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THE STUDY OF DESIGN OF INDUSTRIAL FACTORY STEEL SHED AND FOUNDATION AND COMPARE WITH REINFORCED CONCRETE PORTAL FRAME STRUCTURE WITH SPECIAL REFERENCE TO DESIGN OF COLUMN & FOOTING

Dr. Arvind Dewangan
(Prof. Civil Engineering) Director, Yogananda College of Engineering & Technology, Jammu – INDIA

Dr. D.P.Gupta
(Prof. Civil Engineering), Director, Shivalik College of Engineering , Dehradun, UK, India

ABSTRACT
The object of project 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.

KEY WORDS: *Loads, Trusses, Pitch, Spans*

Sub Area: *Construction Technology & Management*, ***Broad Area:*** *Civil Engineering*

INTRODUCTION
All the portal frames are analyzed according to the principles of elastic theory for dead load, live load and wind load as described in '2.1. For simplifying the analysis, the loads are assumed to act at four intermediate points on the rafter andat one intermediate point on the column. It is assumed that the frames are supported on an isolated footing. In the case of isolated footing, the idealized support condition for the column can be fixed end condition or hinged end condition depending on the soil strata. If the isolated footing is vresting on hard rock, it can be assumed as a fiied base because the rock will not deform much to allow the rotation of the foundation, and if it is resting on normal soil, it can be assumed as hinged because due to the compressibility of the soil, the foundation can undergo a rotation relieving off the moment. In the case of the columns supported by a pile foundation, the base of the column should be assumed as fixed. Analysis has been carried put for both cases of support conditions, that is,

fured and hinged. The portal frames have been analyzed using a plane frame computer programme which is based on stiffness method of analysis. Three degrees of freedom are assumed at each node. In this method, the structure coordinates are specified at all the nodal points including the supports. The number of forces at each node is equal to the possible degrees of freedom per node that are inputted. Then, the stiffness matrix of the structure is assembled and the boundary conditions are incorporated. The resulting simultaneous equations are solved for displacements, using which the member end actions are finally obtained.

REVIEW OF LITERATURE

Various is codes and handbooks, bis publications, insdab publications are referred to study the topic. For design of industrial structure, the general guideline given in "reinforced concrete designers handbook" by C. E. Reynolds & stidman" are followed & the same logic is used in analysis & design of structure in staad platform. As the main plant building houses the various machinery & the chemical design unit i steam dryers etc. It is designed in reinforced cement concrete with more cover to reinforcement to meet requirement. The provision of is 456-2000 (table 16) are studied for this purpose & cover is provided accordingly.

The load on structure i.e. Live load on floor, floor finish load, dead load of various material, wind load on trusses & structure are taken as per is 875-1987 part 1, 2 &3(code of practice for design loads — other than earthquake).

For calculation of design wind speed & design wind pressure a structure & truss the various provision of is 875-1987 are used.

1) The roof truss part is studied form textbook of "design of steel structure" by arya & ajmani. The various guideline & clauses of IS 800 (code of practice for general construction in steel) are followed for design of roof trusses.
2) Sp : 6 (i) 1964 — 181 handbook for structural engineers —structural steel sections is used for dimension & properties like sectional area, moment of inertia, radius of gyration, section modulus, centre of gravity of angle sections used in trusses.
3) Is 456 — 2000 (code of practice for plain & reinforcement concrete) is referred for general & special design requirement for structural members & systems & also for limit state method of design.
4) The various provisions of is 456 — 2000 studied are - Section 3

   CI. 18.2 — method of design.
   Cl. 19.2 — dead loads
   Cl. 19.3 — imposed & wind loads
   Cl. 20.1 — overturning
   Cl. 21.1 — fire resistanc
   Cl. 26 — requirement governing reinforcement & detailing
   Table 16 & 16 a — nominal cover requirement
5) Section 4 - cl. 28.1 — design requirement for concrete corbels
6) Section 5 — design by limit state method

   Cl. 35.3 - limit state of serviceability
   Cl. 37.1 — analysis of structure
   Cl. 39.6 — column design for biaxial body
   Cl. 40.1 — shear reinforcement
7) IS 1893 — part 1 criteria for earthquake resistant design of structure is followed for various provisions & lateral load calculations due to earthquake.
8) IS 13920- (ductile detailing of rcc structures subjected to seismic forces) guideline regarding ductile detailing studied are
9) Section 6 ---

   Cl. 6.1 - beams — general guidelines
   Cl. 6.2 — longitudinal reinforcement
   Cl. 6.2.5 — anchorage of beam bars in external joint.
   Cl. 6.3 web reinforcement
10) Section 7 —

   Cl. 7.1 column — general guidelines
   Cl. 7.2 — longitudinal reinforcement
   Cl. 7.3 — transverse reinforcement
   Cl. 7.4 — special confining reinforcement of column
11) Sp-38 (s & t) 1987— steel structure design handbook is referred for various truss detailing like gusset plate thickness, anchor bolt diameter & length. Gantry grider design is also done by guideline of sp 38 (s & t) 1987. The insdag handbook published by ministry of steel is used for overall arrangement of trusses; wind bracing connection details trusses, lap splice details etc.

A publication, national seminar on "industrial structure in concrete" by indian concrete institute & dept. Of science & technology for staad pro

12) Various provisions of sp 34 (5 & t) 1987 — handbook on concrete reinforcement & detailing, studied are —
13) Section 7—fig. 7.15— beam column junction at exterior joint.
14) Section 8 — curtailment rule for bars of beams
15) Section 9 — reinforcement arrangement for floor slab
16) Section 12— ductility requirement for earthquake resistant building.

Figure 7.19 (page 96) reinforcement detailing.

METHODOLOGY

1) The analysis of portal frames has been made using a computer programme based on the stiffness method of analysis.
2) The internal pressure / suction specified in is:875: 1893 for buildings with normal Permeability (+-o.2) has been considered in design.
3) The structural design of rcc sections is based on is:456:2000 since for a precast Construction, there fore m 25 concrete has been used for the design of all portal Frames,and 6.0 m span rcc purlins and cladding runners.The 12.0 m span.
4) For portal frames, of both fixed and hinged support,prismatic rafter sections are adopted. Prismatic column sections are adopted for portal frames with fured support and non- prismatic column sections are adopted for portal frames with hinged base.
5) To facilitate prefabricated construction, the position of joints and the joint detail Shave been included to illustrate the method of detailing. This should not be Considered as the only available method for detailing.
6) The typified design results are given for purlins, cladding runners and frame Members. Design of other elements, such as lugs to support the purlins, brackets To Support cladding runners and eaves beams are also covered. Bracing and foundation Designs have not been typified because of varying design parameters.However, a Typical example of bracing design and footing design is included.
7) on the basis of typified designs for different spans, spacings, roof slopes, etc, some Conclusions regarding the more economical designs is covered.

SPACING OF TRUSS AND PURLINS

USUAL SPACING OF TRUSSES VARIES FROM 5 TO TOM. THE RANGE OF ECONOMICAL SPACING OF TRUSSES VARIES FROM ONE FIFTH TO ONE THIRD OF THE SPAN. FOR LARGER SPANS SMALLER SPACING TO SPAN RATIO SHOULD BE USED AND VICE VERSA. WHERE THE ROOF IS SUBJECTED TO ONLY WIND LOADS, LARGER SPACING OF TRUSSES WOULD BE ECONOMICAL. QUITE OFTEN SPACING OF HOUSES IS KEPT AT 4M. SPACINGS 3M TO 4.5M FOR SPANS UPTO 15M AND 4.5 M TO 6M FOR SPAN 15 TO 30 METER ARE SUITABLE. FOR LARGER SPANS , SAY 45M AND ABOVE, IT WILL BE MORE ECONOMICAL TO SPACE THE TRUSSES 12M TO 15M AND USE LONGITUDINAL TRUSSES IN PLACE OF PURLINS. THE SPACING OF PURLINS DEPENDS LARGELY ON THE MAXIMUM SAFE SPAN OF THE ROOF COVERING, GLAZING SHEETS ETC. NATURALLY IT SHOULD BE LESS THAN OR EQUAL TO THEIR SAFE SPANS WHEN THEY ARE DIRECTLY PLACED ON THE PURLINS. BUT IF THE COVERING IS SUPPORTED THROUGH BATTENS AND COMMON RAFTERS, THE SPACING OF PURLINS MAY BE KEPT AT WILL, PREFERABLY LOCATED AT THE PANEL POINTS OF THE TRUSS, BY VARYING THE SPACING AND SIZE OF BATTENS AND COMMON RAFTERS.

DESIGN OF COLUMN

THE DESIGN FORCES AT VARIOUS CRITICAL SECTIONS OF C-C GRID MIDDLE COLUMN ARE TAKEN FROM STAAD

AT SECTION B:
Factored moment, m_u = 893 kn.m
Factored axial force = 446 kn
Column height (h) =5.5 m above the foundation
Slenderness ratio along major axis = (1.5 x h) / d
= (1.5 x 5.5) /1.0
= 8.25
Slenderness ratio along minor axis = (0.75 x h) / d
= (0.75 x 5.5) / 0.3
12.19 = 12
Hence, the column is designed as a short column.
Minimum eccentricity along the minor axis accord-
Ing to 25.1.2 of 18:456-2000
(unsupported length / 500) + (d / 30)
= (5500 / 500) + (1000 / 30)
= 44.33 say 45mm
Factored bending moment along the minor axis
= 893 x 0.045 = 38.835 kn.m

This is negligible and the nominal reinforcement provided along the longer face can take care of this moment.
Provide equal reinforcement on two opposite sides
And assuming 20 mm diameter bars,
D' = 45+10
= 55mm
D' / d = 55 / 1000
= 0.055 = 0.1

$Pu / fck\ b\ d^2 = 446 \times 10^3 / (25 \times 300 \times 1000)$
= 0.059
$Mu / fck\ b\ d^2 = 893 \times 10^6 / (25 \times 300 \times 1000^2)$
= 0.119
From chart 32 of sp: 16,
(0.06 + 0.08) / 2
P / fck = 0.07
P / 25 = 0.07
P = 1.75 percent
Ast = pbd / 100
= (1.75 x 300 x 1000) /100
= 5250 mm2
Provide 18 no 20 mm diameter bars giving an area of
5654.86 mm2
Provide 8mm diameter, four legged lateral ties. @ 300mm centre-to-centre for the entire length of the rafter
As per clause 26.5.3.2 of 1s:456-2000
Lateral ties is the minimum of:
1)300mm
2) 16 x20=32omm
3) 48 x.8 = 384 mm
Hence, provide 8 mm diameter lateral ties at
300 mm centre-to-centre.

DESIGN OF FOOTING

LOAD COMBINATIONS FOR FOUNDATION DESIGN
DEFLECTION CHECK
LOAD COMB 100 DL+LL
1 1.0 2 1.0
*
LOAD COMB 101 DL+LL + WL+ZP
1 1.0 2 1.0 4 1.0
LOAD COMB 102 DL+LL + WL-ZP
1 1.0 2 1.0 5 1.0
LOAD COMB 103 DL+LL + WL+XP
1 1.0 2 1.0 6 1.0
LOAD COMB 104 DL+LL + WL-XP
1 1.0 2 1.0 7 1.0
LOAD COMB 105 DL+LL + WL+ZS
1 1.0 2 1.0 8 1.0
LOAD COMB 106 DL+LL + WL-ZS
1 1.0 2 1.0 9 1.0
LOAD COMB 107 DL+LL + WL+XS
1 1.0 2 1.0 10 1.0
LOAD COMB 108 DL+LL + WL-XS
1 1.0 2 1.0 11 1.0
*
LOAD COMB 109 0.9DL + WL+ZP
1 0.9 4 1.0
LOAD COMB 110 0.9DL + WL-ZP

1 0.9 5 1.0
LOAD COMB 111 0.9DL + WL+XP
1 0.9 6 1.0
LOAD COMB 112 0.9DL + WL-XP
1 0.9 7 1.0
LOAD COMB 113 0.9DL + WL+ZS
1 0.9 8 1.0
LOAD COMB 114 0.9DL + WL-ZS
1 0.9 9 1.0
LOAD COMB 115 0.9DL + WL+XS
1 0.9 10 1.0
LOAD COMB 116 0.9DL + WL-XS
1 0.9 11 1.0
*
LOAD COMB 117 DL+LL+SLX
1 1.0 2 1.0 12 1.0

LOAD COMB 118 DL+LL-SLX
1 1.0 2 1.0 12 -1.0
LOAD COMB 119 DL+LL+SLZ
1 1.0 2 1.0 13 1.0
LOAD COMB 120 DL+LL-SLZ
1 1.0 2 1.0 13 -1.0
*
LOAD COMB 121 0.9DL+SLX
1 0.9 12 1.0
LOAD COMB 122 0.9DL-SLX
1 0.9 12 -1.0
LOAD COMB 123 0.9DL+SLZ
1 0.9 13 1.0
LOAD COMB 124 0.9DL-SLZ
1 0.9 13 -1.0

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BIOGRAPHY

**Dr. Arvind Dewangan**, **(Prof. Civil Engineering) Director, Yogananda College of Engineering & Technology, Jammu - INDIA**. His highest academic qualification is PhD in Mining & Geological Engineering. He has 12years of experience in teaching and research. He has published 139 papers in International and National journals and won more than40- times National level Essay Competition. He has published various articles about Technical & Higher education in national level competition magazine like – Competition Success Review, i-SUCCEED, Civil Services Chronicle, Pratiyogita Sahitya, Pratiyogita Vikas, and Pratiyogita Darpan also.

**Dr. D.P.Gupta : Dr. D.P. Gupta** is working as a Director in Shivalik College of Engineering Dehradun-UK, INDIA. His research paper have been published 47 research Papers in various National and International Journals**.** Young, dynamic and enterprising technocrat, Dr. D. P Gupta , attained the Degree in Bachelor of Engineering in the year 1984 from the Maulana Azad College of Technology, Bhopal. He enriched his qualification by acquiring the Master's Degree (M.Tech) from the same College of repute. His zest for learning did not end here which prompted him to pursue further higher studies in Engineering, resulting in the award of Ph.D Degree by the Maulana Azad National Institution of Technology, Bhopal under the Barkattulah University, Bhopal (M.P.). He is also deeply and emotionally involved in various projects related to R & D. Eversince his joining the College, he is diverting all his energies towards creation, development and upgradation. He has published about 55 papers in International and National journals.