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Dynamic Analysis of Integrated Building at Airport

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ABSTRACT: With the advancement of finite element tools the analysis and design of huge and special structures is possible now-a-days. In this paper the analysis of airport integrated building has been carried using the finite element software SAP 2000. By considering the necessary functionality of the building, the number of columns required is reduced from 60 to 30 by introducing truss POD in the structural system. The building has been analysed using Response spectrum method as per IS 1893 and the dynamic responses are obtained.

KEYWORDS: Airport building, Modelling, Seismic analysis, Dynamic Response

I AIRPORT TERMINAL BUILDING

Airports are important national resources which serve a key role in transportation of people and goods. The primary buildings in airport consist of passenger terminal buildings, control towers, cargo buildings, hangars, airport maintenance buildings and fire and rescue stations. To achieve sustainable developments the analysis and design of airport buildings should focus on function, construction materials, construction technology and energy savings.

The essential functional requirement of the Terminal Building is a free space for the movement of passengers and goods. One of the ways to get free space in the terminal building is having less number of columns with cautious planning and design in terms of the safety of the structure. The design of any complex and superior building should satisfy not only the vertical loads coming on the structural elements but also the horizontal loads such as wind and earthquake forces. The new Integrated Terminal Building at Mumbai’s Chhatrapati Shivaji International Airport has a long-span roof covering a total of 70 000 m^2 over various functional requirements, making it one of the largest roofs in the world without an expansion joint [1]. In this study a similar kind of airport terminal building system is modeled using the finite element software SAP 2000 and is analysed for seismic resistance using response spectrum method as specified in IS 1893:2002. The structural consists of steel moment resisting frames comprising of composite mega columns and long-span steel rooftop trusses.

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II MODEL OF STRUCTURAL SYSTEM

Modelling of the columns and the pod is done in SAP2000. The columns are assigned fixed support condition at bottom. The upper end of the column is left free to join truss POD. The spacing of columns in X-direction is 32m and in Y-direction is 64m as shown in Fig.1. The columns are being modelled with steel encased concrete properties of M 60 concrete and Fe 345 steel. The Modulus of elasticity obtained from the composite parameters is 2.32 GPA [2]. The diameter of the column is assumed as 2.7m

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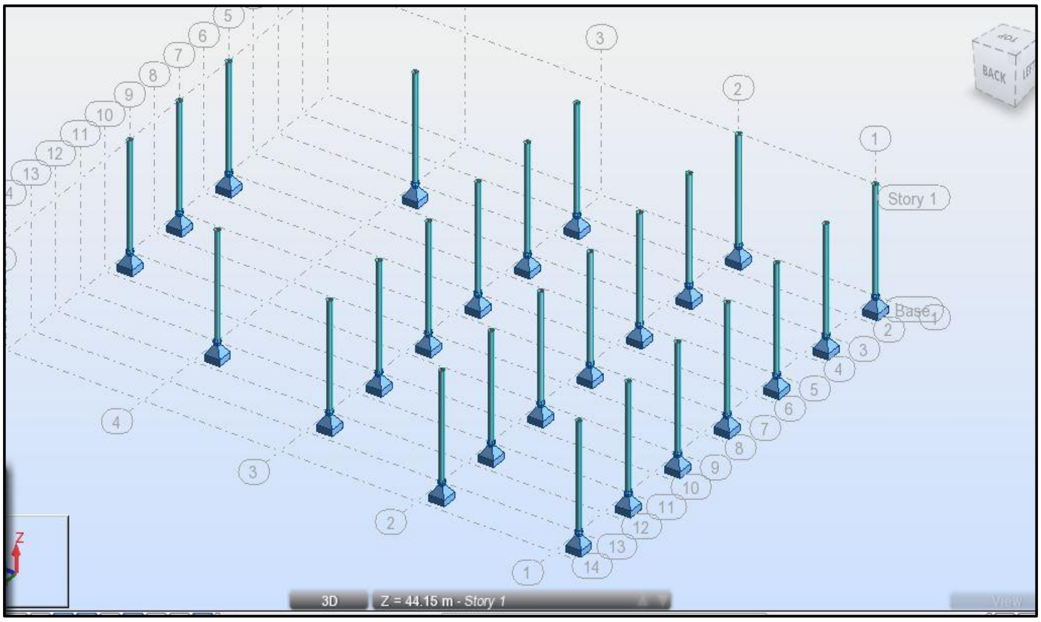

Fig 1 Model of columns

The columns are being modelled with steel encased concrete properties of M 60 concrete and Fe 345 steel. The Modulus of elasticity obtained from the composite parameters is 2.32 GPA [2]. The diameter of the column is assumed as 2.7m.

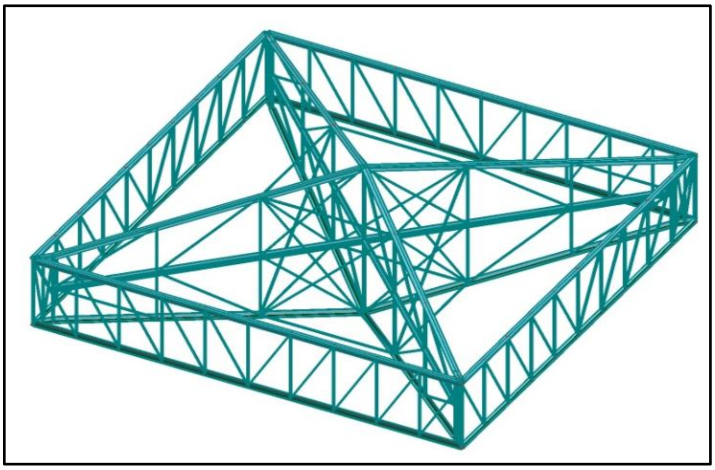

Fig 2 Model of Truss POD

. The truss POD (Fig.2) is modelled with properties of Fe 345 steel. Hollow sections with 0.315 m diameter are considered for this. This POD is modelled in such a way that it can transfer the load coming on it to columns in arch action. The complete model of the structural system is show in Fig.3.

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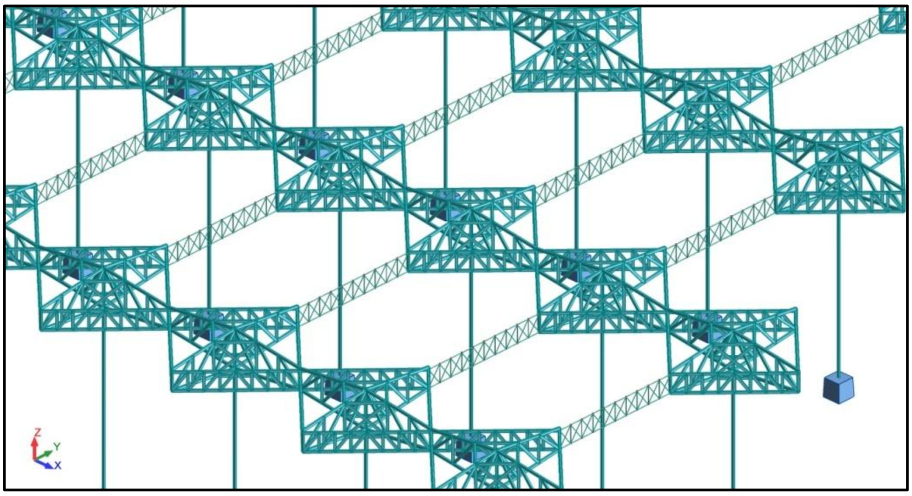

Fig 3 Model of Assembled Structural system

III RESPONSE SPECTRUM ANALYSIS

A response spectrum is a plot of the peak response amplitude (displacement, velocity or acceleration) versus time period of many linear single degree of freedom oscillators to a give component of ground motion. Response-spectrum analysis (RSA) is a linear-dynamic statistical analysis method. One of its applications is to assess the peak response of buildings to earthquakes. In this paper RSA is adopted using SAP 2000 software to determine the dynamic response of the airport terminal building under study. The procedure for the analysis is given below.

1. After the structural system is modelled, the properties of the structure are assigned.
2. Then dead load for entire structure is assigned and the live load is obtained from IS 875 (part-V).
3. The response spectrum as given in IS 1893 is considered as input for the analysis. The seismic zone factor (Z) assigned is 0.36 (severe) and the soil type assigned is of medium soil.
4. Run the analysis.
5. Read the level of response from the spectrum for the period of each of the modes considered.

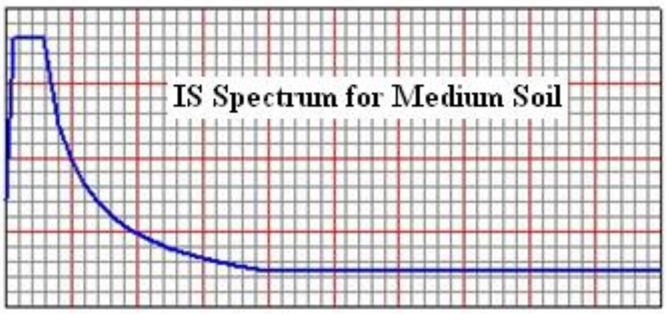

Fig 4 Response Spectrum Function-Input

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IV RESULTS AND DISCUSSION

Dynamic Responses

The response-spectrum analysis shows the contribution from each natural mode of vibration to indicate the maximum seismic response in terms of pseudo-spectral acceleration, velocity, or displacement. Table 1 represents the dynamic response of the building under study. The fundamental time period of the structural system is found to be 0.4259 sec. The response acceleration and displacement are found as 0.9 m/sec^2 and 6.6 mm. Generally structures of shorter period suffer with greater acceleration, whereas longer period structures experience greater displacement. From the analysis it is observed that the airport terminal building suffers with greater acceleration and also the first mode participation is more in the dynamic response. These inputs would be useful in the design of structural components against earthquake loadings. In addition the stresses near the POD element (Fig. 5) may be beneficial to the designers and engineers to select the suitable materials for truss elements [3].

Table 1 Response Acceleration and Displacement

Mode Number	Period	Frequency	Acceleration	Displacement
	sec	Hz	m/sec^2	m
1	0.4259	2.348	0.9	0.006636
2	0.143939	6.9474	0.9	-5.755E-10
3	0.018288	54.682	0.45875	4.744E-14
4	0.000103	9698.9	0.36056	-2.353E-14
5	0.0001	10021	0.36054	-2.403E-15
6	0.000009534	104890	0.36005	1.17E-20

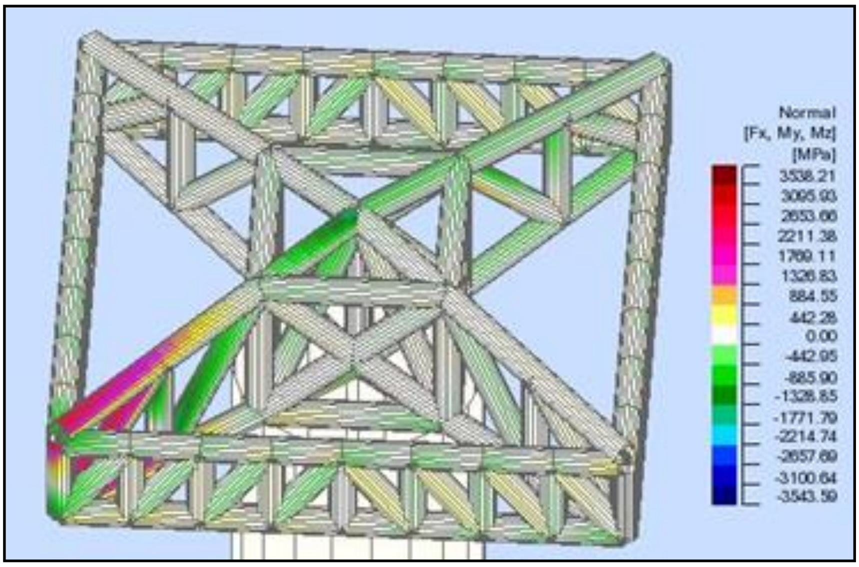

Fig 5 Von –misses Stresses near POD

V. CONCLUSION

Airport space flexibility depends on the planning and design of structural system. In this paper to fulfil one of the flexibility criteria the column spacing in the structural system is increased by using advance technique known as POD. The dynamic analysis of the airport integrated building is carried out using response spectrum method which would help the engineers for the design of such complex buildings.

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