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DESIGN OF UNIT BAY FRAME STRUCTURE OF POWERHOUSE OF HYDRO POWER PLANT

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ABTRACT : The purpose of this research work is to provide a detailed structural design of unit bay frame of an power house under different loading conditions. The study and analysis that we have carried out in this study gives a brief idea regarding the methodology in analysing , modelling and designing of powerhouse under different types of loading conditions. The critical combinations and applications of loads at required particular locations in this project has been highlighted which was found out after extensive study of the behaviour of structure for all possible loading cases using STAAD.Pro software in this study we analysed the frame structure under different loading combinations keeping in view the earthquake , floods ,wind loads etc and the results we got satisfied the applied load combinations under which the structure is safe. From the design calculations it is observed that the proposed sizes of structural elements are safe for critical load combinations. As we have carried out the study in Staad pro software, the results may vary from researcher to researcher or under different approaches depending upon the values used for different loading combinations and other factors The methods used in this design has taken into account all the possible drastic effects on the frame structure especially the forces associated with the natural calamities.

OBJECTIVE

The objective of this project is to present the detailed analysis and design of frame structure for Unit bay-1 of Powerhouse starting from MIV(Main Inlet Valve) floor at El. 1182 till EOT crane beam Top at EL. 1205. Refer for layout of Powerhouse.

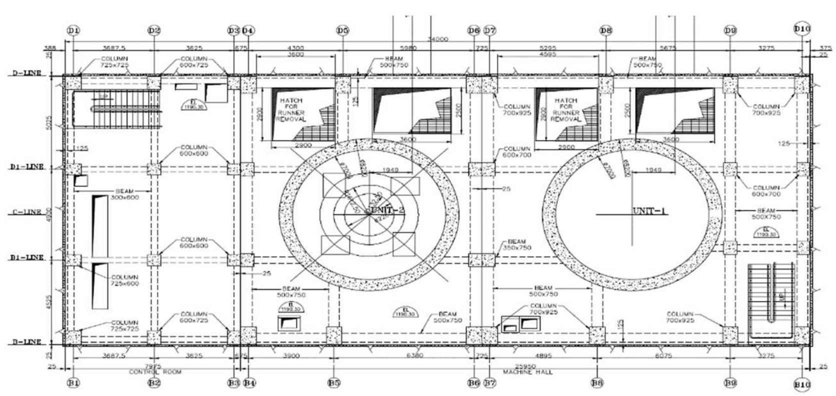

Fig. 1. Plan and Cross section of Powerhouse Unit Bay

CAHIERS MAGELLANES-NS
Volume 06 Issue 2
2024
ISSN:1624-1940
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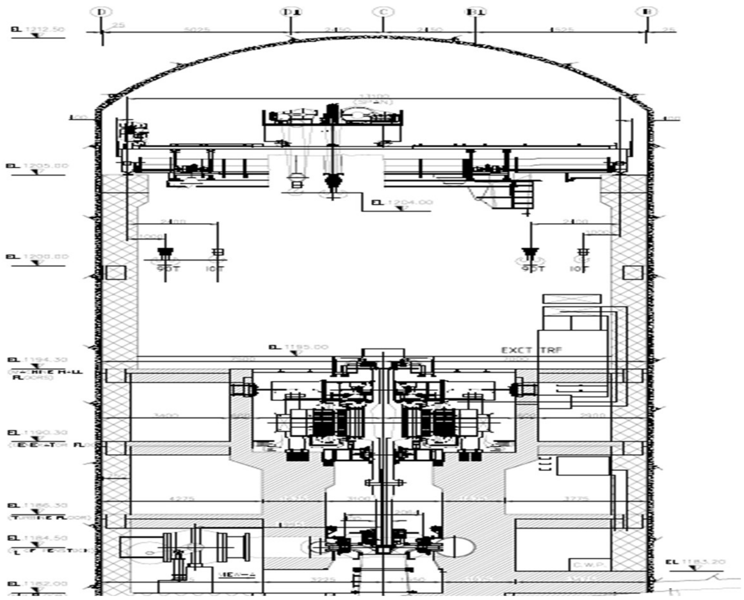
http://magellanes.com/



1 REFERENCES, MANUALS AND STANDARDS

- *IS 456-2000, "Code of Practice for Plain and Reinforced Concrete", Fourth Revision*
- *IS 13920:1993: Ductile detailing of R.C.C structures subjected to Seismic forces*
- *IS 1893:2002, "Criteria for Earthquake Resistant Design of Structures"*
- *SP 16: Design Aids for IS 456-2000*
- *Site Specific design Earthquake Parameters for Tehri Pumped Storage Project site, Uttarakhand.*
- *Reinforcement Concrete Design by "Pillai and Menon"*

2 INPUT DATA

Grade of Concrete	: M 25
Grade of Reinforcement	: Fe 500
Modulus of Elasticity of Concrete (M 25)	: 2.5 x 107 kN/m2
Poisson's ratio of Concrete	: 0.2
Unit weight of RCC	: 24 kN/m3

3 DESIGN CRITERIA

3.1 Design Basis

The 3D frame structure of Unit Bay have been modeled using line and plate elements in STAAD.Pro software. The frame model has been generated for full erection/operation loads.

The structural elements such as Beam, Column and Slab have been designed using Limit State Method of design. The reinforcement has been calculated for the maximum response in the members in the corresponding to most critical loading condition.

3.2 Concrete Clear Cover

For design purpose clear cover to reinforcement shall be 40 mm in beams, 50mm in columns and 75mm in slabs.

3.3 Minimum Percentage of Reinforcement

Minimum reinforcement is recommended in flexure members not only to resist unforeseen possible load effects, but also to control cracking in concrete due to shrinkage and temperature variations. Minimum reinforcement percentage requirement has been calculated as per IS 456:2000 anwd IS

ISSN:1624-1940
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http://magellanes.com/

13920:1993, and the higher conservative value has been adopted in design. Refer Table 1 for minimum percentage of reinforcement.

Table 1. ***Minimum Percentage of Steel (M25 and Fe 500***

Sl. No.	**Member**	**As per IS 456:2000**	**As per IS 13920**
1.	Beam	0.17% (=0.85/fy)	0.24% for M25 (=0.24*sqrt(fck)/fy)
2.	Slabs	0.12%	Same as IS 456:2000
3.	Column	0.80%	Same as IS 456:2000

4 DESIGN APPROACH

The powerhouse complex is divided into various structural units. There are 2 TG units each separated by an expansion/Contraction joint, and each unit is designed as an independent structure. It is analysed using mathematical modelling in STAAD Pro. The structure is designed for most critical load combination expected during life of structure as per codal provisions. Two same models of frame structure have been developed for the analysis. The first model is used for the Moving wheel analysis of the EOT crane in order to find the most critical position of EOT wheels for different condition i.e. position of wheel to get the maximum bending moments (Span moment and End Moment) and Shear force in EOT beam and Similarly position of wheel for maximum Axial load in Column.

Table 2 Moving wheel analysis summery

Sl. No.	**Condition of Wheel loading**	**Combination no. of moving wheel STAAD model**
1.	Maximum bending moment at End in EOT Beam	80
2.	Maximum bending moment at Span in EOT Beam	80
3.	Maximum shear force in EOT Beam	95
4.	Maximum axial load in EOT columns.	113

From the first model, position of wheel is replicated in the second model as member loads that are applied on EOT beam along with moment generated due to eccentricity of EOT carne w.r.t. to the EOT column CG. Similarly, CT (cross travel) and LT (long travel) thrust and seismic inertia of wheel load

ISSN:1624-1940
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http://magellanes.com/

in both X and Z direction are also applied at the same position of wheels in the second model.

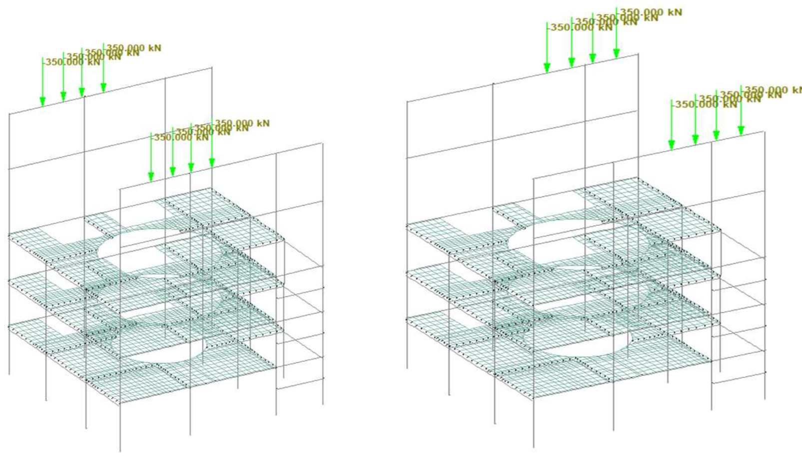

Figure 2: Moving wheel analysis STAAD model

5. DESIGN LOADS

5.1 Self Weight

The self-weight of each structural member has been assigned with factor '-1' acting vertical downward and the Staad pro software will automatically access the self-weight as per section sizes and material properties. Other than this, dead load of CR-100 rail is also applied on EOT beam of magnitude 0.89kN/m^2.

5.2 Live Load

In table-2 of IS 4247 (Part 1), uniformly distributed floor loads have been given for various floor of powerhouse complex.

On conservative side, the floor loads suggested in table-2 of IS 4247 (Part 1) are considered and applied in STAAD model at different floors are as follows:

- Turbine floor (EL. 1186.30) : 15 kN/m2
- Generator floor (EL. 1190.30) : 10 kN/m2
- Operation floor (EL. 1194.30) : 10 kN/m2

5.3 EOT CRANE LOAD

Table 3 EOT crane wheel loads for first stage analysis

Sl. No.	Description	Data	Remarks
1	EOT Capacity	90T/10T	
2	No of EOT	1	
3	Type	Double Girder	
4	Mode of operation	Single	
6	No. of wheels on each side	4 + 4	
7	Wheel spacing (m)	As shown in below fig	
8	Static (LT) wheel load per wheel, without impact	300.00 kN	
9	Wheel load (considering impact)	350.00 kN	**Refer:** Aneexure-1 EOT Wheel Load

ISSN:1624-1940
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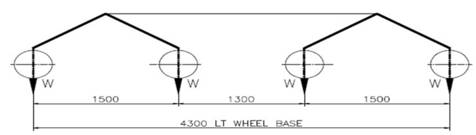
http://magellanes.com/

			calculation
10	Longitudinal Surge (LT) (Along the length of rails)	5% LT Wheel Load i.e. 17.5kN	**Refer**: Point no. ‘C’ and ‘D’ in Cl. 6.3 of IS 875 (Part 2) – 1987
11	Transverse Surge (CT) (Acrossthe length of rails)	5% CT Wheel Load i.e. 17.5kN	
12	Eccentricity in wheel load (between wheel & column centre)	212.5mm	Column c/c = 13.525m, EOT span = 13.1m. Therefore, e = 0.2125m ((13.525-13.1)/2)



L. T. WHEEL LOAD DIAGRAM

5.4 SEISMIC INERTIA FORCES

Seismic forces have been calculated based on the recommendations given in the site-specific studies report, data collected through various refrences/internet. STAAD calculates seismic forces based on parameters provided. The software calculates natural period of structure using Rayleigh’s method and corresponding spectral acceleration for x and z direction. The response spectrum in Staad.Pro is based on IS 1893:2000 recommendation for rocky/hard soil; therefore, to make it compatible with response spectrum given in the site-specific report, the PGA coefficient (Z) value was modified and multiplied by the ratio of maximum ordinate of both response spectrums.

As per Site specific report:

Equation for calculating spectral acceleration

$$S_a/(PGA) = \begin{cases} 1; & 0.00 \le T \le 0.030 \\ (T/0.030)^{\alpha}; & 0.030 \le T \le T_1 \\ A; & T_1 \le T \le T_2 \\ V/T; & T_2 \le T \le T_3 \\ D/T^2; & T \ge T_3 \end{cases} \quad -(3)$$

The values of α, T_1, A, T_2, V, T_3, D are given in the following Table

Damping %	α	T_1 (s)	A	T_2 (s)	V (s)	T_3 (s)	D (s^2)
1.000	1.235	0.130	6.120	0.380	2.326	3.990	9.302
2.000	0.921	0.140	4.130	0.430	1.817	4.120	7.632
5.000	0.646	0.150	2.830	0.450	1.302	4.860	6.509
7.000	0.547	0.150	2.410	0.450	1.109	4.970	5.543
10.000	0.449	0.150	2.060	0.450	0.948	5.120	5.212

CAHIERS MAGELLANES-NS
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http://magellanes.com/

PGA value for DBE 0.18

Maximum ordinate of spectral acceleration for 5% damping 2.830
As per IS
1893:2016
Maximum ordinate of spectral acceleration for 5% damping 2.50
Ratio of two values (2.83/2.50) 1.132

Values given in the STAAD.Pro:

Zone factor	0.5675
Importance factor, I	1.50
Response reduction factor, R	3.00
Damping	5%
Depth of Structure	> 30m

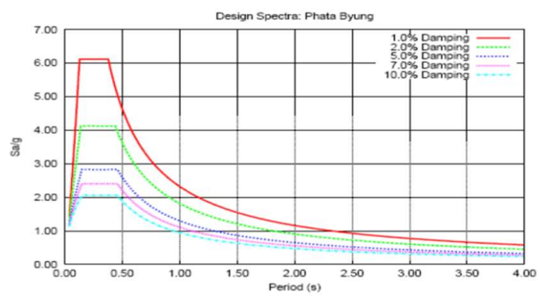

Figure 3 Normalised Horizontal Spectral Acceleration for various conditions.

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*********************************************************
* UNITS - KN    METE                                    *
* TIME PERIOD FOR X 1893 LOADING =    0.78769 SEC       *
* SA/G PER 1893=    1.270, LOAD FACTOR= 1.000           *
* FACTOR V  PER 1893 AT GL=    0.1801 X  11798.51       *
* FACTOR V  PER 1893 AT 30 M=    0.0902 X  11798.51     *
* FACTOR V  PER 1893 BELOW 30 M=    0.0901 X  11798.51  *
*      FACTOR V  PER 1893=    0.0901 X  11798.51        *
*                                                       *
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Figure 4 Time period, Sa/g and Horizontal seismic coeff. calculated by STAAD.pro along X

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*********************************************************
* UNITS - KN    METE                                    *
* TIME PERIOD FOR Z 1893 LOADING =    0.78769 SEC       *
* SA/G PER 1893=    1.270, LOAD FACTOR= 1.000           *
* FACTOR V  PER 1893 AT GL=    0.1801 X  11798.51       *
* FACTOR V  PER 1893 AT 30 M=    0.0902 X  11798.51     *
* FACTOR V  PER 1893 BELOW 30 M=    0.0901 X  11798.51  *
*      FACTOR V  PER 1893=    0.0901 X  11798.51        *
*                                                       *
*********************************************************
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Figure 5 : Time period, Sa/g and Horizontal seismic coeff. calculated by STAAD.pro along Z

As been incorporated and additionally the seismic inertia due to wheel loads are also considered as

CAHIERS MAGELLANES-NS
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http://magellanes.com/

primary load in STAAD as per the below calculations.
P = W*αh
Where,
P = horizontal earthquake force (kN)
W = EOT wheel load (kN)
αh = seismic coefficient
αh is horizontal ground acceleration due to earthquake [m/s²]
P = Static wheel load*ah = 300*0.18 = 54.0kN (applied in both X & Z directions)
Horizontal and vertical inertial forces are applied at the centre of gravity of the elements.
In the seismic definition of STAAD model, all the load above the raft level i.e. beams and columns,
Loading combinations
A load combination is a set of load cases that are applied to the structure simultaneously or sequentially.
A load case is a single type of load, such as dead load, live load, wind load, earthquake load, etc
Load combinations as per Indian standards IS 456 & IS 1893 (Part 1) and partial load factors are adopted as per table-18 of IS 456 in analysis.
Refer below the list of Primary Load cases and load combinations for analysis with partial safety factor taken for design and serviceability condition that are applied in STAAD model.

Table 4 List of Primary Load Cases

Primary Load Number	Description of Primary Load
1	EQ-X
2	EQ-Z
3	DEAD LOAD
4	LIVE LOAD
5	SC-FOR MAX BM-END IN BEAM
6	SC-FOR MAX BM-SPAN IN BEAM
7	SC-FOR MAX SHEAR FORCE IN BEAM
8	SC-FOR MAX AXIAL LOAD IN COLUMN
9	MC (CT THRUST)-FOR MAX BM-END IN BEAM
10	MC (CT THRUST)-FOR MAX BM-SPAN IN BEAM
11	MC (CT THRUST)-FOR MAX SHEAR FORCE IN BEAM
12	MC (CT THRUST)-FOR MAX AXIAL LOAD IN COLUMN
13	MC (LT THRUST)-FOR MAX BM-END IN BEAM
14	MC (LT THRUST)-FOR MAX BM-SPAN IN BEAM
15	MC (LT THRUST)-FOR MAX SHEAR FORCE IN BEAM
16	MC (LT THRUST)-FOR MAX AXIAL LOAD IN COLUMN
17	EOT INERTIA-X-FOR MAX BM-END IN BEAM
18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM
19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM
20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN
21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM
22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM
23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM
24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN

Abbreviations: SC- Static Crane, MC-Moving Crane, CT-Cross Travel and LT-Long Travel

Table 5 List of Load Combinations

Comb.	Primary load No.	Primary L/C Name	Load Factor
101	3	DEAD LOAD	1.50
	4	LIVE LOAD	1.50

ISSN:1624-1940
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http://magellanes.com/

	5	SC-FOR MAX BM-END IN BEAM	1.50
102	3	DEAD LOAD	1.50
	4	LIVE LOAD	1.50
	6	SC-FOR MAX BM-SPAN IN BEAM	1.50
103	3	DEAD LOAD	1.50
	4	LIVE LOAD	1.50
	7	SC-FOR MAX SHEAR FORCE IN BEAM	1.50
104	3	DEAD LOAD	1.50
	4	LIVE LOAD	1.50
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	1.50
105	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	9	MC (CT THRUST)-FOR MAX BM-END IN BEAM	1.20
106	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	10	MC (CT THRUST)-FOR MAX BM-SPAN IN BEAM	1.20
107	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	11	MC (CT THRUST)-FOR MAX SHEAR FORCE IN BEAM	1.20
108	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	12	MC (CT THRUST)-FOR MAX AXIAL LOAD IN COLUMN	1.20
109	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	13	MC (LT THRUST)-FOR MAX BM-END IN BEAM	1.20
110	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	14	MC (LT THRUST)-FOR MAX BM-SPAN IN BEAM	1.20
111	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	15	MC (LT THRUST)-FOR MAX SHEAR FORCE IN BEAM	1.20
112	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	16	MC (LT THRUST)-FOR MAX AXIAL LOAD IN COLUMN	1.20
113	3	DEAD LOAD	1.50
	1	EQ-X	1.50
	2	EQ-Z	0.45
114	3	DEAD LOAD	1.50
	1	EQ-X	1.50
	2	EQ-Z	-0.45
115	3	DEAD LOAD	1.50
	1	EQ-X	-1.50
	2	EQ-Z	0.45
116	3	DEAD LOAD	1.50
	1	EQ-X	-1.50
	2	EQ-Z	-0.45

ISSN:1624-1940
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http://magellanes.com/

117	3	DEAD LOAD	1.50
	1	EQ-X	0.45
	2	EQ-Z	1.50
118	3	DEAD LOAD	1.50
	1	EQ-X	0.45
	2	EQ-Z	-1.50
119	3	DEAD LOAD	1.50
	1	EQ-X	-0.45
	2	EQ-Z	1.50
120	3	DEAD LOAD	1.50
	1	EQ-X	-0.45
	2	EQ-Z	-1.50
121	1	EQ-X	1.20
	2	EQ-Z	0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	5	SC-FOR MAX BM-END IN BEAM	1.20
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	1.20
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	0.36
122	1	EQ-X	1.20
	2	EQ-Z	-0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	5	SC-FOR MAX BM-END IN BEAM	1.20
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	1.20
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	-0.36
123	1	EQ-X	-1.20
	2	EQ-Z	0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	5	SC-FOR MAX BM-END IN BEAM	1.20
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	-1.20
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	0.36
124	1	EQ-X	-1.20
	2	EQ-Z	-0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	5	SC-FOR MAX BM-END IN BEAM	1.20
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	-1.20
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	-0.36
125	1	EQ-X	0.36
	2	EQ-Z	1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	5	SC-FOR MAX BM-END IN BEAM	1.20
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	0.36
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	1.20
126	1	EQ-X	0.36
	2	EQ-Z	-1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	5	SC-FOR MAX BM-END IN BEAM	1.20
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	0.36
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	-1.20

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

127	1	EQ-X	-0.36
	2	EQ-Z	1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	5	SC-FOR MAX BM-END IN BEAM	1.20
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	-0.36
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	1.20
128	1	EQ-X	-0.36
	2	EQ-Z	-1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	5	SC-FOR MAX BM-END IN BEAM	1.20
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	-0.36
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	-1.20
129	1	EQ-X	1.20
	2	EQ-Z	0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	6	SC-FOR MAX BM-SPAN IN BEAM	1.20
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	1.20
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	0.36
130	1	EQ-X	1.20
	2	EQ-Z	-0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	6	SC-FOR MAX BM-SPAN IN BEAM	1.20
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	1.20
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	-0.36
131	1	EQ-X	-1.20
	2	EQ-Z	0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	6	SC-FOR MAX BM-SPAN IN BEAM	1.20
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	-1.20
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	0.36
132	1	EQ-X	-1.20
	2	EQ-Z	-0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	6	SC-FOR MAX BM-SPAN IN BEAM	1.20
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	-1.20
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	-0.36
133	1	EQ-X	0.36
	2	EQ-Z	1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	6	SC-FOR MAX BM-SPAN IN BEAM	1.20
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	0.36
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	1.20

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
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134	1	EQ-X	0.36
	2	EQ-Z	-1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	6	SC-FOR MAX BM-SPAN IN BEAM	1.20
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	0.36
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	-1.20
135	1	EQ-X	-0.36
	2	EQ-Z	1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	6	SC-FOR MAX BM-SPAN IN BEAM	1.20
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	-0.36
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	1.20
136	1	EQ-X	-0.36
	2	EQ-Z	-1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	6	SC-FOR MAX BM-SPAN IN BEAM	1.20
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	-0.36
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	-1.20
137	1	EQ-X	1.20
	2	EQ-Z	0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	7	SC-FOR MAX SHEAR FORCE IN BEAM	1.20
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	1.20
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	0.36
138	1	EQ-X	1.20
	2	EQ-Z	-0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	7	SC-FOR MAX SHEAR FORCE IN BEAM	1.20
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	1.20
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	-0.36
139	1	EQ-X	-1.20
	2	EQ-Z	0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	7	SC-FOR MAX SHEAR FORCE IN BEAM	1.20
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	-1.20
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	0.36
140	1	EQ-X	-1.20
	2	EQ-Z	-0.36
	3	DEAD LOAD	1.20

CAHIERS MAGELLANES-NS
Volume 06 Issue 2
2024

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

	4	LIVE LOAD	1.20
	7	SC-FOR MAX SHEAR FORCE IN BEAM	1.20
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	-1.20
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	-0.36
141	1	EQ-X	0.36
	2	EQ-Z	1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	7	SC-FOR MAX SHEAR FORCE IN BEAM	1.20
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	0.36
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	1.20
142	1	EQ-X	0.36
	2	EQ-Z	-1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	7	SC-FOR MAX SHEAR FORCE IN BEAM	1.20
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	0.36
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	-1.20
143	1	EQ-X	-0.36
	2	EQ-Z	1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	7	SC-FOR MAX SHEAR FORCE IN BEAM	1.20
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	-0.36
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	1.20
144	1	EQ-X	-0.36
	2	EQ-Z	-1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	7	SC-FOR MAX SHEAR FORCE IN BEAM	1.20
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	-0.36
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	-1.20
145	1	EQ-X	1.20
	2	EQ-Z	0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	1.20
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	1.20
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	0.36
146	1	EQ-X	1.20
	2	EQ-Z	-0.36
	3	DEAD LOAD	1.20

CAHIERS MAGELLANES-NS
Volume 06 Issue 2
2024

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

	4	LIVE LOAD	1.20
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	1.20
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	1.20
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	-0.36
147	1	EQ-X	-1.20
	2	EQ-Z	0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	1.20
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	-1.20
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	0.36
148	1	EQ-X	-1.20
	2	EQ-Z	-0.36
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	1.20
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	-1.20
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	-0.36
149	1	EQ-X	0.36
	2	EQ-Z	1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	1.20
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	0.36
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	1.20
150	1	EQ-X	0.36
	2	EQ-Z	-1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	1.20
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	0.36
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	-1.20
151	1	EQ-X	-0.36
	2	EQ-Z	1.20
	3	DEAD LOAD	1.20
	4	LIVE LOAD	1.20
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	1.20
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	-0.36
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	1.20
152	1	EQ-X	-0.36
	2	EQ-Z	-1.20
	3	DEAD LOAD	1.20

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

	4	LIVE LOAD	1.20
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	1.20
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	-0.36
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	-1.20
201	3	DEAD LOAD	1.00
	4	LIVE LOAD	1.00
	5	SC-FOR MAX BM-END IN BEAM	1.00
202	3	DEAD LOAD	1.00
	4	LIVE LOAD	1.00
	6	SC-FOR MAX BM-SPAN IN BEAM	1.00
203	3	DEAD LOAD	1.00
	4	LIVE LOAD	1.00
	7	SC-FOR MAX SHEAR FORCE IN BEAM	1.00
204	3	DEAD LOAD	1.00
	4	LIVE LOAD	1.00
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	1.00
205	3	DEAD LOAD	1.00
	4	LIVE LOAD	1.00
	9	MC (CT THRUST)-FOR MAX BM-END IN BEAM	1.00
206	3	DEAD LOAD	1.00
	4	LIVE LOAD	1.00
	10	MC (CT THRUST)-FOR MAX BM-SPAN IN BEAM	1.00
207	3	DEAD LOAD	1.00
	4	LIVE LOAD	1.00
	11	MC (CT THRUST)-FOR MAX SHEAR FORCE IN BEAM	1.00
208	3	DEAD LOAD	1.00
	4	LIVE LOAD	1.00
	12	MC (CT THRUST)-FOR MAX AXIAL LOAD IN COLUMN	1.00
209	3	DEAD LOAD	1.00
	4	LIVE LOAD	1.00
	13	MC (LT THRUST)-FOR MAX BM-END IN BEAM	1.00
210	3	DEAD LOAD	1.00
	4	LIVE LOAD	1.00
	14	MC (LT THRUST)-FOR MAX BM-SPAN IN BEAM	1.00
211	3	DEAD LOAD	1.00
	4	LIVE LOAD	1.00
	15	MC (LT THRUST)-FOR MAX SHEAR FORCE IN BEAM	1.00
212	3	DEAD LOAD	1.00
	4	LIVE LOAD	1.00
	16	MC (LT THRUST)-FOR MAX AXIAL LOAD IN COLUMN	1.00
213	3	DEAD LOAD	1.00
	1	EQ-X	1.00
	2	EQ-Z	0.30
214	3	DEAD LOAD	1.00

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

	1	EQ-X	1.00
	2	EQ-Z	-0.30
215	3	DEAD LOAD	1.00
	1	EQ-X	-1.00
	2	EQ-Z	0.30
216	3	DEAD LOAD	1.00
	1	EQ-X	-1.00
	2	EQ-Z	-0.30
217	3	DEAD LOAD	1.00
	1	EQ-X	0.30
	2	EQ-Z	1.00
218	3	DEAD LOAD	1.00
	1	EQ-X	0.30
	2	EQ-Z	-1.00
219	3	DEAD LOAD	1.00
	1	EQ-X	-0.30
	2	EQ-Z	1.00
220	3	DEAD LOAD	1.00
	1	EQ-X	-0.30
	2	EQ-Z	-1.00
221	1	EQ-X	0.80
	2	EQ-Z	0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	5	SC-FOR MAX BM-END IN BEAM	0.80
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	0.80
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	0.24
222	1	EQ-X	0.80
	2	EQ-Z	-0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	5	SC-FOR MAX BM-END IN BEAM	0.80
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	0.80
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	-0.24
223	1	EQ-X	-0.80
	2	EQ-Z	0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	5	SC-FOR MAX BM-END IN BEAM	0.80
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	-0.80
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	0.24
224	1	EQ-X	-0.80
	2	EQ-Z	-0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	5	SC-FOR MAX BM-END IN BEAM	0.80
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	-0.80
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	-0.24
225	1	EQ-X	0.24
	2	EQ-Z	0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	5	SC-FOR MAX BM-END IN BEAM	0.80
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	0.24

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	0.80
226	1	EQ-X	0.24
	2	EQ-Z	-0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	5	SC-FOR MAX BM-END IN BEAM	0.80
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	0.24
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	-0.80
227	1	EQ-X	-0.24
	2	EQ-Z	0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	5	SC-FOR MAX BM-END IN BEAM	0.80
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	-0.24
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	0.80
228	1	EQ-X	-0.24
	2	EQ-Z	-0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	5	SC-FOR MAX BM-END IN BEAM	0.80
	17	EOT INERTIA-X-FOR MAX BM-END IN BEAM	-0.24
	21	EOT INERTIA-Z-FOR MAX BM-END IN BEAM	-0.80
229	1	EQ-X	0.80
	2	EQ-Z	0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	6	SC-FOR MAX BM-SPAN IN BEAM	0.80
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	0.80
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	0.24
230	1	EQ-X	0.80
	2	EQ-Z	-0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	6	SC-FOR MAX BM-SPAN IN BEAM	0.80
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	0.80
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	-0.24
231	1	EQ-X	-0.80
	2	EQ-Z	0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	6	SC-FOR MAX BM-SPAN IN BEAM	0.80
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	-0.80
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	0.24
232	1	EQ-X	-0.80
	2	EQ-Z	-0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	6	SC-FOR MAX BM-SPAN IN BEAM	0.80
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	-0.80
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	-0.24

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

233	1	EQ-X	0.24
	2	EQ-Z	0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	6	SC-FOR MAX BM-SPAN IN BEAM	0.80
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	0.24
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	0.80
234	1	EQ-X	0.24
	2	EQ-Z	-0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	6	SC-FOR MAX BM-SPAN IN BEAM	0.80
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	0.24
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	-0.80
235	1	EQ-X	-0.24
	2	EQ-Z	0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	6	SC-FOR MAX BM-SPAN IN BEAM	0.80
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	-0.24
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	0.80
236	1	EQ-X	-0.24
	2	EQ-Z	-0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	6	SC-FOR MAX BM-SPAN IN BEAM	0.80
	18	EOT INERTIA-X-FOR MAX BM-SPAN IN BEAM	-0.24
	22	EOT INERTIA-Z-FOR MAX BM-SPAN IN BEAM	-0.80
237	1	EQ-X	0.80
	2	EQ-Z	0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	7	SC-FOR MAX SHEAR FORCE IN BEAM	0.80
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	0.80
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	0.24
238	1	EQ-X	0.80
	2	EQ-Z	-0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	7	SC-FOR MAX SHEAR FORCE IN BEAM	0.80
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	0.80
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	-0.24
239	1	EQ-X	-0.80
	2	EQ-Z	0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80

CAHIERS MAGELLANES-NS
Volume 06 Issue 2
2024

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

	7	SC-FOR MAX SHEAR FORCE IN BEAM	0.80
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	-0.80
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	0.24
240	1	EQ-X	-0.80
	2	EQ-Z	-0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	7	SC-FOR MAX SHEAR FORCE IN BEAM	0.80
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	-0.80
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	-0.24
241	1	EQ-X	0.24
	2	EQ-Z	0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	7	SC-FOR MAX SHEAR FORCE IN BEAM	0.80
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	0.24
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	0.80
242	1	EQ-X	0.24
	2	EQ-Z	-0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	7	SC-FOR MAX SHEAR FORCE IN BEAM	0.80
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	0.24
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	-0.80
243	1	EQ-X	-0.24
	2	EQ-Z	0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	7	SC-FOR MAX SHEAR FORCE IN BEAM	0.80
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	-0.24
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	0.80
244	1	EQ-X	-0.24
	2	EQ-Z	-0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	7	SC-FOR MAX SHEAR FORCE IN BEAM	0.80
	19	EOT INERTIA-X-FOR MAX SHEAR FORCE IN BEAM	-0.24
	23	EOT INERTIA-Z-FOR MAX SHEAR FORCE IN BEAM	-0.80
245	1	EQ-X	0.80
	2	EQ-Z	0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

	8	SC-FOR MAX AXIAL LOAD IN COLUMN	0.80
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	0.80
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	0.24
246	1	EQ-X	0.80
	2	EQ-Z	-0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	0.80
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	0.80
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	-0.24
247	1	EQ-X	-0.80
	2	EQ-Z	0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	0.80
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	-0.80
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	0.24
248	1	EQ-X	-0.80
	2	EQ-Z	-0.24
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	0.80
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	-0.80
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	-0.24
249	1	EQ-X	0.24
	2	EQ-Z	0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	0.80
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	0.24
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	0.80
250	1	EQ-X	0.24
	2	EQ-Z	-0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	0.80
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	0.24
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	-0.80
251	1	EQ-X	-0.24
	2	EQ-Z	0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

	8	SC-FOR MAX AXIAL LOAD IN COLUMN	0.80
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	-0.24
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	0.80
252	1	EQ-X	-0.24
	2	EQ-Z	-0.80
	3	DEAD LOAD	1.00
	4	LIVE LOAD	0.80
	8	SC-FOR MAX AXIAL LOAD IN COLUMN	0.80
	20	EOT INERTIA-X-FOR MAX AXIAL LOAD IN COLUMN	-0.24
	24	EOT INERTIA-Z-FOR MAX AXIAL LOAD IN COLUMN	-0.80

6. ANALYSIS & DESIGN

6.1 F E M Model and Analysis

Unit bay structural members are designed for critical load combinations. Design of each structural elements have been done as describe below.

6.2 Crane Beam

Table 6: Summary of Structural member sizes and Reinforcement adopted.

Sl. No.	Member	Description
1	EOT Crane Column (700X925 mm)	Main: Dia. 32mm -16Nos Ties: Dia. 10mm - 100/200mm c/c
2	EOT Crane Beam (1000X1200 mm)	Main: Dia. 25mm -5T & 7B Side Face: Dia. 16mm – 3Nos Stirrups: Dia. 10mm - 6L- 100/200mm c/c
3	Beams along Grid B & D (500X750 mm)	Main: Dia. 25mm -4T & 4B Side Face: Dia. 16mm – 2 Nos Stirrups: Dia. 10mm - 4L- 100/200mm c/c
4	Floor Beams Along Grid 7 & 10 (500X750 mm)	Main: Dia. 25mm -4T & 4B Side Face: Dia. 16mm – 2 Nos Stirrups: Dia. 10mm - 2L- 100/200mm c/c
5	Floor Beams Along the flow (500X750 mm)	Main: Dia. 25mm -4T & 6B Side Face: Dia. 16mm – 2 Nos Stirrups: Dia. 10mm - 6L- 100/200mm c/c
6	Floor Beams Across the flow (350X750 mm)	Main: Dia. 20mm -3T & 3B Side Face: Dia. 16mm – 2 Nos Stirrups: Dia. 10mm - 4L- 100/200mm c/c
7	Stair Breams (350X400 mm)	Main: Dia. 16mm -2T & 2B Side Face: Dia. 10mm – 2 Nos Stirrups: Dia. 10mm - 2L- 100/200mm c/c
8	Floor Slab (250mm Thick)	Reinforcement along the Flow ● Top Reinforcement-16mm Dia @ 250 c/c

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

		● Bottom Reinforcement-16mm Dia @ 250 c/c Reinforcement across the Flow ● Top Reinforcement-20mm Dia @ 250 c/c ● Bottom Reinforcement-16mm Dia @ 250 c/c

The EOT Crane Beam is design for the most critical location of the wheel loads that can induce the maximum vertical bending moment are located by using vehicular (moving) load option in STAAD Pro. Similarly, the most critical location of wheel loads that can induce the maximum shear force are also located. The crane wheel loads are then applied in numerical model at these wheel locations. Crane beam has been designed for the most critical load combination.
The Crane beam is design for maximum bending moment, torsion & shear force. Ductile detailing is done for beam as per IS 13920. For details of structural design of crane beam, refer Annexure-II

6.3 Crane Column

Structural design of Crane column has been done for the maximum bending moments & axial force resulted from two independent analyses (Bending moment and Axial Force).
For details of structural design of crane beam, refer Annexure-II

6.4 Tie Beams

Tie beams are provided between crane columns. The tie beams are checked for critical load combinations.
The beams are designed for maximum bending moment, torsion & shear force. Ductile detailing for Tie beams are accordance with IS 13920. For details of structural design of tie beams, refer Annexure-II.

6.5 Intermediate floor Beams , Slabs and Columns

Intermediate floor beams, slabs & columns are designed for the critical load combinations. For details of structural design of Intermediate floor beams, slabs & columns, refer Annexure-II

7. CONCLUSION AND RECOMMENDATIONS

From the design calculations for Unit Bay frame Structure, it is be observed that the proposed sizes of structural elements are safe for critical load combinations. The design results for Unit bay-1 in powerhouse are summarised in the table:

8. ANNEXURE

CAHIERS MAGELLANES-NS
Volume 06 Issue 2
2024

ISSN:1624-1940
DOI 10.6084/m9.figshare.2632574
http://magellanes.com/

LOAD CALCULATION FOR EOT CRANE (Max. Wheel Load)
1x90T EOT: Mode of operation - Single

Input Data

SWL	900 kN
Span of crane, S	13.1 m
Impact factor	1.18 (M3 crane,Table-1,IS 3177:1999)
crane wt	470 kN
crab wt	316 kN
cabin wt	0 kN
Total no. of wheel	8
Hook approach, A	1
No. of wheel on each side	4

Sl. No.	Loading Conditions
1	Static crane with 100% load capacity, SC-100%
2	Moving crane with 100% load capacity, MC-100%

1. Static crane with 100% load capacity, SC-100%

Wheel load when the trolley is in min. hook position

(S - A) * (Crab wt. + SWL) / (S * No. of LT wheels /2) + (Crane Wt. - Crab Wt.-Cabin Wt.)/No. of LT wheels

For full load, lifting weight	900 kN
Total Load per wheel	300.0 kN

2. Moving crane with 100% load capacity, MC-100%

Wheel load when the trolley is in min. hook position

[(Impact factor x Lifting capacity + Trolley wt.)x(Span-Hook approach)/Span)]/ No. of wheels on each side

For full load, lifting weight	900 kN
Total Load per wheel	350.6 kN

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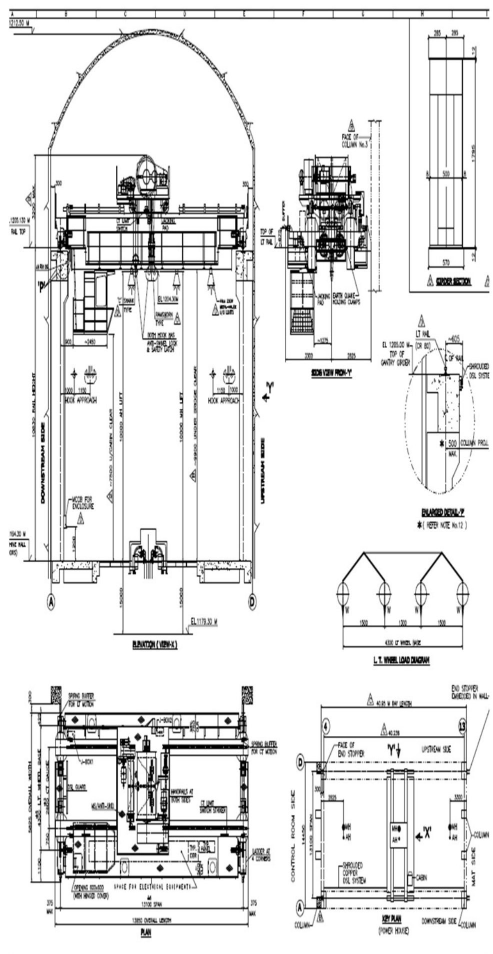
9. DRAWING



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7. IS 4247 PART *3(*Structural design of surface electric power stations-sub structure).