.26	7.11	0.0
		WL	54.78	29.35	0.2

(*Continued*)

TABLE 35 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 18.0 m   Column Height = 6.0 m   Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−23.37	9.02	−2307.3
		LL	−15.48	8.56	−2184.1
		WL	20.62	16.62	4504.7
1/3.0	150	*DL*	−23.23	8.90	−2263.0
		LL	−15.47	8.46	−2147.9
		WL	30.95	24.77	6674.6
1/3.0	200	*DL*	−23.19	8.86	−2247.4
		LL	−15.47	8.43	−2132.6
		WL	41.27	32.94	8852.3
1/4.0	100	*DL*	−23.19	9.25	−2281.7
		LL	−17.82	10.28	−2532.0
		WL	23.40	18.05	4658.0
1/4.0	150	*DL*	−23.08	9.16	−2250.1
		LL	−17.81	10.21	−2504.1
		WL	35.11	26.95	6928.4
1/4.0	200	*DL*	−23.08	9.17	−2249.4
		LL	−17.81	10.22	−2503.0
		WL	46.80	35.93	9232.5
1/5.0	100	*DL*	−23.11	9.37	−2245.8
		LL	−19.27	11.39	−2726.8
		WL	25.21	19.11	4782.1
1/5.0	150	*DL*	−23.08	9.33	−2227.4
		LL	−19.27	11.32	−2697.3
		WL	37.81	28.52	7113.3
1/5.0	200	*DL*	−23.03	9.28	−2209.7
		LL	−19.26	11.26	−2675.8
		WL	50.42	37.89	9426.1

TABLE 36 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 18.0 m — Column Height = 6.0 m — Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−29.23	7.07	0.0
		LL	−20.63	7.26	0.0
		WL	30.93	18.03	0.2
1/3.0	150	*DL*	−30.00	7.23	0.0
		LL	−20.62	7.25	0.0
		WL	46.40	27.02	0.2
1/3.0	200	*DL*	−31.40	7.53	0.0
		LL	−20.63	7.25	0.0
		WL	61.86	36.00	0.4
1/4.0	100	*DL*	−28.97	7.07	0.0
		LL	−23.75	8.59	0.0
		WL	34.26	18.82	0.1
1/4.0	150	*DL*	−28.86	7.14	0.0
		LL	−23.75	8.58	0.0
		WL	51.39	28.21	0.1
1/4.0	200	*DL*	−29.61	7.28	0.0
		LL	−23.75	8.58	0.0
		WL	68.53	37.59	0.3
1/5.0	100	*DL*	−28.60	7.24	0.0
		LL	−25.68	9.73	0.0
		WL	36.52	19.86	0.2
1/5.0	150	*DL*	−28.62	7.17	0.0
		LL	−25.69	9.43	0.0
		WL	54.78	29.27	0.2
1/5.0	200	*DL*	−29.49	7.35	0.0
		LL	−25.69	9.42	0.0
		WL	73.04	39.00	0.2

(Continued)

TABLE 36 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 18.0 m | Column Height = 6.0 m | Frame Spacing = 6.0 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN m)
			Fixed Base		
1/3.0	100	*DL*	−29.31	11.06	−2836.6
		LL	−20.63	11.50	−2939 1
		WL	27.45	22.22	6043 2
1/3.0	150	*DL*	−29.18	10.96	−2797.1
		LL	−20.63	11.42	−2907.3
		WL	41.19	33.20	8990.9
1/3.0	200	*DL*	−29.13	10.90	−2775.3
		LL	−20.63	11.38	−2885.7
		WL	54.93	44.15	11922.6
1/4.0	100	*DL*	−29.66	11.46	−2819.9
		LL	−23.75	13.72	−3369.0
		WL	31.18	24.05	6194.8
1/4.0	150	*DL*	−29.49	11.33	−2775.2
		LL	−23.75	13.62	−3326.9
		WL	46.79	35.88	9203.7
1/4.0	200	*DL*	−29.41	11.25	−2744.8
		LL	−23.75	13.53	−3292.5
		WL	62.40	47.63	12175.9
1/5.0	100	*DL*	−29.43	11.52	−2746.8
		LL	−29.69	15.11	−3594.9
		WL	33.60	25.36	6316.4
1/5.0	150	*DL*	−29.18	11.42	−2714.4
		LL	−25.68	15.05	−3569.2
		WL	50.40	37.92	9420.1
1/5.0	200	*DL*	−29.07	11.37	−2696.4
		LL	−25.69	15.03	−3555.9
		WL	67.20	50.49	12520.4

TABLE 37 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 18.0 m Column Height = 9.0 m Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−29.17	4.31	0.0
		LL	−15.47	3.76	0.0
		WL	27.43	16.81	0.2
1/3.0	150	*DL*	−31.12	4.55	0.0
		LL	−15.47	3.76	0.0
		WL	41.14	25.21	0.4
1/3.0	200	*DL*	−33.73	4.85	0.0
		LL	−15.47	3.76	0.0
		WL	54.85	33.61	0.4
1/4.0	100	*DL*	−27.96	4.20	0.0
		LL	−17.81	4.40	0.0
		WL	29.74	16.70	0.1
1/4.0	150	*DL*	−29.83	4.41	0.0
		LL	−17.81	4.40	0.0
		WL	44.61	25.05	0.4
1/4.0	200	*DL*	−31.64	4.63	0.0
		LL	−17.81	4.40	0.0
		WL	59.47	33.40	0.2
1/5.0	100	*DL*	−27.72	4.18	0.0
		LL	−19.26	4.80	0.0
		WL	31.38	16.81	0.2
1/5.0	150	*DL*	−29.71	4.42	0.0
		LL	−19.26	4.80	0.0
		WI	47.06	25.21	0.3
1/5.0	200	*DL*	−31.52	4.64	0.0
		LL	−19.26	4.80	0.0
		WL	62.74	33.62	0.2

(*Continued*)

TABLE 37 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 18.0 m   Column Height = 9.0 m   Frame Spacing = 4.5 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−25.48	6.01	−2175.9
		LL	−15.47	5.77	−2085.4
		WL	21.85	18.58	6832.5
1/3.0	150	*DL*	−25.93	6.23	−2276.5
		LL	−15.47	5.97	−2177.2
		WL	32.60	28.07	10481.4
1/3.0	200	*DL*	−26.36	6.45	−2392.3
		LL	−15.47	6.19	−2288.2
		WL	43.18	37.71	14376.6
1/4.0	100	*DL*	−25.18	5.95	−2077.3
		LL	−17.81	6.70	−2337.8
		WL	24.56	18.72	6692.3
1/4.0	150	*DL*	−25.30	5.97	−2085.0
		LL	−17.81	6.73	−2343.6
		WL	36.82	28.10	10048.8
1/4.0	200	*DL*	−25.71	6.26	−2210.1
		LL	−17.81	7.06	−2485.6
		WL	48.84	37.92	13874.5
1/5.0	100	*DL*	−25.83	5.96	−2033.6
		LL	−19.26	7.32	−2491.0
		WL	26.32	19.00	6756.2
1/5.0	150	*DL*	−25.10	5.91	−2010.1
		LL	−19.26	7.29	−2476.6
		WL	39.48	28.47	10098.9
1/5.0	200	*DL*	−26.10	6.09	−2080.3
		LL	−19.27	7.49	−2551.2
		WL	52.54	38.23	13694.6

TABLE 38 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 18.0 m | Column Height = 9.0 m | Frame Spacing = 6.0 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−36.66	5.20	0.0
		LL	−20.62	4.99	0.0
		WL	36.57	22.39	0.2
1/3.0	150	*DL*	−40.31	5.62	0.0
		LL	−20.63	4.99	0.0
		WL	54.85	33.59	0.4
1/3.0	200	*DL*	−43.05	5.95	0.0
		LL	−20.63	4.99	0.0
		WL	73.13	44.78	0.2
1/4.0	100	*DL*	−35.34	5.08	0.0
		LL	−23.75	5.83	0.0
		WL	39.65	22.25	0.2
1/4.0	150	*DL*	−38.16	5.39	0.0
		LL	−23.75	5.85	0.0
		WL	59.47	33.37	0.2
1/4.0	200	*DL*	−39.81	5.57	0.0
		LL	−23.76	5.83	0.0
		WL	79.31	44.50	0.4
1/5.0	100	*DL*	−35.20	5.07	0.0
		LL	−25.69	6.37	0.0
		WL	41.83	22.39	0.3
1/5.0	150	*DL*	−37.88	5.37	0.0
		LL	−25.70	6.37	0.0
		WL	62.76	33.58	0.2
1/5.0	200	*DL*	−39.65	5.58	0.0
		LL	−25.69	6.36	0.0
		WL	83.66	44.77	0.4

(Continued)

TABLE 38 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 18.0 m Column Height = 9.0 m Frame Spacing = 6.0 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−32.77	7.25	−2623.1
		LL	−20.63	7.69	−2773.7
		WL	29.11	24.77	9111.0
1/3.0	150	*DL*	−32.44	7.48	−2729.6
		LL	−20.63	7.94	−2883.5
		WL	43.46	37.40	13960.3
1/3.0	200	*DL*	−33.63	7.79	−2864.4
		LL	−20.63	8.13	−2977.0
		WL	57.69	50.13	18974.5
1/4.0	100	*DL*	−32.70	7.35	−2571.6
		LL	23.75	9.10	−3174.5
		WL	32.68	25.07	9012.3
1/4.0	150	*DL*	−31.91	7.31	−2556.7
		LL	−23.75	9.11	−3175.2
		WL	49.01	37.62	13521.8
1/4.0	200	*DL*	−33.76	7.62	−2671.8
		LL	−23.75	9.27	−3237.7
		WL	65.21	50.37	18234.1
1/5.0	100	*DL*	−32.57	7.35	−2508.9
		LL	−25.69	9.96	−3392.4
		WL	35.03	25.48	9116.1
1/5.0	150	*DL*	−31.80	7.28	−2479.6
		LL	−25.69	9.88	−3354.3
		WL	52.57	38.40	13584.5
1/5.0	200	*DL*	−33.52	7.41	−2516.0
		LL	−25.69	9.79	−3315.5
		WL	70.13	50.72	17983.4

TABLE 39 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 18.0 m | Column Height = 12.0 m | Frame Spacing = 4.5 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−35.84	3.47	0.0
		LL	−15.47	2.85	0.0
		WL	33.31	21.12	0.4
1/3.0	150	*DL*	−38.52	3.66	0.0
		LL	−15.47	2.85	0.0
		WL	49.96	31.67	0.4
1/3.0	200	*DL*	−43.77	4.08	0.0
		LL	−15.47	2.85	0.0
		WL	66.61	42.22	0.2
1/4.0	100	*DL*	−34.37	3.34	0.0
		LL	−17.81	3.32	0.0
		WL	35.43	20.86	0.2
1/4.0	150	*DL*	−37.68	3.60	0.0
		LL	−17.82	3.32	0.0
		WL	53.16	31.29	0.4
1/4.0	200	*DL*	−40.83	3.85	0.0
		LL	−17.82	3.31	0.0
		WL	70.87	41.72	0.2
1/5.0	100	*DL*	−34.24	3.34	0.0
		LL	−19.26	3.61	0.0
		WL	37.01	20.88	0.2
1/5.0	150	*DL*	−37.39	3.57	0.0
		LL	−19.27	3.61	0.0
		WL	55.51	31.31	0.5
1/5.0	200	*DL*	−40.52	3.81	0.0
		LL	−19.27	3.61	0.0
		WL	74.02	41.74	0.2

(Continued)

TABLE 39 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 18.0 m | Column Height = 12.0 m | Frame Spacing = 4.5 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−28.81	4.65	−2195.0
		LL	−15.47	4.53	−2130.5
		WL	23.33	22.99	11342.5
1/3.0	150	*DL*	−29.51	4.85	−2317 2
		LL	−15.47	4.72	−2246.5
		WL	34.61	34.70	17477 2
1/3.0	200	*DL*	−31.18	5.06	−2442.3
		LL	−15.47	4.84	−2321.9
		WL	45.77	46.44	23755.0
1/4.0	100	*DL*	−28.07	4.40	−1994.4
		LL	−17.81	5.04	−2278.3
		WL	26.14	22.79	10834.4
1/4.0	150	*DL*	−29.19	4.77	−2194.5
		LL	−17.81	5.46	−2503.8
		WL	38.66	34.65	16987.9
1/4.0	200	*DL*	−30.78	4.88	−2260.8
		LL	−17.81	5.57	−2566.9
		WL	51.29	46.37	22977.4
1/5.0	100	*DL*	−27.98	4.37	−1935.6
		LL	−19.27	5.44	−2407.5
		WL	27.89	22.89	10764.9
1/5.0	150	*DL*	−28.52	4.58	−2044.7
		LL	−19.26	5.76	−2562.7
		WL	41.52	34.70	16611.8
1/5.0	200	*DL*	−30.81	4.84	−2175.8
		LL	−19.26	5.97	−2671.7
		WL	54.98	46.57	22641.8

TABLE 40 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 18.0 m   Column Height = 12.0 m   Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−45.21	4.15	0.0
		LL	−20.63	3.79	0.0
		WL	44.41	28.31	0.4
1/3.0	150	*DL*	−51.17	4.61	0.0
		LL	−20.63	3.78	0 0
		WL	66.61	42.20	0.4
1/3.0	200	*DL*	−54.81	4.88	0.0
		LL	−20.63	3.78	0.0
		WL	88.81	56.27	0.4
1/4.0	100	*DL*	−44.87	4.12	0.0
		LL	−23.76	4.40	0.0
		WL	47.24	27.79	0.5
1/4.0	150	*DL*	−48.00	4.33	0.0
		LL	−23.76	4.40	0.0
		WL	70.87	41.69	0.1
1/4.0	200	*DL*	−54.20	4.82	0.0
		LL	−23.75	4.39	0.0
		WL	94.49	55.59	0.2
1/5.0	100	*DL*	−42.48	3.91	0.0
		LL	−25.70	4.78	0.0
		WL	49.35	27.81	0.5
1/5.0	150	*DL*	−47.83	4.32	0.0
		LL	−25.69	4.78	0.0
		WL	74.01	41.71	0.1
1/5.0	200	*DL*	−50.38	4.51	0.0
		LL	−25.69	4.78	0.0
		WL	98.68	55.61	0.2

(*Continued*)

TABLE 40 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 18.0 m Column Height = 12.0 m Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)	Axial (kN)	Shear (kN)	Moment (kN.m)
		Fixed Base		
1/3.0	100 *DL*	−36.40	5.58	−2632.7
	LL	−20.63	6.03	−2826.0
	WL	31.10	30.64	15113.3
1/3.0	150 *DL*	−37.73	5.80	−2754.4
	LL	−20.63	6.20	−2926.1
	WL	46.30	46.17	23102.1
1/3.0	200 *DL*	−39.14	6.05	−2904.2
	LL	−20.62	6.38	−3042.0
	WL	61.15	61.84	31500.7
1/4.0	100 *DL*	−35.80	5.40	−2449.7
	LL	−23.75	6.85	−3095.8
	WL	34.74	30.48	14583.3
1/4.0	150 *DL*	−37.15	5.80	−2679.1
	LL	−23.75	7.37	−3383.0
	WL	51.35	46.32	22889.6
1/4.0	200 *DL*	−39.74	5.94	−2735.0
	LL	−23.75	7.35	−3362.6
	WL	68.49	61.72	30464.9
1/5.0	100 *DL*	−35.69	5.35	−2375.0
	LL	−25.69	7.40	−3270.7
	WL	37.09	30.63	14487.5
1/5.0	150 *DL*	−36.46	5.62	−2513.7
	LL	−25.69	7.83	−3487.8
	WL	55.13	46.45	22443.0
1/5.0	200 *DL*	−39.20	5.77	−2569.4
	LL	−25.69	7.71	−3419.5
	WL	73.68	61.74	29652.0

TABLE 41 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 24.0 m Column Height = 9.0 m Frame Spacing = 4.5 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−35.72	7.79	0.0
		LL	−20.62	6.57	0.0
		WL	32.14	18.42	0.1
1/3.0	150	*DL*	−37.87	8.16	0.0
		LL	−20.63	6.57	0.0
		WL	48.20	27.62	0.4
1/3.0	200	*DL*	−41.11	8.76	0.0
		LL	−20.63	6.56	0.0
		WL	64.27	36.82	0.4
1/4.0	100	*DL*	−33.55	7.42	0.0
		LL	−23.75	7.75	0.0
		WL	35.41	19.00	0.3
1/4.0	150	*DL*	−35.76	7.81	0.0
		LL	−23.75	7.74	0.0
		WL	53.10	28.47	0.3
1/4.0	200	*DL*	−37.90	8.21	0.0
		LL	−23.75	7.74	0.0
		WL	70.80	37.94	0.4
1/5.0	100	*DL*	−32.64	7.33	0.0
		LL	−25.69	8.50	0.0
		WL	37.65	19.60	0.3
1/5.0	150	*DL*	−34.57	7.67	0.0
		LL	−25.69	8.49	0.0
		WL	56.46	29.38	0.2
1/5.0	200	*DL*	−36.67	8.07	0.0
		LL	−25.69	8.49	0.0
		WL	75.28	39.15	0.4

(*Continued*)

TABLE 41 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 24.0 m | Column Height = 9.0 m | Frame Spacing = 4.5 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−32.63	11.18	−4253.1
		LL	−20.63	10.45	−3966.8
		WL	27.76	22.06	9041.7
1/3.0	150	*DL*	−32.54	11.15	−4231.6
		LL	−20.63	10.43	−3946.3
		WL	41.64	33.03	13512.7
1/3.0	200	*DL*	−31.85	11.17	−4234.7
		LL	−20.63	10.44	−3949.8
		WL	55.50	44.05	18026.9
1/4.0	100	*DL*	−32.08	11.09	−4047.7
		LL	−23.76	12.37	−4504.4
		WL	31.49	23.55	9159.8
1/4.0	150	*DL*	−31.94	11.06	−4028.0
		LL	−23.76	12.36	−4490.8
		WL	47.22	35.28	13704.5
1/4.0	200	*DL*	−30.73	10.82	−3916.4
		LL	−23.76	12.18	−4400.9
		WL	63.01	46.66	18017.3
1/5.0	100	*DL*	−32.41	11.27	−3989.4
		LL	−25.69	13.54	−4784.0
		WL	33.89	24.63	9285.3
1/5.0	150	*DL*	−32.10	11.16	−3941.7
		LL	−25.69	13.53	−4768.5
		WL	50.83	36.90	13890.6
1/5.0	200	*DL*	−30.47	10.79	−3786.9
		LL	−25.69	13.31	−4662.0
		WL	67.82	48.71	18232.5

TABLE 42 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 24.0 m | Column Height = 9.0 m | Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−44.61	9.42	0.0
		LL	−27.50	8.72	0.0
		WL	42.85	24.53	0.2
1/3.0	150	*DL*	−48.89	10.18	0.0
		LL	−27.50	8.72	0.0
		WL	64.26	36.79	0.5
1/3.0	200	*DL*	−52.12	10.77	−0.0
		LL	−27.50	8.71	0.0
		WL	85.68	49.04	0.1
1/4.0	100	*DL*	−42.27	9.02	0.0
		LL	−31.67	10.28	0.0
		WL	47.21	25.27	0.4
1/4.0	150	*DL*	−45.42	9.58	0.0
		LL	−31.67	10.28	0.0
		WL	70.80	37.87	0.4
1/4.0	200	*DL*	−47.53	9.96	0.0
		LL	−31.67	10.27	−0.0
		WL	94.40	50.47	0.2
1/5.0	100	*DL*	−42.08	9.08	0.0
		LL	−34.25	11.27	0.0
		WL	50.19	26.06	0.4
1/5.0	150	*DL*	−44.15	9.44	0.0
		LL	−34.25	11.26	0.0
		WL	75.28	39.06	0.4
1/5.0	200	*DL*	−47.31	10.03	0.0
		LL	−34.25	11.26	0.0
		WL	100.37	52.06	0.4

(*Continued*)

TABLE 42 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 24.0 m　　Column Height = 9.0 m　　Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)	Axial (kN)	Shear (kN)	Moment (kN m)
		Fixed Base		
1/3.0	100 *DL*	41.35	13.68	−5170.8
	LL	−27.50	13.81	5205.5
	WL	37.03	29.25	11920.9
1/3.0	150 *DL*	−41.30	13.67	−5158.3
	LL	−27.50	13.81	−5194.3
	WL	55.53	43.84	17851.8
1/3.0	200 *DL*	−40.71	13.63	−5134.0
	LL	−27.50	13.77	−5167.0
	WL	74.04	58.34	23714.4
1/4.0	100 *DL*	−40.93	13.64	−4949.2
	LL	−31.67	16.33	−5910.9
	WL	41.98	31.20	12071.1
1/4.0	150 *DL*	−40.57	13.51	−4888.6
	LL	−31.67	16.32	−5888.7
	WL	62.97	46.73	18051.6
1/4.0	200 *DL*	−41.03	13.42	−4819.4
	LL	−31.66	15.95	−5710.0
	WL	84.06	61.51	23564.2
1/5.0	100 *DL*	−41.00	13.72	−4824.2
	LL	−34.25	17.86	−6265.7
	WL	45.19	32.59	12217.9
1/5.0	150 *DL*	−38.70	13.39	−4710.0
	LL	−34.25	18.04	−6330.4
	WL	67.75	49.15	18450.4
1/5.0	200 *DL*	−39.32	13.38	−4678.1
	LL	−34.25	17.75	−6190.6
	WL	90.39	64.88	24219.0

TABLE 43 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 24.0 m   Column Height = 12.0 m   Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Hinged Base		
1/3.0	100	DL	−42.81	6.35	0.0
		LL	−20.63	5.03	0.0
		WL	36.57	22.42	0.4
1/3.0	150	DL	−45.88	6.71	0.0
		LL	−20.63	5.03	0.0
		WL	54.86	33.63	0.4
1/3.0	200	DL	−48.92	7.08	0.0
		LL	−20.62	5.03	0.0
		WL	73.13	44.83	0.1
1/4.0	100	DL	−40.50	6.03	0.0
		LL	−23.75	5.88	0.0
		WL	39.65	22.29	0.4
1/4.0	150	DL	−44.12	6.45	0.0
		LL	−23.75	5.88	0.0
		WL	59.47	33.42	0.2
1/4.0	200	DL	−47.76	6.90	0.0
		LL	−23.76	5.88	0.0
		WL	79.31	44.57	0.2
1/5.0	100	DL	−39.15	5.89	0.0
		LL	−25.69	6.42	0.0
		WL	41.83	22.43	0.4
1/5.0	150	DL	−43.94	6.46	0.0
		LL	−25.69	6.42	0.0
		WL	62.74	33.64	0.2
1/5.0	200	DL	−41.56	6.91	0.0
		LL	−25.69	6.42	0.0
		WL	83.67	44.85	0.2

(*Continued*)

TABLE 43 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 24.0 m | Column Height = 12.0 m | Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−35.41	8.37	−4063.0
		LL	−20.63	7.88	3818.4
		WL	29.03	24.89	12332.2
1/3.0	150	*DL*	−34.80	8.52	−4166.6
		LL	−20.63	8.07	3935.7
		WL	43.36	37.53	18827.9
1/3.0	200	*DL*	36.39	8.89	4387.4
		LL	−20.63	8.26	4063.4
		WL	57.54	50.30	25602.7
1/4.0	100	*DL*	−34.63	8.19	−3842.5
		LL	23.75	9.30	−4352.7
		WL	32.62	25.20	12217.4
1/4.0	150	*DL*	33.76	8.18	−3830.7
		LL	−23.75	9.28	−4335.0
		WL	48.92	37.78	18283.8
1/4.0	200	*DL*	−35.77	8.41	−3939.8
		LL	−23.75	9.33	−4359.3
		WL	65.17	50.45	24462.3
1/5.0	100	*DL*	−33.47	8.07	−3684.2
		LL	−25.69	10.05	−4575.2
		WL	35.01	25.53	12237.5
1/5.0	150	*DL*	−33.49	8.10	−3690.5
		LL	−25.69	10.07	−4579.6
		WL	52.50	38.32	18369.8
1/5.0	200	*DL*	−35.72	8.30	−3770.1
		LL	−25.68	9.98	−4526.8
		WL	70.03	50.98	24320.1

TABLE 44 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 24.0 m Column Height = 12.0 m Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−53.84	7.68	−0.0
		LL	−27.50	6.68	0.0
		WL	48.75	29.87	0.2
1/3.0	150	*DL*	−57.49	8.10	0.0
		LL	−27.50	6.67	0.0
		WL	73.12	44.80	0.1
1/3.0	200	*DL*	−64.72	8.98	0.0
		LL	−27.51	6.67	0.0
		WL	97.52	59.74	0.4
1/4.0	100	*DL*	−50.07	7.16	0.0
		LL	−31.67	7.80	0.0
		WL	52.87	29.69	0.5
1/4.0	150	*DL*	−56.27	7.92	0.0
		LL	−31.68	7.81	0.0
		WL	79.31	44.52	0.2
1/4.0	200	*DL*	−59.23	8.27	0.0
		LL	−31.68	7.80	0.0
		WL	105.74	59.36	0.1
1/5.0	100	*DL*	−49.87	7.17	0.0
		LL	−34.25	8.52	0.0
		WL	55.77	29.87	0.4
1/5.0	150	*DL*	−56.04	7.93	0.0
		LL	−34.27	8.52	0.0
		WL	83.68	44.81	0.2
1/5.0	200	*DL*	−58.98	8.28	0.0
		LL	−34.26	8.51	0.0
		WL	111.55	59.73	0.4

(*Continued*)

TABLE 44 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 24.0 m Column Height = 12.0 m Frame Spacing = 6.0 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−43.29	10.03	−4851.2
		LL	−27.50	10.42	−5024.5
		WL	38.73	33.14	16371.9
1/3.0	150	*DL*	−44.65	10.41	−5066.7
		LL	−27.50	10.65	−5157.1
		WL	57.88	49.93	24943.9
1/3.0	200	*DL*	−46.91	10.77	−5278.0
		LL	−27.50	10.88	−5307.0
		WL	76.83	66.90	33865.0
1/4.0	100	*DL*	−42.21	9.71	−4524.1
		LL	−31.67	12.12	−5631.6
		WL	43.57	33.42	16000.6
1/4.0	150	*DL*	−44.06	9.95	−4642.0
		LL	−31.66	12.29	−5716.1
		WL	65.24	50.32	24218.4
1/4.0	200	*DL*	−46.10	10.34	−4833.0
		LL	−31.67	12 42	−5780.6
		WL	86.87	67.26	32506.5
1/5.0	100	*DL*	−42.13	9.76	−4440.5
		LL	−34.25	13.35	−6055.9
		WL	46.69	34.02	16247.1
1/5.0	150	*DL*	−44.25	9.98	−4530.6
		LL	−34.25	13.35	−6043.6
		WL	70.00	51.03	24339.6
1/5.0	200	*DL*	−45.66	10.04	−4531.8
		LL	−34.25	12.99	−5848.0
		WL	93.52	67.54	31828.9

TABLE 45 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 30.0 m | Column Height = 9.0 m | Frame Spacing = 4.5 m

Slope	Wind Load (kg m²)		Axial (kN)	Shear (kN)	Moment (kN m)
			Hinged Base		
1/3.0	100	*DL*	−41.62	11.87	0.0
		LL	−25.78	10.04	0.0
		WL	37.59	22.55	0.3
1/3.0	150	*DL*	−44.10	12.46	0.0
		LL	−25.78	10.04	0.0
		WL	56.38	33.80	0.2
1/3.0	200	*DL*	−47.66	13.32	0.0
		LL	−25.78	10.03	0.0
		WL	75.17	45.03	0.4
1/4.0	100	*DL*	−39.75	11.70	0.0
		LL	−29.69	11.94	0.0
		WL	41.82	23.80	0.3
1/4.0	150	*DL*	−42.29	12.32	0.0
		LL	−29.68	11.93	0.0
		WL	62.72	35.66	0.4
1/4.0	200	*DL*	−44.59	12.87	0.0
		LL	−29.69	11.93	0.0
		WL	83.63	47.53	0.2
1/5.0	100	*DL*	−39.08	11.55	0.0
		LL	−32.11	13.43	0.0
		WL	44.66	25.15	0.2
1/5.0	150	*DL*	−40.18	11.86	0.0
		LL	−32.11	13.15	0.0
		WL	66.99	37.25	0.2
1/5.0	200	*DL*	−42.60	12.49	0.0
		LL	−32.11	13.14	0.0
		WL	89.31	49.63	0.4

(Continued)

TABLE 45 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 30.0 m | Column Height = 9.0 m | Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN m)
			Fixed Base		
1/3.0	100	*DL*	−39.57	17.36	−6790.4
		LL	−25.79	15.83	−6181.4
		WL	34.00	28.42	11664.7
1/3.0	150	*DL*	−39.20	17.20	−6715.8
		LL	−25.79	15.81	−6161.2
		WL	50.99	42.57	17445.3
1/3.0	200	*DL*	−37.18	16.63	−6454.7
		LL	−25.79	15.68	−6075.9
		WL	68.03	56.46	23012.4
1/4.0	100	*DL*	−39.99	18.09	−6780.0
		LL	−29.69	19.00	−7113.1
		WL	38.72	31.14	12054.6
1/4.0	150	*DL*	−39.63	17.93	−6704.3
		LL	−29.70	18.99	−7089.8
		WL	98.08	46.65	18022.2
1/4.0	200	*DL*	−39.53	17.84	−6645.9
		LL	−29.69	18.89	−7025.3
		WL	77.43	61.96	23854.6
1/5.0	100	*DL*	−39.97	18.22	−6608.0
		LL	−32.11	20.98	−7600.2
		WL	41.75	33.05	12332.6
1/5.0	150	*DL*	−39.55	18.03	−6518.3
		LL	−32.11	20.95	−7564.7
		WL	62.62	49.49	18417.3
1/5.0	200	*DL*	−39.87	18.20	−6583.0
		LL	−32.11	21.11	−7626.4
		WL	83.46	66.28	24683.4

TABLE 46 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 30.0 m | Column Height = 9.0 m | Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN m)
			Hinged Base		
1/3.0	100	*DL*	−53.07	14.71	−0.0
		LL	−34.38	13.34	0.0
		WL	50.12	29.99	0.4
1/3.0	150	*DL*	−56.79	15.59	0.0
		LL	−34.38	13.33	−0.0
		WL	75.18	44.95	0.2
1/3.0	200	*DL*	−60.32	16.43	−0.0
		LL	−34.38	13.32	−0.0
		WL	100.23	59.89	0.2
1/4.0	100	*DL*	−49.99	14.30	0.0
		LL	−39.58	15.85	0.0
		WL	55.75	31.64	0.4
1/4.0	150	*DL*	−52.40	14.87	0.0
		LL	−39.58	15.84	0.0
		WL	83.63	47.42	0.4
1/4.0	200	*DL*	−56.06	15.79	0.0
		LL	−39.58	15.83	−0.0
		WL	111.50	63.18	0.1
1/5.0	100	*DL*	−49.32	14.30	0.0
		LL	−42.81	18.00	−0.0
		WL	59.54	33.62	0.4
1/5.0	150	*DL*	−51.41	14.75	0.0
		LL	−42.81	17.45	0.0
		WL	89.32	49.51	0.4
1/5.0	200	*DL*	−54.85	15.59	0.0
		LL	−42.81	17.44	0.0
		WL	119.08	65.96	0.1

(Continued)

TABLE 46 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 30.0 m | Column Height = 9.0 m | Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−50.04	21.28	−8266.1
		LL	−34.38	20.92	−8102.3
		WL	45.35	37.64	15341.3
1/3.0	150	*DL*	−49.81	21.20	−8215.9
		LL	−34.38	20.89	−8071.8
		WL	68.01	56.37	22934.5
1/3.0	200	*DL*	−47.22	20.36	−7841.0
		LL	−34.38	20.69	−7943.4
		WL	90.76	74.71	30205.7
1/4.0	100	*DL*	−50.67	22.18	−8254.2
		LL	−39.58	25.10	−9318.5
		WL	51.62	41.21	15839.8
1/4.0	150	*DL*	−50.37	22.07	−8186.0
		LL	−39.58	25.06	−9272.3
		WL	77.43	61.69	23652.0
1/4.0	200	*DL*	−47.12	21.19	−7851.9
		LL	−39.59	25.11	−9280.0
		WL	103.24	82.31	31531.2
1/5.0	100	*DL*	−51.34	22.50	−8082.0
		LL	−42.81	27.56	−9884.6
		WL	55.68	43.56	16117.5
1/5.0	150	*DL*	−46.27	20.82	−7443.9
		LL	−42.81	27.36	−9762.1
		WL	83.53	64.98	23935.5
1/5.0	200	*DL*	−47.33	21.17	−7550.0
		LL	−42.81	27.36	−9735.1
		WL	111.36	86.57	31823.1

TABLE 47 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 30.0 m Column Height 12.0 m Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−49.07	9.78	0.0
		LL	−25.78	7.76	0.0
		WL	41.16	24.00	0.4
1/3.0	150	*DL*	−52.55	10.34	−0.0
		LL	−25.78	7.76	0.0
		WL	61.73	35.98	0.1
1/3.0	200	*DL*	−56.00	10.93	−0.0
		LL	25.78	7.75	0.0
		WL	82.29	47.97	0.2
1/4.0	100	*DL*	−45.71	9.33	0.0
		LL	−29.69	9.13	0.0
		WL	45.20	24.08	0.2
1/4.0	150	*DL*	−51.35	10.30	0.0
		LL	29.69	9.13	0.0
		WL	67.78	36.10	0.2
1/4.0	200	*DL*	−55.26	10.94	0.0
		LL	−29.69	9.12	0.0
		WL	90.38	48.14	0.1
1/5.0	100	*DL*	−44.95	9.21	0.0
		LL	−32.11	10.01	0.0
		WL	47.98	24.65	0.4
1/5.0	150	*DL*	−47.68	9.65	0.0
		LL	−32.11	10.00	0.0
		WL	71.97	36.96	0.4
1/5.0	200	*DL*	−51.09	10.24	0.0
		LL	−32.11	9.99	0.0
		WL	95.94	49.24	0.4

(Continued)

TABLE 47 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 30.0 m Column Height = 12.0 m Frame Spacing = 4.5 m

SLOPE	WIND LOAD (kg/m²)		AXIAL (kN)	SHEAR (kN)	MOMENT (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−42.11	13.26	−6653.8
		LL	−25.79	12.31	−6162.2
		WL	34.97	27.48	15007.9
1/3.0	150	*DL*	−42.07	13.24	−6624.0
		LL	−25.79	12.26	−6122.1
		WL	52.46	41.13	22410.5
1/3.0	200	*DL*	−41.55	13.22	−6581.8
		LL	−25.78	12.13	−6025.1
		WL	70.01	54.56	29561.9
1/4.0	100	*DL*	−39.49	12.87	−6174.5
		LL	−29.70	14.31	−6850.1
		WL	39.64	28.92	14942.2
1/4.0	150	*DL*	−41.92	13.39	−6437.0
		LL	−29.69	14.49	−6949.0
		WL	59.39	43.62	22624.0
1/4.0	200	*DL*	−40.29	12.97	−6178.3
		LL	−29.69	14.11	−6711.4
		WL	79.32	57.37	29471.1
1/5.0	100	*DL*	−42.11	13.37	−6250.7
		LL	−32.10	15.83	−7388.2
		WL	42.59	30.33	15283.5
1/5.0	150	*DL*	−41.55	13.20	−6154.5
		LL	−32.11	15.82	−7363.1
		WL	63.89	45.44	22868.6
1/5.0	200	*DL*	−41.51	13.22	−6153.8
		LL	−32.10	15.81	−7343.1
		WL	65.17	60.53	30429.4

TABLE 48 FOUNDATION FORCES OF LATTICE PORTAL FRAMES

Span = 30.0 m | Column Height = 12.0 m | Frame Spacing = 6.0 m

Slope	Wind Load (kg/m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Hinged Base		
1/3.0	100	*DL*	−61.60	11.90	−0.0
		LL	−34.38	10.30	0.0
		WL	54.87	31.95	0.4
1/3.0	150	*DL*	−65.94	12.62	−0.0
		LL	−34.38	10.30	−0.0
		WL	82.30	47.92	0.2
1/3.0	200	*DL*	−73.89	13.94	−0.0
		LL	−34.38	10.29	−0.0
		WL	109.73	63.90	0.2
1/4.0	100	*DL*	−58.33	11.52	0.0
		LL	−39.58	12.12	0.0
		WL	60.26	32.06	0.2
1/4.0	150	*DL*	−65.11	12.64	0.0
		LL	−39.58	12.11	0.0
		WL	90.38	48.08	0.1
1/4.0	200	*DL*	−68.47	13.21	0.0
		LL	−39.58	12.11	−0.0
		WL	120.50	64.11	0.2
1/5	100	*DL*	−55.76	11.05	0.0
		LL	−42.81	13.27	−0.0
		WL	63.97	32.79	0.5
1/5.0	150	*DL*	−60.71	11.89	−0.0
		LL	−42.81	13.27	−0.0
		WL	95.94	49.14	0.4
1/5.0	200	*DL*	−67.19	12.98	0.0
		LL	−42.81	13.26	0.0
		WL	127.93	65.50	0.2

(Continued)

TABLE 48 FOUNDATION FORCES OF LATTICE PORTAL FRAMES—*Contd*

Span = 30.0 m　　Column Height = 12.0 m　　Frame Spacing = 6.0 m

Slope	Wind Load (kg m²)		Axial (kN)	Shear (kN)	Moment (kN.m)
			Fixed Base		
1/3.0	100	*DL*	−53.32	16.18	−8071.2
		LL	−34.37	16.25	−8080.0
		WL	46.64	36.43	19782.6
1/3.0	150	*DL*	−50.97	15.73	−7809.5
		LL	−34.38	16.10	−7964.1
		WL	70.03	54.42	29386.0
1/3.0	200	*DL*	−54.15	16.37	−8146.8
		LL	−34.37	16.26	−8064.9
		WL	93.22	72.79	39509.3
1/4.0	100	*DL*	−53.78	16.53	−7913.2
		LL	−39.59	19.14	−9138.2
		WL	52.82	38.57	19920.4
1/4.0	150	*DL*	−53.30	16.36	−7816.4
		LL	−39.58	19.12	−9107.7
		WL	79.21	57.79	29806.5
1/4.0	200	*DL*	−54.31	16.41	−7781.4
		LL	−39.58	18.68	−8831.4
		WL	105.76	76.10	38930.4
1/5.0	100	*DL*	−53.18	16.24	−7543.0
		LL	−42.81	20.89	−9679.2
		WL	56.82	40.15	20127.6
1/5.0	150	*DL*	−49.41	15.42	−7127.0
		LL	−42.82	20.63	−9509.1
		WL	85.28	59.78	29828.8
1/5.0	200	*DL*	−49.91	15.50	−7149.4
		LL	−42.80	20.59	−9470.7
		WL	113.68	79.59	39659.6

TABLE 49 CONSTANTS OF POLYNOMINAL EQUATION FOR OPTIMAL LATTICE PORTAL FRAMES

Base Condition	Corner Leg Members Spacing (mm) of	Coefficient Values				
		k_0	k_1	k_2	k_3	k_4
Fixed	Column haunch	18.7	0.281	0.820	0.136	0.143
	Column base	17.9	0.271	0.928	0.064	0.106
	Beam haunch	15.0	0.701	0.423	0.245	0.095
	Beam crown	7.9	0.344	0.847	0.148	0.217
	Column and beam width	12.1	0.384	0.385	0.296	0.198
Hinged	Column haunch	29.0	0.173	0.899	0.202	0.150
	Column base	55.6	0.070	0.806	0.079	0.130
	Beam haunch	27.3	0.506	0.447	0.190	0.138
	Beam crown	27.6	0.432	0.432	0.156	0.160
	Column and beam width	3.2	0.376	0.878	0.402	0.315

TABLE 50 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 9.0 m | Column Height = 4.5 m | Frame Spacing = 4.5 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt (kg/m²)
					Hinged Base				
1/3.0	100	Column	45	21	5050 × 6	14-Dia	8-Dia	36	
		Beam	42	21	5050 × 6	18-Dia	14-Dia	33	13.3
	150	Column	48	24	5050 × 6	16-Dia	10-Dia	39	
		Beam	44	24	5050 × 6	18-Dia	14-Dia	35	13.9
	200	Column	50	26	6060 × 6	16-Dia	10-Dia	40	
		Beam	46	26	6060 × 6	18-Dia	12-Dia	36	15.4
1/4.0	100	Column	45	21	5050 × 6	14-Dia	8-Dia	36	
		Beam	42	21	5050 × 6	18-Dia	14-Dia	33	13.1
	150	Column	48	24	5050 × 6	16-Dia	10-Dia	39	
		Beam	44	24	5050 × 6	18-Dia	14-Dia	35	13.7
	200	Column	50	26	6060 × 6	16-Dia	10-Dia	40	
		Beam	46	26	6060 × 6	18-Dia	14-Dia	37	15.4
1/5.0	100	Column	45	21	5050 × 6	14-Dia	8-Dia	36	
		Beam	42	21	5050 × 6	18-Dia	14-Dia	33	13.0
	150	Column	48	24	5050 × 6	16-Dia	10-Dia	39	
		Beam	44	24	5050 × 6	18-Dia	14-Dia	35	13.7
	200	Column	50	26	6060 × 6	16-Dia	10-Dia	40	
		Beam	46	26	6060 × 6	18-Dia	14-Dia	36	15.3
					Fixed Base				
1/3.0	100	Column	27	19	5050 × 6	10-Dia	8-Dia	20	
		Beam	31	19	5050 × 6	16-Dia	12-Dia	24	12.0
	150	Column	28	21	5050 × 6	10-Dia	8-Dia	22	
		Beam	32	21	5050 × 6	16-Dia	12-Dia	24	12.0
	200	Column	29	22	5050 × 6	12-Dia	8-Dia	23	
		Beam	33	22	5050 × 6	16-Dia	10-Dia	25	12.1
1/4.0	100	Column	27	19	5050 × 6	10-Dia	8-Dia	20	
		Beam	31	19	5050 × 6	16-Dia	12-Dia	24	11.8
	150	Column	28	21	5050 × 6	10-Dia	8-Dia	22	
		Beam	32	21	5050 × 6	16-Dia	12-Dia	25	11.9
	200	Column	29	22	5050 × 6	12-Dia	8-Dia	23	
		Beam	33	22	5050 × 6	16-Dia	12-Dia	25	12.2
1/5.0	100	Column	27	19	5050 × 6	10-Dia	8-Dia	20	
		Beam	31	19	5050 × 6	16-Dia	12-Dia	24	11.8
	150	Column	28	21	5050 × 6	10-Dia	8-Dia	22	
		Beam	32	21	5050 × 6	16-Dia	12-Dia	25	11.8
	200	Column	29	22	5050 × 6	10-Dia	8-Dia	23	
		Beam	33	22	5050 × 6	16-Dia	12-Dia	26	11.8

TABLE 51 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 9.0 m | Column Height = 4.5 m | Frame Spacing = 6.0 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
					Hinged Base				
1/3.0	100	Column	47	24	5050 × 6	14-Dia	10-Dia	37	
		Beam	44	24	5050 × 6	18-Dia	16-Dia	35	10.3
	150	Column	50	27	6060 × 6	16-Dia	10-Dia	40	
		Beam	47	27	6060 × 6	4040 × 6	14-Dia	37	13.1
	200	Column	53	29	7575 × 6	16-Dia	12-Dia	42	
		Beam	49	29	7575 × 6	4040 × 6	14-Dia	39	15.3
1/4.0	100	Column	47	24	5050 × 6	14-Dia	10-Dia	37	
		Beam	44	24	5050 × 6	4040 × 6	16-Dia	35	11.6
	150	Column	50	27	6060 × 6	16-Dia	10-Dia	40	
		Beam	47	27	6060 × 6	4040 × 6	16-Dia	37	13.2
	200	Column	52	29	6565 × 6	16-Dia	12-Dia	42	
		Beam	49	29	6565 × 6	4040 × 6	14-Dia	38	13.8
1/5.0	100	Column	47	24	5050 × 6	14-Dia	10-Dia	37	
		Beam	44	24	5050 × 6	4040 × 6	16-Dia	35	11.5
	150	Column	50	27	5050 × 6	16-Dia	10-Dia	40	
		Beam	47	27	5050 × 6	4040 × 6	16-Dia	38	11.9
	200	Column	52	29	6565 × 6	16-Dia	12-Dia	42	
		Beam	49	29	6565 × 6	4040 × 6	14-Dia	39	13.7
					Fixed Base				
1/3.0	100	Column	28	21	5050 × 6	10-Dia	8-Dia	21	
		Beam	33	21	5050 × 6	16-Dia	12-Dia	26	9.0
	150	Column	29	23	5050 × 6	10-Dia	8-Dia	23	
		Beam	34	23	5050 × 6	16-Dia	12-Dia	27	9.0
	200	Column	30	24	5050 × 6	12-Dia	8-Dia	23	
		Beam	35	24	5050 × 6	18-Dia	12-Dia	27	9.7
1/4.0	100	Column	28	21	5050 × 6	10-Dia	8-Dia	21	
		Beam	33	21	5050 × 6	18-Dia	14-Dia	25	9.5
	150	Column	29	23	5050 × 6	12-Dia	8-Dia	23	
		Beam	34	23	5050 × 6	18-Dia	14-Dia	27	9.8
	200	Column	30	24	5050 × 6	12-Dia	8-Dia	23	
		Beam	35	24	5050 × 6	18-Dia	12-Dia	28	9.6
1/5.0	100	Column	28	21	5050 × 6	12-Dia	8-Dia	21	
		Beam	33	21	5050 × 6	18-Dia	14-Dia	26	9.7
	150	Column	29	23	5050 × 6	12-Dia	8-Dia	23	
		Beam	34	23	5050 × 6	18-Dia	14-Dia	26	9.7
	200	Column	30	24	5050 × 6	12-Dia	8-Dia	23	
		Beam	35	24	5050 × 6	18-Dia	12-Dia	27	9.5

TABLE 52 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 9.0 m | Column Height = 6.0 m | Frame Spacing = 4.5 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Intersection with Corner Leg Members (cm)	Unit Wt. (kg/m²)
					Hinged Base				
1/3.0	100	Column	58	27	5050 × 6	18-Dia	10-Dia	46	
		Beam	47	27	5050 × 6	18-Dia	14-Dia	37	16.7
	150	Column	62	31	7575 × 6	4040 × 6	12-Dia	50	
		Beam	51	31	7575 × 6	18-Dia	14-Dia	41	24.3
	200	Column	64	34	8080 × 6	4040 × 6	12-Dia	52	
		Beam	53	34	8080 × 6	4040 × 6	12-Dia	43	27.1
1/4.0	100	Column	58	27	5050 × 6	18-Dia	10-Dia	46	
		Beam	47	27	5050 × 6	18-Dia	14-Dia	38	16.5
	150	Column	61	31	6565 × 6	4040 × 6	12-Dia	50	
		Beam	50	31	6565 × 6	4040 × 6	14-Dia	40	24.0
	200	Column	64	34	7575 × 6	4040 × 6	12-Dia	52	
		Beam	53	34	7575 × 6	4040 × 6	12-Dia	42	25.8
1/5.0	100	Column	58	27	5050 × 6	18-Dia	10-Dia	46	
		Beam	47	27	5050 × 6	18-Dia	16-Dia	38	16.7
	150	Column	61	31	6060 × 6	4040 × 6	12-Dia	50	
		Beam	50	31	6060 × 6	4040 × 6	14-Dia	39	22.9
	200	Column	64	34	7575 × 6	4040 × 6	12-Dia	52	
		Beam	53	34	7575 × 6	4040 × 6	14-Dia	41	25.9
					Fixed Base				
1/3.0	100	Column	34	21	5050 × 6	12-Dia	8-Dia	27	
		Beam	34	21	5050 × 6	16-Dia	12-Dia	27	14.1
	150	Column	36	23	5050 × 6	12-Dia	8-Dia	28	
		Beam	36	23	5050 × 6	16-Dia	12-Dia	28	14.1
	200	Column	37	24	5050 × 6	12-Dia	8-Dia	29	
		Beam	37	24	5050 × 6	16-Dia	10-Dia	29	13.9
1/4.0	100	Column	34	21	5050 × 6	12-Dia	8-Dia	27	
		Beam	34	21	5050 × 6	16-Dia	14-Dia	27	14.2
	150	Column	36	23	5050 × 6	12-Dia	8-Dia	28	
		Beam	36	23	5050 × 6	16-Dia	12-Dia	28	14.0
	200	Column	37	24	5050 × 6	14-Dia	8-Dia	29	
		Beam	37	24	5050 × 6	16-Dia	10-Dia	28	14.2
1/5.0	100	Column	34	21	5050 × 6	12-Dia	8-Dia	27	
		Beam	34	21	5050 × 6	16-Dia	14-Dia	27	14.1
	150	Column	36	23	5050 × 6	12-Dia	8-Dia	28	
		Beam	36	23	5050 × 6	16-Dia	12-Dia	28	13.9
	200	Column	37	24	5050 × 6	14-Dia	8-Dia	29	
		Beam	37	24	5050 × 6	18-Dia	10-Dia	29	14.7

TABLE 53 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 9.0 m Column Height = 6.0 m Frame Spacing = 6.0 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
				Hinged Base					
1/3.0	100	Column	60	30	6060 × 6	18-Dia	12-Dia	48	
		Beam	50	30	6060 × 6	4040 × 6	16-Dia	41	15.9
	150	Column	64	35	8080 × 6	4040 × 6	14-Dia	52	
		Beam	54	35	8080 × 6	4040 × 6	14-Dia	43	20.8
	200	Column	67	38	8080 × 8	4040 × 6	14-Dia	54	
		Beam	56	38	8080 × 8	4040 × 6	14-Dia	45	24.5
1/4.0	100	Column	60	30	6060 × 6	18-Dia	12-Dia	48	
		Beam	50	30	6060 × 6	4040 × 6	16-Dia	40	15.7
	150	Column	64	35	7575 × 6	4040 × 6	14-Dia	52	
		Beam	53	35	7575 × 6	4040 × 6	16-Dia	42	20.0
	200	Column	67	38	9090 × 6	4040 × 6	14-Dia	54	
		Beam	56	38	9090 × 6	4040 × 6	14-Dia	44	22.1
1/5.0	100	Column	60	30	6060 × 6	18-Dia	12-Dia	48	
		Beam	50	30	6060 × 6	4040 × 6	16-Dia	39	15.6
	150	Column	64	35	7575 × 6	4040 × 6	14-Dia	52	
		Beam	53	35	7575 × 6	4040 × 6	16-Dia	43	19.9
	200	Column	67	38	9090 × 6	4040 × 6	14-Dia	54	
		Beam	56	38	9090 × 6	4040 × 6	14-Dia	43	22.0
				Fixed Base					
1/3.0	100	Column	35	23	5050 × 6	12-Dia	8-Dia	27	
		Beam	37	23	5050 × 6	18-Dia	14-Dia	29	11.2
	150	Column	37	25	5050 × 6	14-Dia	10-Dia	29	
		Beam	38	25	5050 × 6	18-Dia	12-Dia	30	11.6
	200	Column	38	27	5050 × 6	14-Dia	10-Dia	30	
		Beam	39	27	5050 × 6	18-Dia	10-Dia	31	11.4
1/4.0	100	Column	35	23	5050 × 6	12-Dia	8-Dia	27	
		Beam	37	23	5050 × 6	18-Dia	14-Dia	28	11.1
	150	Column	37	25	5050 × 6	12-Dia	10-Dia	29	
		Beam	38	25	5050 × 6	18-Dia	14-Dia	30	11.3
	200	Column	38	27	5050 × 6	14-Dia	10-Dia	30	
		Beam	39	27	5050 × 6	18-Dia	10-Dia	31	11.3
1/5.0	100	Column	35	23	5050 × 6	12-Dia	8-Dia	27	
		Beam	37	23	5050 × 6	18-Dia	16-Dia	29	11.2
	150	Column	37	25	5050 × 6	14-Dia	10-Dia	29	
		Beam	38	25	5050 × 6	18-Dia	14-Dia	30	11.6
	200	Column	38	27	5050 × 6	14-Dia	10-Dia	30	
		Beam	39	27	5050 × 6	18-Dia	12-Dia	31	11.4

TABLE 54 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 12.0 m Column Height = 4.5 m Frame Spacing = 4.5 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
					Hinged Base				
1/3.0	100	Column	47	23	5050 × 6	14-Dia	10-Dia	37	
		Beam	48	23	5050 × 6	4040 × 6	14-Dia	38	13.8
	150	Column	50	27	5050 × 6	16-Dia	10-Dia	40	
		Beam	51	27	5050 × 6	4040 × 6	16-Dia	40	14.5
	200	Column	52	29	6060 × 6	16-Dia	12-Dia	42	
		Beam	53	29	6060 × 6	4040 × 6	14-Dia	42	15.9
1/4.0	100	Column	47	23	5050 × 6	14-Dia	10-Dia	37	
		Beam	48	23	5050 × 6	4040 × 6	16-Dia	38	13.9
	150	Column	50	27	5050 × 6	16-Dia	10-Dia	40	
		Beam	51	27	5050 × 6	4040 × 6	16-Dia	41	14.3
	200	Column	52	29	6060 × 6	16-Dia	12-Dia	42	
		Beam	53	29	6060 × 6	4040 × 6	16-Dia	42	15.9
1/5.0	100	Column	47	23	5050 × 6	14-Dia	10-Dia	37	
		Beam	48	23	5050 × 6	4040 × 6	16-Dia	38	13.8
	150	Column	50	27	5050 × 6	16-Dia	10-Dia	40	
		Beam	51	27	5050 × 6	4040 × 6	16-Dia	40	14.2
	200	Column	52	29	5050 × 6	16-Dia	12-Dia	42	
		Beam	53	29	5050 × 6	4040 × 6	16-Dia	42	14.4
					Fixed Base				
1/3.0	100	Column	29	21	5050 × 6	12-Dia	8-Dia	23	
		Beam	37	21	5050 × 6	18-Dia	12-Dia	29	11.5
	150	Column	30	23	5050 × 6	12-Dia	8-Dia	24	
		Beam	39	23	5050 × 6	18-Dia	12-Dia	30	11.5
	200	Column	31	24	5050 × 6	12-Dia	8-Dia	25	
		Beam	40	24	5050 × 6	18-Dia	12-Dia	31	11.5
1/4.0	100	Column	29	21	5050 × 6	12-Dia	8-Dia	23	
		Beam	37	21	5050 × 6	18-Dia	12-Dia	29	11.3
	150	Column	30	23	5050 × 6	12-Dia	8-Dia	24	
		Beam	39	23	5050 × 6	18-Dia	12-Dia	30	11.3
	200	Column	31	24	5050 × 6	12-Dia	8-Dia	25	
		Beam	40	24	5050 × 6	18-Dia	12-Dia	31	11.3
1/5.0	100	Column	29	21	5050 × 6	12-Dia	8-Dia	23	
		Beam	37	21	5050 × 6	18-Dia	12-Dia	29	11.2
	150	Column	30	23	5050 × 6	12-Dia	8-Dia	24	
		Beam	39	23	5050 × 6	18-Dia	12-Dia	30	11.2
	200	Column	31	24	5050 × 6	12-Dia	8-Dia	25	
		Beam	40	24	5050 × 6	18-Dia	14-Dia	31	11.5

TABLE 55 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 12.0 m | Column Height = 4.5 m | Frame Spacing = 6.0 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
				Hinged Base					
1/3.0	100	Column	49	26	5050 × 6	16-Dia	10-Dia	39	
		Beam	51	26	5050 × 6	4040 × 6	16-Dia	40	10.9
	150	Column	52	30	6060 × 6	16-Dia	12-Dia	42	
		Beam	54	30	6060 × 6	4040 × 6	16-Dia	43	12.1
	200	Column	54	33	7575 × 6	16-Dia	12-Dia	42	
		Beam	56	32	7575 × 6	4040 × 6	16-Dia	45	13.9
1/4.0	100	Column	49	26	5050 × 6	16-Dia	10-Dia	39	
		Beam	51	26	5050 × 6	4040 × 6	18-Dia	41	11.0
	150	Column	52	30	5050 × 6	16-Dia	12-Dia	42	
		Beam	54	30	5050 × 6	4040 × 6	18-Dia	42	11.1
	200	Column	54	33	6565 × 6	16-Dia	12-Dia	42	
		Beam	56	33	6565 × 6	4040 × 6	18-Dia	45	12.8
1/5.0	100	Column	49	26	5050 × 6	16-Dia	10-Dia	39	
		Beam	51	26	5050 × 6	4040 × 6	18-Dia	40	10.9
	150	Column	52	30	5050 × 6	16-Dia	12-Dia	42	
		Beam	54	30	5050 × 6	4040 × 6	18-Dia	43	11.0
	200	Column	54	33	6060 × 6	16-Dia	12-Dia	42	
		Beam	56	33	6060 × 6	4040 × 6	18-Dia	45	12.2
				Fixed Base					
1/3.0	100	Column	30	23	6060 × 6	12-Dia	8-Dia	23	
		Beam	40	23	5050 × 6	4040 × 6	12-Dia	31	10.5
	150	Column	31	25	5050 × 6	12-Dia	8-Dia	25	
		Beam	41	25	5050 × 6	4040 × 6	14-Dia	33	10.3
	200	Column	32	27	5050 × 6	14-Dia	10-Dia	25	
		Beam	42	27	5050 × 6	4040 × 6	14-Dia	34	10.6
1/4.0	100	Column	30	23	6060 × 6	14-Dia	8-Dia	23	
		Beam	40	23	5050 × 6	4040 × 6	14-Dia	31	10.7
	150	Column	32	25	6060 × 6	14-Dia	8-Dia	25	
		Beam	41	25	5050 × 6	4040 × 6	14-Dia	33	10.8
	200	Column	33	27	6060 × 6	14-Dia	10-Dia	25	
		Beam	42	27	5050 × 6	4040 × 6	14-Dia	34	10.9
1/5.0	100	Column	30	23	6565 × 6	14-Dia	8-Dia	23	
		Beam	40	23	5050 × 6	4040 × 6	14-Dia	32	10.9
	150	Column	32	25	6060 × 6	14-Dia	8-Dia	25	
		Beam	41	25	5050 × 6	4040 × 6	14-Dia	33	10.7
	200	Column	33	27	6060 × 6	14-Dia	10-Dia	25	
		Beam	42	27	5050 × 6	4040 × 6	14-Dia	33	10.8

TABLE 56 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 12.0 m | Column Height = 6.0 m | Frame Spacing = 4.5 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Intersection with Corner Leg Members (cm)	Unit Wt. (kg/m²)
				Hinged Base					
1/3.0	100	Column	60	30	5050 × 6	18-Dia	12-Dia	48	
		Beam	55	30	5050 × 6	4040 × 6	16-Dia	43	16.8
	150	Column	64	34	6565 × 6	4040 × 6	14-Dia	52	
		Beam	58	34	6565 × 6	4040 × 6	16-Dia	46	21.4
	200	Column	67	38	8080 × 6	4040 × 6	14-Dia	54	
		Beam	61	38	8080 × 6	4040 × 6	16-Dia	48	24.2
1/4.0	100	Column	60	30	5050 × 6	18-Dia	12-Dia	48	
		Beam	55	30	5050 × 6	4040 × 6	18-Dia	44	16.9
	150	Column	64	34	6060 × 6	4040 × 6	14-Dia	52	
		Beam	58	34	6060 × 6	4040 × 6	18-Dia	47	20.7
	200	Column	66	38	7575 × 6	4040 × 6	14-Dia	54	
		Beam	61	38	7575 × 6	4040 × 6	16-Dia	49	23.0
1/5.0	100	Column	60	30	5050 × 6	18-Dia	12-Dia	48	
		Beam	55	30	5050 × 6	4040 × 6	18-Dia	43	16.8
	150	Column	64	34	6060 × 6	4040 × 6	14-Dia	52	
		Beam	58	34	6060 × 6	4040 × 6	18-Dia	47	20.6
	200	Column	66	38	7575 × 6	4040 × 6	14-Dia	54	
		Beam	61	38	7575 × 6	4040 × 6	16-Dia	48	22.9
				Fixed Base					
1/3.0	100	Column	37	24	5050 × 6	12-Dia	8-Dia	29	
		Beam	42	24	5050 × 6	18-Dia	14-Dia	33	13.0
	150	Column	39	26	5050 × 6	12-Dia	10-Dia	30	
		Beam	43	26	5050 × 6	18-Dia	14-Dia	35	13.3
	200	Column	40	27	5050 × 6	14-Dia	10-Dia	32	
		Beam	45	27	5050 × 6	18-Dia	12-Dia	36	13.4
1/4.0	100	Column	37	24	5050 × 6	12-Dia	8-Dia	29	
		Beam	42	24	5050 × 6	18-Dia	14-Dia	33	12.9
	150	Column	39	26	5050 × 6	12-Dia	10-Dia	30	
		Beam	43	26	5050 × 6	4040 × 6	14-Dia	34	15.0
	200	Column	40	27	5050 × 6	14-Dia	10-Dia	32	
		Beam	45	27	5050 × 6	4040 × 6	14-Dia	35	15.4
1/5.0	100	Column	37	24	5050 × 6	12-Dia	8-Dia	29	
		Beam	42	24	5050 × 6	4040 × 6	14-Dia	32	14.6
	150	Column	39	26	5050 × 6	12-Dia	10-Dia	30	
		Beam	43	26	5050 × 6	4040 × 6	14-Dia	34	14.8
	200	Column	40	27	5050 × 6	14-Dia	10-Dia	32	
		Beam	45	27	5050 × 6	4040 × 6	14-Dia	35	15.2

TABLE 57 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 12.0 m — Column Height = 6.0 m — Frame Spacing = 6.0 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt (kg/m²)
				Hinged Base					
1/3.0	100	Column	63	34	6060 × 6	4040 × 6	12-Dia	50	
		Beam	58	34	6060 × 6	4040 × 6	18-Dia	46	15.5
	150	Column	67	39	8080 × 6	4040 × 6	14-Dia	54	
		Beam	62	39	8080 × 6	4040 × 6	18-Dia	48	18.4
	200	Column	69	42	8080 × 6	4040 × 6	16-Dia	57	
		Beam	64	42	8080 × 6	4040 × 6	16-Dia	50	21.6
1/4.0	100	Column	63	34	6060 × 6	4040 × 6	12-Dia	50	
		Beam	58	34	6060 × 6	4040 × 6	18-Dia	47	15.3
	150	Column	67	39	7575 × 6	4040 × 6	14-Dia	54	
		Beam	62	39	7575 × 6	4040 × 6	18-Dia	49	17.5
	200	Column	70	42	9090 × 6	4040 × 6	16-Dia	57	
		Beam	64	42	9090 × 6	4040 × 6	18-Dia	51	19.7
1/5.0	100	Column	63	34	6060 × 6	4040 × 6	12-Dia	50	
		Beam	58	34	6060 × 6	4040 × 6	4040 × 6	47	16.2
	150	Column	67	39	7575 × 6	4040 × 6	14-Dia	54	
		Beam	62	39	7575 × 6	4040 × 6	4040 × 6	48	18.4
	200	Column	70	42	9090 × 6	4040 × 6	16-Dia	57	
		Beam	64	42	9090 × 6	4040 × 6	18-Dia	50	19.6
				Fixed Base					
1/3.0	100	Column	38	26	5050 × 6	12-Dia	10-Dia	30	
		Beam	45	26	5050 × 6	4040 × 6	16-Dia	36	11.6
	150	Column	40	28	5050 × 6	14-Dia	10-Dia	31	
		Beam	47	28	5050 × 6	4040 × 6	16-Dia	37	11.9
	200	Column	41	30	5050 × 6	14-Dia	10-Dia	38	
		Beam	48	30	5050 × 6	4040 × 6	14-Dia	38	11.7
1/4.0	100	Column	38	26	5050 × 6	14-Dia	10-Dia	30	
		Beam	45	26	5050 × 6	4040 × 6	16-Dia	36	11.7
	150	Column	40	28	5050 × 6	14-Dia	10-Dia	31	
		Beam	47	28	5050 × 6	4040 × 6	16-Dia	37	11.7
	200	Column	41	30	5050 × 6	14-Dia	10-Dia	33	
		Beam	48	30	5050 × 6	4040 × 6	14-Dia	38	11.5
1/5.0	100	Column	38	26	5050 × 6	14-Dia	10-Dia	30	
		Beam	45	26	5050 × 6	4040 × 6	16-Dia	35	11.6
	150	Column	40	28	5050 × 6	14-Dia	10-Dia	31	
		Beam	47	28	5050 × 6	4040 × 6	16-Dia	37	11.7
	200	Column	41	30	5050 × 6	16-Dia	10-Dia	33	
		Beam	48	30	5050 × 6	4040 × 6	16-Dia	38	12.0

TABLE 58 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 12.0 m | Column Height = 9.0 m | Frame Spacing = 4.5 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (*D*) (cm)	Width (*B*) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
					Hinged Base				
1/3.0	100	Column	85	43	8080 × 6	4040 × 6	16-Dia	69	
		Beam	66	43	8080 × 6	4040 × 6	16-Dia	52	35.5
	150	Column	91	49	110110 × 8	4040 × 6	18-Dia	72	
		Beam	71	49	110110 × 8	4040 × 6	18-Dia	57	45.1
	200	Column	95	54	130130 × 8	4040 × 6	4040 × 6	75	
		Beam	74	54	130130 × 8	5050 × 6	4040 × 6	57	55.5
1/4.0	100	Column	85	43	8080 × 6	4040 × 6	16-Dia	69	
		Beam	66	43	8080 × 6	4040 × 6	18-Dia	53	35.5
	150	Column	90	49	100100 × 8	4040 × 6	18-Dia	72	
		Beam	70	49	110110 × 8	4040 × 6	18-Dia	56	41.8
	200	Column	95	54	130130 × 8	4040 × 6	4040 × 6	75	
		Beam	74	54	130130 × 8	5050 × 6	4040 × 6	58	54.9
1/5.0	100	Column	85	43	8080 × 6	4040 × 6	16-Dia	69	
		Beam	66	43	8080 × 6	4040 × 6	18-Dia	53	35.4
	150	Column	90	49	100100 × 8	4040 × 6	18-Dia	72	
		Beam	70	49	100100 × 8	4040 × 6	4040 × 6	55	43.1
	200	Column	95	54	130130 × 8	4040 × 6	4040 × 6	75	
		Beam	74	54	130130 × 8	5050 × 6	4040 × 6	58	54.7
					Fixed Base				
1/3.0	100	Column	52	28	5050 × 6	16-Dia	10-Dia	41	
		Beam	50	28	5050 × 6	4040 × 6	14-Dia	39	19.0
	150	Column	55	30	6060 × 6	18-Dia	12-Dia	43	
		Beam	51	30	5050 × 6	4040 × 6	12-Dia	40	21.1
	200	Column	57	32	8080 × 6	18-Dia	12-Dia	46	
		Beam	53	32	6060 × 6	4040 × 6	12-Dia	42	24.5
1/4.0	100	Column	52	28	5050 × 6	16-Dia	10-Dia	41	
		Beam	50	28	5050 × 6	4040 × 6	14-Dia	39	18.8
	150	Column	55	30	6060 × 6	18-Dia	12-Dia	43	
		Beam	51	30	5050 × 6	4040 × 6	12-Dia	40	20.8
	200	Column	57	32	7575 × 6	18-Dia	12-Dia	46	
		Beam	52	32	5050 × 6	4040 × 6	12-Dia	42	22.8
1/5.0	100	Column	52	28	5050 × 6	16-Dia	10-Dia	41	
		Beam	50	28	5050 × 6	4040 × 6	14-Dia	39	18.7
	150	Column	55	30	6060 × 6	18-Dia	12-Dia	43	
		Beam	51	30	5050 × 6	4040 × 6	12-Dia	40	20.8
	200	Column	57	32	7575 × 6	18-Dia	12-Dia	46	
		Beam	53	32	5050 × 6	4040 × 6	12-Dia	42	22.7

TABLE 59 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 12.0 m | Column Height = 9.0 m | Frame Spacing = 6.0 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (*D*) (cm)	Width (*B*) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
				Hinged Base					
1/3.0	100	Column	89	49	100100 × 8	4040 × 6	18-Dia	72	
		Beam	70	49	100100 × 8	4040 × 6	18-Dia	54	31.7
	150	Column	95	55	130130 × 8	4040 × 6	4040 × 6	75	
		Beam	75	55	130130 × 8	5050 × 6	4040 × 6	60	41.6
	200	Column	99	61	130130 × 10	4040 × 6	4040 × 6	78	
		Beam	78	61	130130 × 10	5050 × 6	4040 × 6	63	48.3
1/4.0	100	Column	89	49	9090 × 8	4040 × 6	18-Dia	72	
		Beam	70	49	9090 × 8	4040 × 6	4040 × 6	56	30.3
	150	Column	95	55	130130 × 8	4040 × 6	4040 × 6	75	
		Beam	75	55	130130 × 8	5050 × 6	4040 × 6	58	41.3
	200	Column	99	61	130130 × 10	4040 × 6	4040 × 6	78	
		Beam	78	61	130130 × 10	6060 × 6	4040 × 6	61	48.7
1/5.0	100	Column	89	49	9090 × 8	4040 × 6	18-Dia	72	
		Beam	70	49	9090 × 8	4040 × 6	4040 × 6	55	30.2
	150	Column	95	55	130130 × 8	4040 × 6	4040 × 6	75	
		Beam	75	55	130130 × 8	5050 × 6	4040 × 6	58	41.1
	200	Column	99	61	130130 × 10	4040 × 6	4040 × 6	78	
		Beam	78	61	130130 × 10	6060 × 6	4040 × 6	61	48.5
				Fixed Base					
1/3.0	100	Column	54	30	6060 × 6	16-Dia	12-Dia	42	
		Beam	53	30	5050 × 6	4040 × 6	14-Dia	42	15.4
	150	Column	57	33	8080 × 6	18-Dia	12-Dia	45	
		Beam	55	33	5050 × 6	4040 × 6	12-Dia	45	17.7
	200	Column	59	35	8080 × 8	4040 × 6	12-Dia	47	
		Beam	57	35	6060 × 6	4040 × 6	12-Dia	45	22 7
1/4.0	100	Column	94	30	5050 × 6	16-Dia	12-Dia	42	
		Beam	53	30	5050 × 6	4040 × 6	16-Dia	42	14.6
	150	Column	57	33	7575 × 6	18-Dia	12-Dia	45	
		Beam	55	33	5050 × 6	4040 × 6	12-Dia	44	17.1
	200	Column	59	35	8080 × 8	4040 × 6	12-Dia	47	
		Beam	57	35	6060 × 6	4040 × 6	12-Dia	45	22.5
1/5.0	100	Column	54	30	5050 × 6	16-Dia	12-Dia	42	
		Beam	53	30	5050 × 6	4040 × 6	16-Dia	42	14.5
	150	Column	57	33	7575 × 6	18-Dia	12-Dia	45	
		Beam	55	33	5050 × 6	4040 × 6	14-Dia	45	17.2
	200	Column	59	35	9090 × 6	4040 × 6	12-Dia	47	
		Beam	57	35	6060 × 6	4040 × 6	12-Dia	45	21.1

TABLE 60 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 18.0 m Column Height = 6.0 m Frame Spacing = 4.5 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (*D*) (cm)	Width (*B*) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
					Hinged Base				
1/3.0	100	Column	63	35	6060 × 6	4040 × 6	14-Dia	52	
		Beam	67	35	6060 × 6	4040 × 6	18-Dia	54	17.5
	150	Column	67	40	6565 × 6	4040 × 6	14-Dia	54	
		Beam	71	40	6565 × 6	4040 × 6	18-Dia	57	18.4
	200	Column	70	44	8080 × 6	4040 × 6	16-Dia	57	
		Beam	74	44	8080 × 6	4040 × 6	4040 × 6	59	22.1
1/4.0	100	Column	63	35	5050 × 6	4040 × 6	14-Dia	52	
		Beam	67	35	5050 × 6	4040 × 6	18-Dia	54	15.9
	150	Column	67	40	6060 × 6	4040 × 6	14-Dia	54	
		Beam	71	40	6060 × 6	4040 × 6	4040 × 6	57	18.6
	200	Column	70	44	7575 × 6	4040 × 6	16-Dia	57	
		Beam	74	44	7575 × 6	4040 × 6	4040 × 6	59	21.1
1/5.0	100	Column	63	35	6060 × 6	4040 × 6	14-Dia	52	
		Beam	67	35	5050 × 6	4040 × 6	4040 × 6	53	17.5
	150	Column	67	40	6060 × 6	4040 × 6	14-Dia	54	
		Beam	71	40	6060 × 6	4040 × 6	4040 × 6	57	18.5
	200	Column	70	44	6565 × 6	4040 × 6	16-Dia	57	
		Beam	74	44	6565 × 6	4040 × 6	4040 × 6	59	19.5
					Fixed Base				
1/3.0	100	Column	41	28	6565 × 6	16-Dia	10-Dia	33	
		Beam	55	28	5050 × 6	4040 × 6	14-Dia	44	14.6
	150	Column	43	30	6060 × 6	16-Dia	10-Dia	34	
		Beam	57	30	5050 × 6	4040 × 6	14-Dia	46	14.3
	200	Column	45	32	6060 × 6	16-Dia	12-Dia	36	
		Beam	59	32	5050 × 6	4040 × 6	14-Dia	47	14.5
1/4.0	100	Column	42	28	7575 × 6	16-Dia	10-Dia	33	
		Beam	55	28	5050 × 6	4040 × 6	14-Dia	44	14.9
	150	Column	44	30	7575 × 6	18-Dia	10-Dia	34	
		Beam	57	30	5050 × 6	4040 × 6	14-Dia	46	14.9
	200	Column	45	32	6565 × 6	16-Dia	12-Dia	36	
		Beam	59	32	5050 × 6	4040 × 6	14-Dia	47	14.6
1/5.0	100	Column	42	28	8080 × 6	16-Dia	10-Dia	33	
		Beam	55	28	5050 × 6	4040 × 6	14-Dia	44	15.1
	150	Column	44	30	7575 × 6	16-Dia	10-Dia	34	
		Beam	57	30	5050 × 6	4040 × 6	14-Dia	45	14.9
	200	Column	45	32	7575 × 6	16-Dia	12-Dia	36	
		Beam	59	32	5050 × 6	4040 × 6	16-Dia	47	15.3

TABLE 61 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 18.0 m Column Height = 6.0 m Frame Spacing = 6.0 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Intersection with Corner Leg Members (cm)	Unit Wt. (kg/m²)
				Hinged Base					
1/3.0	100	Column	66	40	6565 × 6	4040 × 6	14-Dia	52	
		Beam	71	40	6565 × 6	4040 × 6	4040 × 6	57	14.7
	150	Column	70	45	8080 × 6	4040 × 6	16-Dia	57	
		Beam	75	45	8080 × 6	5050 × 6	4040 × 6	61	17.5
	200	Column	73	49	8080 × 8	4040 × 6	18-Dia	60	
		Beam	78	49	8080 × 8	5050 × 6	4040 × 6	63	20.4
1/4.0	100	Column	66	40	6565 × 6	4040 × 6	14-Dia	52	
		Beam	71	40	6060 × 6	5050 × 6	4040 × 6	57	15.0
	150	Column	70	45	6565 × 6	4040 × 6	16-Dia	57	
		Beam	75	45	6565 × 6	5050 × 6	4040 × 6	59	15.6
	200	Column	73	49	8080 × 6	4040 × 6	18-Dia	60	
		Beam	78	49	8080 × 6	5050 × 6	4040 × 6	63	17.5
1/5.0	100	Column	66	40	6565 × 6	4040 × 6	14-Dia	52	
		Beam	71	40	6060 × 6	5050 × 6	4040 × 6	57	14.9
	150	Column	70	45	6565 × 6	4040 × 6	16-Dia	57	
		Beam	75	45	6565 × 6	5050 × 6	4040 × 6	61	15.5
	200	Column	73	49	8080 × 6	4040 × 6	18-Dia	60	
		Beam	78	49	8080 × 6	5050 × 6	4040 × 6	63	17.4
				Fixed Base					
1/3.0	100	Column	43	30	8080 × 6	18-Dia	10-Dia	34	
		Beam	59	30	5050 × 6	4040 × 6	14-Dia	47	11.8
	150	Column	45	33	7575 × 6	18-Dia	12-Dia	35	
		Beam	62	33	5050 × 6	4040 × 6	14-Dia	49	11.8
	200	Column	47	35	7575 × 6	18-Dia	12-Dia	37	
		Beam	63	35	5050 × 6	4040 × 6	14-Dia	51	11.8
1/4.0	100	Column	43	30	9090 × 6	18-Dia	10-Dia	34	
		Beam	60	30	6060 × 6	4040 × 6	16-Dia	47	12.9
	150	Column	45	33	9090 × 6	18-Dia	12-Dia	35	
		Beam	62	33	6060 × 6	4040 × 6	16-Dia	50	13.1
	200	Column	47	35	8080 × 6	18-Dia	12-Dia	37	
		Beam	63	35	6060 × 6	4040 × 6	16-Dia	51	12.7
1/5.0	100	Column	43	30	8080 × 6	18-Dia	10-Dia	34	
		Beam	60	30	6060 × 6	4040 × 6	16-Dia	48	13.4
	150	Column	45	33	8080 × 6	18-Dia	12-Dia	35	
		Beam	62	33	6060 × 6	4040 × 6	16-Dia	49	13.6
	200	Column	47	35	9090 × 6	18-Dia	12-Dia	37	
		Beam	63	35	6060 × 6	4040 × 6	16-Dia	50	13.0

TABLE 62 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 18.0 m   Column Height = 9.0 m   Frame Spacing = 4.5 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA, ISRO	Lacing B-Plane ISA, ISRO	Spacing of Lacing Intersection with Corner Leg Members (cm)	Unit Wt. (kg/m²)
					Hinged Base				
1/3.0	100	Column	89	50	8080 × 8	4040 × 6	18-Dia	72	
		Beam	81	50	8080 × 8	4040 × 6	4040 × 6	65	30.6
	150	Column	95	57	100100 × 8	4040 × 6	4040 × 6	75	
		Beam	86	57	100100 × 8	5050 × 6	4040 × 6	67	37 9
	200	Column	100	63	130130 × 8	4040 × 6	4040 × 6	78	
		Beam	90	63	130130 × 8	5050 × 6	4040 × 6	72	45.0
1/4.0	100	Column	90	50	9090 × 6	4040 × 6	18-Dia	72	
		Beam	81	50	9090 × 6	5050 × 6	4040 × 6	63	29 0
	150	Column	95	57	9090 × 8	4040 × 6	4040 × 6	75	
		Beam	86	57	9090 × 8	5050 × 6	4040 × 6	68	35.2
	200	Column	99	63	110110 × 8	4040 × 6	4040 × 6	78	
		Beam	90	63	110110 × 8	5050 × 6	4040 × 6	71	40.0
1/5.0	100	Column	90	50	9090 × 6	4040 × 6	18-Dia	72	
		Beam	81	50	9090 × 6	5050 × 6	4040 × 6	65	28.8
	150	Column	95	57	9090 × 8	4040 × 6	4040 × 6	75	
		Beam	86	57	9090 × 8	5050 × 6	4040 × 6	67	35.0
	200	Column	99	63	110110 × 8	4040 × 6	4040 × 6	78	
		Beam	90	63	110110 × 8	5050 × 6	4040 × 6	70	39.8
					Fixed Base				
1/3.0	100	Column	58	33	5050 × 6	18-Dia	12-Dia	47	
		Beam	65	33	5050 × 6	4040 × 6	18-Dia	52	17.1
	150	Column	61	36	6060 × 6	18-Dia	12-Dia	48	
		Beam	68	36	5050 × 6	4040 × 6	16-Dia	54	17.6
	200	Column	64	38	7575 × 6	4040 × 6	14-Dia	51	
		Beam	70	38	5050 × 6	4040 × 6	14-Dia	55	20.7
1/4.0	100	Column	58	33	5050 × 6	18-Dia	12-Dia	47	
		Beam	65	33	5050 × 6	4040 × 6	18-Dia	53	16.9
	150	Column	61	36	5050 × 6	18-Dia	12-Dia	48	
		Beam	68	36	5050 × 6	4040 × 6	18-Dia	54	16.9
	200	Column	64	38	6565 × 6	4040 × 6	14-Dia	51	
		Beam	70	38	5050 × 6	4040 × 6	16-Dia	56	19.9
1/5.0	100	Column	58	33	6060 × 6	18-Dia	12-Dia	47	
		Beam	65	33	5050 × 6	4040 × 6	18-Dia	52	17.6
	150	Column	61	36	5050 × 6	18-Dia	12-Dia	48	
		Beam	68	36	5050 × 6	4040 × 6	18-Dia	55	16.8
	200	Column	64	38	6060 × 6	4040 × 6	14-Dia	51	
		Beam	70	38	6060 × 6	5050 × 6	16-Dia	57	21.3

TABLE 63 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 18.0 m | Column Height = 9.0 m | Frame Spacing = 6.0 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Intersection with Corner Leg Members (cm)	Unit Wt. (kg/m²)
				Hinged Base					
1/3.0	100	Column	93	57	9090 × 8	4040 × 6	4040 × 6	75	
		Beam	86	57	9090 × 8	5050 × 6	4040 × 6	67	26.7
	150	Column	100	65	130130 × 8	4040 × 6	4040 × 6	78	
		Beam	91	65	130130 × 8	5050 × 6	4040 × 6	72	33.8
	200	Column	104	71	130130 × 10	4040 × 6	4040 × 6	81	
		Beam	95	71	130130 × 10	6060 × 6	4040 × 6	75	40.1
1/4.0	100	Column	93	57	8080 × 8	4040 × 6	4040 × 6	75	
		Beam	85	57	8080 × 8	5050 × 6	4040 × 6	66	24.7
	150	Column	99	65	110110 × 8	4040 × 6	4040 × 6	78	
		Beam	91	65	110110 × 8	5050 × 6	4040 × 6	71	30.1
	200	Column	104	71	130130 × 8	4040 × 6	4040 × 6	81	
		Beam	95	71	130130 × 8	6060 × 6	4040 × 6	77	34.4
1/5.0	100	Column	93	57	8080 × 8	4040 × 6	4040 × 6	75	
		Beam	85	57	8080 × 8	5050 × 6	4040 × 6	67	24.5
	150	Column	99	65	110110 × 8	4040 × 6	4040 × 6	78	
		Beam	91	65	110110 × 8	6060 × 6	4040 × 6	73	30.7
	200	Column	104	71	130130 × 8	4040 × 6	4040 × 6	81	
		Beam	95	71	130130 × 8	6565 × 6	4040 × 6	76	34.7
				Fixed Base					
1/3.0	100	Column	60	36	6060 × 6	18-Dia	14-Dia	48	
		Beam	70	36	5050 × 6	4040 × 6	4040 × 6	57	14.5
	150	Column	63	39	6565 × 6	4040 × 6	14-Dia	51	
		Beam	73	39	5050 × 6	4040 × 6	16-Dia	59	15.1
	200	Column	66	41	9090 × 6	4040 × 6	14-Dia	52	
		Beam	75	41	6060 × 6	5050 × 6	16-Dia	61	18.2
1/4.0	100	Column	60	36	6565 × 6	18-Dia	14-Dia	48	
		Beam	70	36	5050 × 6	5050 × 6	4040 × 6	56	15.5
	150	Column	63	39	6060 × 6	4040 × 6	14-Dia	51	
		Beam	73	39	5050 × 6	5050 × 6	16-Dia	59	15.7
	200	Column	66	41	8080 × 6	4040 × 6	14-Dia	52	
		Beam	75	41	6565 × 6	5050 × 6	16-Dia	59	17.8
1/5.0	100	Column	60	36	7575 × 6	18-Dia	14-Dia	48	
		Beam	70	36	5050 × 6	5050 × 6	4040 × 6	57	16.0
	150	Column	63	39	6565 × 6	4040 × 6	14-Dia	51	
		Beam	73	39	5050 × 6	5050 × 6	4040 × 6	59	16.8
	200	Column	66	41	7575 × 6	4040 × 6	14-Dia	52	
		Beam	76	41	7575 × 6	5050 × 6	18-Dia	61	18.2

TABLE 64 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 18.0 m — Column Height = 12.0 m — Frame Spacing = 4.5 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
					Hinged Base				
1/3.0	100	Column	115	65	110110 × 8	5050 × 6	4040 × 6	92	
		Beam	92	65	110110 × 8	5050 × 6	4040 × 6	72	48.0
	150	Column	121	74	110110 × 10	5050 × 6	4040 × 6	96	
		Beam	98	74	110110 × 10	5050 × 6	4040 × 6	79	55.1
	200	Column	127	81	150150 × 10	5050 × 6	4040 × 6	100	
		Beam	103	81	150150 × 10	6060 × 6	4040 × 6	82	69.8
1/4.0	100	Column	114	65	100100 × 8	5050 × 6	4040 × 6	92	
		Beam	92	65	100100 × 8	5050 × 6	4040 × 6	74	44.8
	150	Column	122	74	130130 × 8	5050 × 6	4040 × 6	96	
		Beam	98	74	130130 × 8	5050 × 6	4040 × 6	77	53.2
	200	Column	127	81	130130 × 10	5050 × 6	4040 × 6	100	
		Beam	102	81	130130 × 10	6060 × 6	4040 × 6	80	62.6
1/5.0	100	Column	114	65	100100 × 8	5050 × 6	4040 × 6	92	
		Beam	92	65	100100 × 8	5050 × 6	4040 × 6	73	44.6
	150	Column	122	74	130130 × 8	5050 × 6	4040 × 6	96	
		Beam	98	74	130130 × 8	6060 × 6	4040 × 6	79	54.0
	200	Column	127	81	130130 × 10	5050 × 6	4040 × 6	100	
		Beam	102	81	130130 × 10	6565 × 6	4040 × 6	83	62.7
					Fixed Base				
1/3.0	100	Column	75	37	6060 × 6	4040 × 6	14-Dia	60	
		Beam	74	37	5050 × 6	4040 × 6	18-Dia	59	23.1
	150	Column	79	40	7575 × 6	4040 × 6	16-Dia	63	
		Beam	77	40	5050 × 6	4040 × 6	14-Dia	61	24.6
	200	Column	82	42	8080 × 8	4040 × 6	16-Dia	64	
		Beam	79	42	6060 × 6	4040 × 6	16-Dia	63	29.1
1/4.0	100	Column	74	37	5050 × 6	4040 × 6	14-Dia	60	
		Beam	74	37	5050 × 6	4040 × 6	4040 × 6	59	22.9
	150	Column	79	40	7575 × 6	4040 × 6	16-Dia	63	
		Beam	77	40	5050 × 6	4040 × 6	16-Dia	61	24.7
	200	Column	82	42	9090 × 6	4040 × 6	16-Dia	64	
		Beam	79	42	6060 × 6	5050 × 6	16-Dia	63	28.4
1/5.0	100	Column	74	37	5050 × 6	4040 × 6	14-Dia	60	
		Beam	74	37	5050 × 6	4040 × 6	4040 × 6	59	22.8
	150	Column	79	40	6565 × 6	4040 × 6	16-Dia	63	
		Beam	77	40	5050 × 6	5050 × 6	16-Dia	63	24.6
	200	Column	82	42	9090 × 6	4040 × 6	16-Dia	64	
		Beam	79	42	6060 × 6	5050 × 6	16-Dia	63	28.3

TABLE 65 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 18.0 m | Column Height = 12.0 m | Frame Spacing = 6.0 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Intersection with Corner Leg Members (cm)	Unit Wt (kg/m²)
					Hinged Base				
1/3.0	100	Column	120	73	130130 × 8	5050 × 6	4040 × 6	96	
		Beam	98	73	130130 × 8	6060 × 6	4040 × 6	79	41.1
	150	Column	127	83	150150 × 10	5050 × 6	4040 × 6	100	
		Beam	104	83	150150 × 10	6060 × 6	4040 × 6	82	52.4
	200	Column	132	91	150150 × 12	6060 × 6	4040 × 6	104	
		Beam	108	91	150150 × 12	6565 × 6	4040 × 6	86	61 1
1/4.0	100	Column	120	73	130130 × 8	5050 × 6	4040 × 6	96	
		Beam	98	73	130130 × 8	6060 × 6	4040 × 6	77	40.7
	150	Column	127	83	130130 × 10	5050 × 6	4040 × 6	100	
		Beam	104	83	130130 × 10	6060 × 6	4040 × 6	84	46 9
	200	Column	132	91	150150 × 12	6060 × 6	4040 × 6	104	
		Beam	108	91	150150 × 12	7575 × 6	5050 × 6	88	62.1
1/5 0	100	Column	119	73	110110 × 8	5050 × 6	4040 × 6	96	
		Beam	97	73	110110 × 8	6060 × 6	4040 × 6	79	36.5
	150	Column	127	83	130130 × 10	5050 × 6	4040 × 6	100	
		Beam	104	83	130130 × 10	6060 × 6	4040 × 6	83	46.7
	200	Column	132	91	150150 × 10	6060 × 6	4040 × 6	104	
		Beam	108	91	150150 × 10	7575 × 6	5050 × 6	87	55.0
					Fixed Base				
1/3.0	100	Column	77	40	6565 × 6	4040 × 6	16-Dia	61	
		Beam	79	40	5050 × 6	5050 × 6	4040 × 6	63	19.8
	150	Column	82	43	9090 × 6	4040 × 6	16-Dia	64	
		Beam	82	43	6060 × 6	5050 × 6	16-Dia	67	21.5
	200	Column	85	46	9090 × 8	4040 × 6	16-Dia	68	
		Beam	85	46	6565 × 6	5050 × 6	16-Dia	67	24.2
1/4.0	100	Column	77	40	6060 × 6	4040 × 6	16-Dia	61	
		Beam	79	40	5050 × 6	5050 × 6	4040 × 6	63	19 2
	150	Column	82	43	9090 × 6	4040 × 6	16-Dia	64	
		Beam	82	43	5050 × 6	5050 × 6	16-Dia	66	20 7
	200	Column	85	46	9090 × 8	4040 × 6	16-Dia	68	
		Beam	85	46	7575 × 6	5050 × 6	16-Dia	68	24.6
1/5.0	100	Column	77	40	6060 × 6	4040 × 6	16-Dia	61	
		Beam	79	40	5050 × 6	5050 × 6	4040 × 6	63	19 1
	150	Column	82	43	9090 × 6	4040 × 6	16-Dia	64	
		Beam	82	43	5050 × 6	5050 × 6	18-Dia	67	20.8
	200	Column	84	46	8080 × 8	4040 × 6	16-Dia	68	
		Beam	85	46	7575 × 6	6060 × 6	16-Dia	67	24.3

TABLE 66 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 24.0 m | Column Height = 9.0 m | Frame Spacing = 4.5 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
				Hinged Base					
1/3.0	100	Column	93	56	8080 × 8	4040 × 6	4040 × 6	75	
		Beam	93	56	8080 × 8	5050 × 6	4040 × 6	74	29.2
	150	Column	98	64	100100 × 8	4040 × 6	4040 × 6	78	
		Beam	99	64	100100 × 8	5050 × 6	4040 × 6	79	33.5
	200	Column	103	70	130130 × 8	4040 × 6	4040 × 6	81	
		Beam	104	70	130130 × 8	6060 × 6	4040 × 6	81	40.9
1/4.0	100	Column	93	56	9090 × 6	4040 × 6	4040 × 6	75	
		Beam	93	56	9090 × 6	5050 × 6	4040 × 6	74	26.6
	150	Column	98	64	9090 × 8	4040 × 6	4040 × 6	78	
		Beam	99	64	9090 × 8	6060 × 6	4040 × 6	79	32.1
	200	Column	103	70	110110 × 8	4040 × 6	4040 × 6	81	
		Beam	103	70	110110 × 8	6060 × 6	4040 × 6	82	36.4
1/5.0	100	Column	92	56	8080 × 6	4040 × 6	4040 × 6	75	
		Beam	93	56	8080 × 6	6060 × 6	4040 × 6	74	26.1
	150	Column	98	64	8080 × 8	4040 × 6	4040 × 6	78	
		Beam	98	64	8080 × 8	6060 × 6	4040 × 6	78	30.0
	200	Column	102	70	100100 × 8	4040 × 6	4040 × 6	81	
		Beam	103	70	100100 × 8	6060 × 6	4040 × 6	81	34.1
				Fixed Base					
1/3.0	100	Column	63	37	7575 × 6	4040 × 6	14-Dia	51	
		Beam	80	37	6060 × 6	5050 × 6	18-Dia	64	20.4
	150	Column	67	40	7575 × 6	4040 × 6	14-Dia	52	
		Beam	83	40	5050 × 6	5050 × 6	18-Dia	66	19.6
	200	Column	69	42	7575 × 6	4040 × 6	16-Dia	56	
		Beam	85	42	5050 × 6	5050 × 6	16-Dia	68	19.5
1/4.0	100	Column	64	37	8080 × 6	4040 × 6	14-Dia	51	
		Beam	80	37	6060 × 6	5050 × 6	18-Dia	65	20.5
	150	Column	67	40	7575 × 6	4040 × 6	14-Dia	52	
		Beam	83	40	6060 × 6	5050 × 6	18-Dia	66	20.2
	200	Column	69	42	6565 × 6	4040 × 6	16-Dia	56	
		Beam	85	42	5050 × 6	5050 × 6	18-Dia	68	19.0
1/5.0	100	Column	64	37	9090 × 6	4040 × 6	14-Dia	51	
		Beam	80	37	6565 × 6	5050 × 6	4040 × 6	64	22.4
	150	Column	67	40	9090 × 6	4040 × 6	14-Dia	52	
		Beam	83	40	6060 × 6	5050 × 6	4040 × 6	67	22.1
	200	Column	69	42	6565 × 6	4040 × 6	16-Dia	56	
		Beam	85	42	5050 × 6	5050 × 6	18-Dia	69	18.8

TABLE 67 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 24.0 m   Column Height = 9.0 m   Frame Spacing = 6.0 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Intersection with Corner Leg Members (cm)	Unit Wt. (kg/m²)
					Hinged Base				
1/3.0	100	Column	97	63	9090 × 8	4040 × 6	4040 × 6	78	
		Beam	99	63	9090 × 8	6060 × 6	4040 × 6	79	24.4
	150	Column	103	72	130130 × 8	4040 × 6	4040 × 6	81	
		Beam	105	72	130130 × 8	6060 × 6	5050 × 6	84	31.4
	200	Column	107	79	130130 × 10	5050 × 6	4040 × 6	85	
		Beam	109	79	130130 × 10	6060 × 6	4040 × 6	87	36.1
1/4.0	100	Column	96	63	8080 × 8	4040 × 6	4040 × 6	78	
		Beam	98	63	8080 × 8	6060 × 6	5050 × 6	79	23.2
	150	Column	103	72	110110 × 8	4040 × 6	4040 × 6	81	
		Beam	105	72	110110 × 8	6565 × 6	5050 × 6	85	28.4
	200	Column	107	79	130130 × 8	5050 × 6	4040 × 6	85	
		Beam	109	79	130130 × 8	6565 × 6	5050 × 6	88	32.2
1/5.0	100	Column	96	63	8080 × 8	4040 × 6	4040 × 6	78	
		Beam	98	63	8080 × 8	6060 × 6	5050 × 6	78	23.1
	150	Column	103	72	100100 × 8	4040 × 6	4040 × 6	81	
		Beam	104	72	100100 × 8	6565 × 6	5050 × 6	84	26.7
	200	Column	107	79	130130 × 8	5050 × 6	4040 × 6	85	
		Beam	109	79	130130 × 8	7575 × 6	5050 × 6	87	32.9
					Fixed Base				
1/3.0	100	Column	66	40	9090 × 6	4040 × 6	14-Dia	52	
		Beam	86	40	6565 × 6	5050 × 6	4040 × 6	70	17.2
	150	Column	69	43	8080 × 6	4040 × 6	16-Dia	54	
		Beam	89	43	6060 × 6	5050 × 6	4040 × 6	72	17.8
	200	Column	71	46	9090 × 6	4040 × 6	16-Dia	56	
		Beam	92	46	6060 × 6	6060 × 6	18-Dia	74	17.1
1/4.0	100	Column	66	40	8080 × 8	4040 × 6	14-Dia	52	
		Beam	86	40	7575 × 6	6060 × 6	4040 × 6	68	19.1
	150	Column	69	43	8080 × 8	4040 × 6	16-Dia	54	
		Beam	89	43	6565 × 6	6060 × 6	4040 × 6	72	18.7
	200	Column	71	46	9090 × 6	4040 × 6	16-Dia	56	
		Beam	92	46	7575 × 6	6060 × 6	4040 × 6	74	18.7
1/5.0	100	Column	66	40	9090 × 8	4040 × 6	14-Dia	52	
		Beam	86	40	7575 × 6	6060 × 6	4040 × 6	69	19.6
	150	Column	69	43	8080 × 6	4040 × 6	16-Dia	54	
		Beam	89	43	5050 × 6	6060 × 6	4040 × 6	71	16.5
	200	Column	71	46	9090 × 6	4040 × 6	16-Dia	56	
		Beam	92	46	6060 × 6	6060 × 6	4040 × 6	74	17.6

TABLE 68 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 24.0 m | Column Height = 12.0 m | Frame Spacing = 4.5 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (*D*) (cm)	Width (*B*) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
				Hinged Base					
1/3.0	100	Column	119	73	110110 × 8	5050 × 6	4040 × 6	96	
		Beam	107	73	110110 × 8	6060 × 6	4040 × 6	84	42.5
	150	Column	126	83	110110 × 10	5050 × 6	4040 × 6	100	
		Beam	113	83	110110 × 10	6060 × 6	4040 × 6	90	48.7
	200	Column	131	91	130130 × 10	6060 × 6	4040 × 6	104	
		Beam	118	91	130130 × 10	6060 × 6	4040 × 6	93	55.7
1/4.0	100	Column	118	73	100100 × 8	5050 × 6	4040 × 6	96	
		Beam	106	73	100100 × 8	6060 × 6	5050 × 6	84	40.6
	150	Column	126	83	130130 × 8	5050 × 6	4040 × 6	100	
		Beam	113	83	130130 × 8	6060 × 6	5050 × 6	91	47.8
	200	Column	131	91	130130 × 10	6060 × 6	4040 × 6	104	
		Beam	118	91	130130 × 10	6565 × 6	5050 × 6	95	56.6
1/5.0	100	Column	118	73	9090 × 8	5050 × 6	4040 × 6	96	
		Beam	106	73	9090 × 8	6060 × 6	5050 × 6	84	38.1
	150	Column	126	83	130130 × 8	5050 × 6	4040 × 6	100	
		Beam	113	83	130130 × 8	6060 × 6	5050 × 6	90	47.5
	200	Column	131	91	130130 × 10	6060 × 6	4040 × 6	104	
		Beam	118	91	130130 × 10	7575 × 6	5050 × 6	94	57.4
				Fixed Base					
1/3.0	100	Column	81	41	6060 × 6	4040 × 6	16-Dia	64	
		Beam	90	41	5050 × 6	5050 × 6	4040 × 6	72	22.3
	150	Column	85	44	6565 × 6	4040 × 6	16-Dia	68	
		Beam	94	44	5050 × 6	5050 × 6	4040 × 6	76	22.8
	200	Column	89	47	9090 × 8	4040 × 6	18-Dia	70	
		Beam	96	47	6060 × 6	5050 × 6	18-Dia	79	25.0
1 4.0	100	Column	81	41	7575 × 6	4040 × 6	16-Dia	64	
		Beam	90	41	5050 × 6	5050 × 6	4040 × 6	72	23.3
	150	Column	85	44	6565 × 6	4040 × 6	16-Dia	68	
		Beam	94	44	5050 × 6	5050 × 6	4040 × 6	74	22.6
	200	Column	88	47	7575 × 6	4040 × 6	18-Dia	70	
		Beam	97	47	6565 × 6	6060 × 6	18-Dia	77	25.1
1/5.0	100	Column	81	41	6565 × 6	4040 × 6	16-Dia	64	
		Beam	90	41	5050 × 6	5050 × 6	4040 × 6	74	22.3
	150	Column	85	44	6565 × 6	4040 × 6	16-Dia	68	
		Beam	94	44	5050 × 6	6060 × 6	4040 × 6	76	23.5
	200	Column	88	47	7575 × 6	4040 × 6	18-Dia	70	
		Beam	97	47	7575 × 6	6060 × 6	4040 × 6	78	26.8

TABLE 69 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 24.0 m Column Height = 12.0 m Frame Spacing = 6.0 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
				Hinged Base					
1/3.0	100	Column	124	82	130130 × 8	5050 × 6	4040 × 6	100	
		Beam	113	82	130130 × 8	6565 × 6	5050 × 6	90	36.7
	150	Column	131	93	130130 × 10	6060 × 6	4040 × 6	104	
		Beam	119	93	130130 × 10	6565 × 6	5050 × 6	97	43.0
	200	Column	137	102	150150 × 12	6060 × 6	5050 × 6	109	
		Beam	125	102	150150 × 12	7575 × 6	5050 × 6	101	55.0
1/4.0	100	Column	124	82	110110 × 8	5050 × 6	4040 × 6	100	
		Beam	112	82	110110 × 8	6565 × 6	5050 × 6	91	32.8
	150	Column	131	93	130130 × 10	6060 × 6	4040 × 6	104	
		Beam	119	93	130130 × 10	7575 × 6	5050 × 6	95	43.4
	200	Column	137	102	150150 × 10	6060 × 6	5050 × 6	109	
		Beam	124	102	150150 × 10	7575 × 6	5050 × 6	98	48.5
1/5.0	100	Column	124	82	110110 × 8	5050 × 6	4040 × 6	100	
		Beam	112	82	110110 × 8	6565 × 6	5050 × 6	90	32.6
	150	Column	131	93	130130 × 10	6060 × 6	4040 × 6	104	
		Beam	119	93	130130 × 10	7575 × 6	5050 × 6	94	43.2
	200	Column	137	102	150150 × 10	6060 × 6	5050 × 6	109	
		Beam	124	102	150150 × 10	8080 × 6	6060 × 6	97	49.5
				Fixed Base					
1/3.0	100	Column	83	45	6565 × 6	4040 × 6	16-Dia	66	
		Beam	97	45	5050 × 6	6060 × 6	4040 × 6	79	17.9
	150	Column	88	48	8080 × 6	4040 × 6	18-Dia	70	
		Beam	101	48	6060 × 6	6060 × 6	4040 × 6	81	19.9
	200	Column	91	51	8080 × 8	4040 × 6	18-Dia	72	
		Beam	104	51	7575 × 6	6060 × 6	4040 × 6	84	22.4
1/4.0	100	Column	83	45	6565 × 6	4040 × 6	16-Dia	66	
		Beam	97	45	5050 × 6	6060 × 6	4040 × 6	77	17.7
	150	Column	88	48	8080 × 6	4040 × 6	18-Dia	70	
		Beam	101	48	6060 × 6	6060 × 6	4040 × 6	82	19.6
	200	Column	91	51	8080 × 8	4040 × 6	18-Dia	72	
		Beam	104	51	8080 × 6	6565 × 6	4040 × 6	85	22.9
1/5.0	100	Column	83	45	7575 × 6	4040 × 6	16-Dia	66	
		Beam	97	45	5050 × 6	6060 × 6	4040 × 6	78	18.3
	150	Column	88	48	9090 × 6	4040 × 6	18-Dia	70	
		Beam	101	48	6565 × 6	6060 × 6	4040 × 6	81	20.4
	200	Column	91	51	8080 × 8	4040 × 6	18-Dia	72	
		Beam	104	51	9090 × 6	6565 × 6	4040 × 6	84	23.4

TABLE 70 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 30.0 m | Column Height = 9.0 m | Frame Spacing = 4.5 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
					Hinged Base				
1/3.0	100	Column	95	61	8080 × 8	4040 × 6	4040 × 6	78	
		Beam	104	61	8080 × 8	6060 × 6	4040 × 6	83	28.0
	150	Column	101	70	100100 × 8	4040 × 6	4040 × 6	81	
		Beam	111	70	100100 × 8	6060 × 6	4040 × 6	87	31.9
	200	Column	106	76	130130 × 8	5050 × 6	4040 × 6	85	
		Beam	116	76	130130 × 8	6565 × 6	4040 × 6	93	38.9
1/4.0	100	Column	95	61	9090 × 6	4040 × 6	4040 × 6	78	
		Beam	104	61	9090 × 6	6060 × 6	4040 × 6	83	25.6
	150	Column	101	70	9090 × 8	4040 × 6	4040 × 6	81	
		Beam	110	70	9090 × 8	6565 × 6	4040 × 6	88	30.2
	200	Column	105	76	110110 × 8	5050 × 6	4040 × 6	85	
		Beam	115	76	110110 × 8	6565 × 6	4040 × 6	93	34.7
1/5.0	100	Column	95	61	8080 × 6	4040 × 6	4040 × 6	78	
		Beam	104	61	8080 × 6	6060 × 6	4040 × 6	84	25.3
	150	Column	101	70	8080 × 8	4040 × 6	4040 × 6	81	
		Beam	110	70	8080 × 8	6565 × 6	4040 × 6	89	28.2
	200	Column	105	76	100100 × 8	5050 × 6	4040 × 6	85	
		Beam	115	76	100100 × 8	7575 × 6	5050 × 6	92	34.6
					Fixed Base				
1/3.0	100	Column	68	40	8080 × 8	4040 × 6	14-Dia	54	
		Beam	94	40	7575 × 6	5050 × 6	16-Dia	75	21.2
	150	Column	71	43	8080 × 8	4040 × 6	16-Dia	56	
		Beam	97	43	6565 × 6	6060 × 6	18-Dia	79	22.0
	200	Column	73	46	7575 × 6	4040 × 6	16-Dia	58	
		Beam	100	46	5050 × 6	6060 × 6	18-Dia	81	19.2
1/4.0	100	Column	68	40	9090 × 8	4040 × 6	14-Dia	54	
		Beam	94	40	7575 × 6	6060 × 6	18-Dia	75	23.0
	150	Column	71	43	9090 × 8	4040 × 6	16-Dia	56	
		Beam	97	43	7575 × 6	6060 × 6	18-Dia	79	23.2
	200	Column	74	46	8080 × 8	4040 × 6	16-Dia	58	
		Beam	100	46	7575 × 6	6060 × 6	18-Dia	81	22.6
1/5.0	100	Column	68	40	100100 × 8	4040 × 6	14-Dia	54	
		Beam	94	40	8080 × 6	6060 × 6	18-Dia	74	24.0
	150	Column	71	43	9090 × 8	4040 × 6	16-Dia	56	
		Beam	98	43	8080 × 6	6060 × 6	18-Dia	78	23.5
	200	Column	74	46	9090 × 8	4040 × 6	16-Dia	58	
		Beam	100	46	8080 × 6	6060 × 6	18-Dia	80	23.6

TABLE 71 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 30.0 m Column Height = 9.0 m Frame Spacing = 6.0 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Inter-section with Corner Leg Members (cm)	Unit Wt. (kg/m²)
					Hinged Base				
1/3.0	100	Column	100	69	100100 × 8	4040 × 6	4040 × 6	81	
		Beam	110	69	100100 × 8	6565 × 6	5050 × 6	87	25.0
	150	Column	106	78	130130 × 8	5050 × 6	4040 × 6	85	
		Beam	117	78	130130 × 8	7575 × 6	5050 × 6	93	30.8
	200	Column	110	86	130130 × 10	5050 × 6	4040 × 6	90	
		Beam	122	86	130130 × 10	7575 × 6	5050 × 6	98	35.1
1/4.0	100	Column	99	69	9090 × 8	4040 × 6	4040 × 6	81	
		Beam	110	69	8080 × 8	7575 × 6	5050 × 6	88	23.3
	150	Column	105	78	100100 × 8	5050 × 6	4040 × 6	85	
		Beam	117	78	100100 × 8	7575 × 6	5050 × 6	93	26.2
	200	Column	110	86	130130 × 8	5050 × 6	4040 × 6	90	
		Beam	122	86	130130 × 8	7575 × 6	5050 × 6	96	30.5
1/5.0	100	Column	99	69	9090 × 8	4040 × 6	4040 × 6	81	
		Beam	110	69	8080 × 8	7575 × 6	5050 × 6	87	23.1
	150	Column	105	78	100100 × 8	5050 × 6	4040 × 6	85	
		Beam	117	78	100100 × 8	7575 × 6	5050 × 6	92	26.1
	200	Column	110	86	130130 × 8	5050 × 6	4040 × 6	90	
		Beam	122	86	130130 × 8	8080 × 6	6060 × 6	98	31.3
					Fixed Base				
1/3.0	100	Column	70	44	100100 × 8	4040 × 6	16-Dia	56	
		Beam	101	44	8080 × 6	6060 × 6	18-Dia	81	18.5
	150	Column	74	47	100100 × 8	4040 × 6	16-Dia	58	
		Beam	104	47	7575 × 6	6060 × 6	18-Dia	83	18.2
	200	Column	76	50	9090 × 6	4040 × 6	18-Dia	60	
		Beam	107	50	6060 × 6	6060 × 6	4040 × 6	87	16.6
1/4.0	100	Column	71	44	130130 × 8	4040 × 6	16-Dia	56	
		Beam	101	44	9090 × 6	6565 × 6	4040 × 6	81	21.6
	150	Column	74	47	110110 × 8	4040 × 6	16-Dia	58	
		Beam	105	47	9090 × 6	6565 × 6	4040 × 6	83	20.7
	200	Column	76	50	8080 × 8	4040 × 6	18-Dia	60	
		Beam	107	50	6060 × 6	6565 × 6	4040 × 6	85	17.4
1/5.0	100	Column	71	44	130130 × 8	4040 × 6	16-Dia	56	
		Beam	101	44	8080 × 8	6565 × 6	4040 × 6	80	22.4
	150	Column	73	47	8080 × 8	4040 × 6	16-Dia	58	
		Beam	104	47	6565 × 6	6565 × 6	4040 × 6	84	17.4
	200	Column	76	50	9090 × 8	4040 × 6	18-Dia	60	
		Beam	107	50	7575 × 6	7575 × 6	4040 × 6	87	19.6

TABLE 72 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 30.0 m　　Column Height = 12.0 m　　Frame Spacing = 4.5 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Intersection with Corner Leg Members (cm)	Unit Wt. (kg/m²)
					Hinged Base				
1/3.0	100	Column	122	79	110110 × 8	5050 × 6	4040 × 6	100	
		Beam	119	79	110110 × 8	6565 × 6	5050 × 6	95	39.9
	150	Column	129	90	110110 × 10	6060 × 6	4040 × 6	104	
		Beam	126	90	110110 × 10	6565 × 6	5050 × 6	102	46.4
	200	Column	135	98	130130 × 10	6060 × 6	5050 × 6	109	
		Beam	131	98	130130 × 10	7575 × 6	5050 × 6	105	53.7
1/4.0	100	Column	121	79	9090 × 8	5050 × 6	4040 × 6	100	
		Beam	118	79	9090 × 8	6565 × 6	5050 × 6	96	35.3
	150	Column	130	90	130130 × 8	6060 × 6	4040 × 6	104	
		Beam	126	90	130130 × 8	7575 × 6	5050 × 6	99	46.0
	200	Column	135	98	130130 × 10	6060 × 6	5050 × 6	109	
		Beam	131	98	130130 × 10	7575 × 6	5050 × 6	106	53.0
1/5.0	100	Column	121	79	9090 × 8	5050 × 6	4040 × 6	100	
		Beam	118	79	9090 × 8	6565 × 6	5050 × 6	95	35.1
	150	Column	129	90	110110 × 8	6060 × 6	4040 × 6	104	
		Beam	126	90	110110 × 8	7575 × 6	5050 × 6	101	41.5
	200	Column	134	98	110110 × 10	6060 × 6	5050 × 6	109	
		Beam	131	98	110110 × 10	7575 × 6	5050 × 6	105	47.6
					Fixed Base				
1/3.0	100	Column	86	45	9090 × 6	4040 × 6	16-Dia	68	
		Beam	105	45	6060 × 6	6060 × 6	4040 × 6	85	24.2
	150	Column	91	48	8080 × 6	4040 × 6	18-Dia	72	
		Beam	110	48	6060 × 6	6060 × 6	4040 × 6	87	23.9
	200	Column	94	51	7575 × 6	4040 × 6	18-Dia	75	
		Beam	113	51	6565 × 6	6060 × 6	4040 × 6	90	24.1
1/4.0	100	Column	86	45	6565 × 6	4040 × 6	16-Dia	68	
		Beam	105	45	5050 × 6	6060 × 6	4040 × 6	85	21.4
	150	Column	91	48	9090 × 6	4040 × 6	18-Dia	72	
		Beam	110	48	6565 × 6	6060 × 6	4040 × 6	88	24.7
	200	Column	94	51	7575 × 6	4040 × 6	18-Dia	75	
		Beam	113	51	6060 × 6	6060 × 6	4040 × 6	90	23.3
1/5.0	100	Column	86	45	8080 × 8	4040 × 6	16-Dia	68	
		Beam	106	45	7575 × 6	6060 × 6	4040 × 6	84	26.1
	150	Column	91	48	8080 × 8	4040 × 6	18-Dia	72	
		Beam	110	48	7575 × 6	6565 × 6	4040 × 6	89	26.9
	200	Column	94	51	9090 × 6	4040 × 6	18-Dia	75	
		Beam	113	51	7575 × 6	6565 × 6	4040 × 6	89	26.0

TABLE 73 DESIGN RESULTS OF LATTICE PORTAL FRAMES

Span = 30.0 m Column Height = 12.0 m Frame Spacing = 6.0 m

Roof Slope	Wind Pressure (kg/m²)	Member	Depth (D) (cm)	Width (B) (cm)	Size of Corner Leg, ISA	Lacing D-Plane ISA/ISRO	Lacing B-Plane ISA/ISRO	Spacing of Lacing Intersection with Corner Leg Members (cm)	Unit Wt (kg/m²)
					Hinged Base				
1/3.0	100	Column	128	89	130130 × 8	6060 × 6	4040 × 6	104	
		Beam	126	89	130130 × 8	7575 × 6	6060 × 6	102	35.5
	150	Column	135	101	130130 × 10	6060 × 6	5050 × 6	109	
		Beam	133	101	130130 × 10	7575 × 6	6060 × 6	105	41.1
	200	Column	141	111	150150 × 12	6060 × 6	5050 × 6	114	
		Beam	139	111	150150 × 12	8080 × 6	6060 × 6	112	51.0
1/4.0	100	Column	127	89	110110 × 8	6060 × 6	4040 × 6	104	
		Beam	125	89	110110 × 6	7575 × 6	6060 × 6	99	32.0
	150	Column	135	101	130130 × 10	6060 × 6	5050 × 6	109	
		Beam	133	101	130130 × 10	8080 × 6	6060 × 6	106	41.0
	200	Column	141	111	150150 × 10	6060 × 6	5050 × 6	114	
		Beam	139	111	150150 × 10	9090 × 6	6060 × 6	110	45.9
1/5.0	100	Column	127	89	100100 × 8	6060 × 6	4040 × 6	104	
		Beam	125	89	100100 × 8	7575 × 6	6060 × 6	101	30.2
	150	Column	135	101	110110 × 10	6060 × 6	5050 × 6	109	
		Beam	133	101	110110 × 10	8080 × 6	6060 × 6	105	37.0
	200	Column	141	111	150150 × 10	6060 × 6	5050 × 6	114	
		Beam	139	111	150150 × 10	9090 × 6	6060 × 6	113	45.5
					Fixed Base				
1/3.0	100	Column	89	49	8080 × 6	4040 × 6	18-Dia	70	
		Beam	113	49	7575 × 6	6565 × 6	4040 × 6	93	20.6
	150	Column	93	53	8080 × 6	4040 × 6	18-Dia	75	
		Beam	117	53	6060 × 6	6565 × 6	4040 × 6	95	18.4
	200	Column	97	56	8080 × 8	5050 × 6	4040 × 6	77	
		Beam	121	56	8080 × 6	6565 × 6	4040 × 6	98	22.4
1/4.0	100	Column	89	49	100100 × 8	4040 × 6	18-Dia	70	
		Beam	114	49	8080 × 6	7575 × 6	4040 × 6	90	22.9
	150	Column	94	53	9090 × 8	4040 × 6	18-Dia	75	
		Beam	118	53	8080 × 6	7575 × 6	4040 × 6	96	22.2
	200	Column	97	56	8080 × 8	5050 × 6	4040 × 6	77	
		Beam	121	56	9090 × 6	7575 × 6	4040 × 6	96	23.7
1/5.0	100	Column	89	49	100100 × 8	4040 × 6	18-Dia	70	
		Beam	114	49	9090 × 6	7575 × 6	4040 × 6	92	23.4
	150	Column	93	53	8080 × 6	4040 × 6	18-Dia	75	
		Beam	117	53	6060 × 6	7575 × 6	4040 × 6	95	18.9
	200	Column	97	56	9090 × 6	5050 × 6	4040 × 6	77	
		Beam	121	56	6565 × 6	7575 × 6	4040 × 6	98	21.2

TABLE 74 LACING CONNECTION DETAILS

Rod Lacings			Angle Lacings			
Rod Size	Fillet Weld		Angle Size	Fillet Weld		Thickness of Gusset (mm)
	Size (mm)	Length (mm)		Size (mm)	Length (mm)	
8 mm ϕ	3	38.3	4040 × 6	4.5	180	8
10 mm ϕ	5	40.6	5050 × 6	4.5	230	8
12 mm ϕ	5	53.9	6060 × 6	4.5	280	8
14 mm ϕ	5	69.2	6565 × 6	4.5	300	10
16 mm ϕ	5	86.7	7575 × 6	4.5	350	10
18 mm ϕ	5	106.5	8080 × 6	4.5	380	10
			9090 × 6	4.5	420	10
			100100 × 8	6.5	430	12
			110110 × 8	6.5	480	12

TABLE 75 HAUNCH AND CROWN CONNECTION DETAILS

Size of Corner Angle	Size of HSFG Bolts (mm)	Number of Bolts	Gusset Plate Thickness (mm)
5050 × 6	20	2	12
6060 × 6	20	2	12
6565 × 6	20	3	12
7575 × 6	20	3	12
8080 × 6	20	3	12
9090 × 6	20	3	12
8080 × 8	20	4	12
9090 × 8	20	4	12
100100 × 8	24	4	16
110110 × 8	24	4	16
130130 × 8	24	4	16
110110 × 10	30	3	20
130130 × 10	30	4	20
150150 × 10	30	4	20
150150 × 12	30	5	20
200200 × 12	30	6	20
200200 × 15	30	8	20

TABLE 76 BASE PLATE CONNECTION DETAILS

SL No.	Corner Angle	Connection Between Stiffener and Corner Angles: Size of Weld (mm)	Connection Between Stiffener and Corner Angles: Total Length of Weld/Angle (mm)	Size of 12 Bolts (mm)	Stiffening Channel Details: ISMC	Stiffening Channel Details: t_s (mm)	Thickness of Base Plate (mm)
1	5050 × 6	4.5	265	20	100	12	20
2	6060 × 6	4.5	320	20	100	12	20
3	6565 × 6	4.5	345	24	125	12	20
4	7575 × 6	4.5	405	24	150	12	20
5	8080 × 6	4.5	430	24	150	12	20
6	9090 × 6	4.5	485	30	150	16	25
7	8080 × 8	6.0	425	30	150	16	25
8	9090 × 8	6.0	480	30	150	16	25
9	100100 × 8	6.0	535	30	200	16	25
10	110110 × 8	6.0	590	36	200	16	32
11	130130 × 8	6.0	705	36	250	16	32
12	110110 × 10	7.5	585	36	200	16	32
13	130130 × 10	7.5	700	45	250	20	40
14	150150 × 10	7.5	810	45	250	20	40
15	150150 × 12	9.0	800	45	250	20	40
16	200200 × 12	9.0	1080	56	350	20	50
17	200200 × 15	12.0	1050	56	350	20	50

NOTE — *See* Fig. 8.