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Dynamic Analysis of Revitalizing Systems in a Steel Turbine Building

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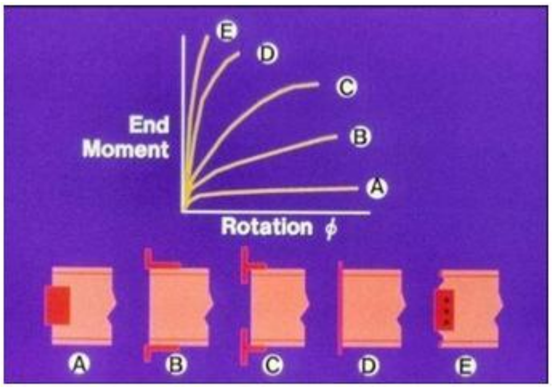
ABSTRACT:

The effective use of bracing systems for as a structural system is of vital importance in the seismic design of structures. Bracing systems are usually analyzed for wind loading only because it is one of the most commonly used lateral load resisting element. Usually for the steel struc- ture the failure is governed by wind loading because of its lesser self-weight when compared to RC structures. But when seismic activity is greater than a particular scale, then the failure governing criteria may vary. It is a model with steel superstructure and concrete foun- dation and three commonly used bracing systems namely X-bracing, K -bracing and V-bracing are incorporated into the structure separately. All the three models were subjected to two types of analysis. Equivalent static meth- od for static analysis and Response spectrum method for dynamic analysis was used. In this project a composite structure is modeled with the help of STAAD pro V8i software.

INTRODUCTION:

The present day scenario in the construction industry is the efficient seismic design of the structure. Both concrete and the steel structures have to be reinforced with sys- tems that resist the lateral loads. Namely, there are three types of lateral load resisting structures. They are braced frames, rigid frames and shear walls. In structural steel construction both braced frames and rigid frames are con- sidered depending on the type of building. The type of systems to be used is mainly determined by the type of connections that are to be used in the building.

There are two types of connections in structural steel, they are simple (shear) connections and moment connections. Bracing systems are to be used separately for lateral stability when the joints have shear connection and in the case of rigid frames moment connections are used. Below Fig shows the type of connections and their rigidity.



The braced frame is an integral part of the lateral load resisting system in structural steel construction. The brac- ing systems are generally governed by the wind loading and as well as the seismic loading in some criteria. The diagonal bracing creates a stable triangular configuration within the steel frame. It is also one of the most economi- cal methods of resisting the wind loads in both open and closed structures.The turbine hall, generating hall or tur- bine building is a building or room in any steam cycle or hydroelectric power plant which houses a number of components vital to the generation of electricity from the steam that comes from the boiler, or from the water com- ing from the reservoir. The components in the turbine hall typically are the turbines and electric generators. The turbine building or turbine hall is an integral part of the nuclear power plant.

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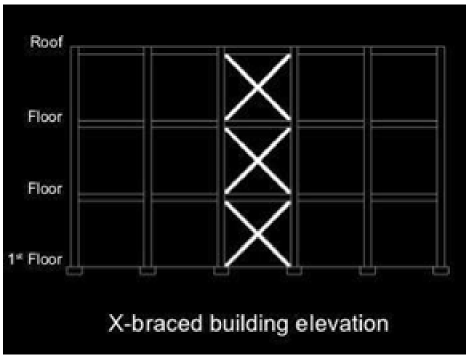
The generation of electricity is done with the help of steam that is obtained from the fission reaction which happens inside the reactor.

TYPES OF BRACING SYSTEMS:

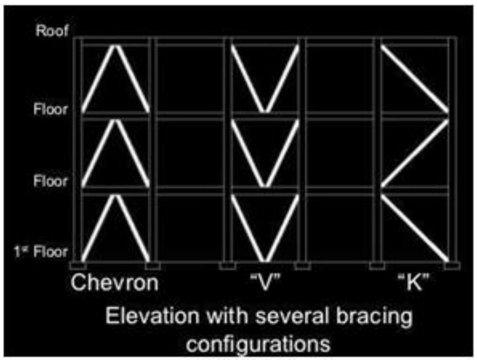
There are several types of bracing systems that can be used in steel structures. Bracing is efficient because the diagonal members work in axial stress and the member sizes can be reduced. Bracing systems are preferred where there are shear connections at the joints. The different types of bracing systems are listed below.

- X - Bracing
- Chevron Bracing
- V - Bracing
- K - Bracing
- Single Diagonal bracing
- Y - Bracing
- Eccentrically Braced Frames

These are some of the commonly used types of bracing systems. Bracing systems can also be modifies accord- ing to the requirements of the buildings. Moment frames and bracing systems can also be used in combination for lesser deflection of the members. Below Fig shows the elevations of buildings with the commonly used bracing systems.



X-braced building elevation



Elevation with several bracing configurations

STRUCTURAL MODELLING:

Modeling a structure deals with the arrangement of structural elements in 3- Dimension with the help of architectural or structural drawings. The turbine building with bracing systems was modeled with the STAAD pro V8i software.

TURBINE MODEL:

Turbine building consists of Steel frames that are ar- ranged orthogonally in plan, parallel to each other which are connected by system of slabs. Turbine building structure consists of hybrid framing arrangement in the form of RCC columns and tie beams up to ground level and steel columns, beams and roof trusses for superstructure. The roofing system at comprises of roof trusses in structural steel with necessary tie bracings and purlins. Steel trusses have connection with steel columns to ensure frame action. All other internal floors are supported by structural steel framing. All connections used in the structure are shear connections. The Turbine Generator building is di- vided into several bays / grids. There are six bays (named as AB, BC, CD, DE, EF & FG) parallel to turbine axis and eleven bays (named as 01-02, 02-03, 03-04 etc) perpendicular to turbine axis. This lay- out of the internal columns satisfies both structural and system requirements.

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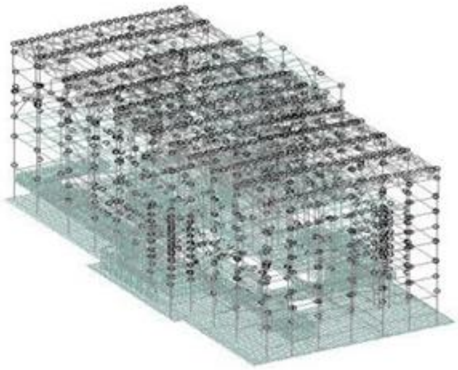
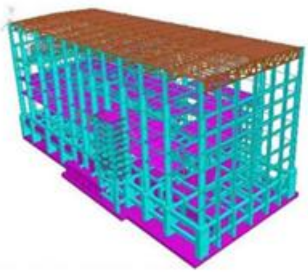


3D view of the turbine model in software Below Fig shows the rendered view of the model developed. The bracings and few members are built up section, therefore the ren- dering option is not available for this type of sections.



Rendered view

DESIGN OF CONNECTIONS:

Turbine building super structure is an assemblage of dif- ferent steel members such as beams, columns and tension members, which are fastened or connected to one another, at member ends. Connections are classified according to the following

Parameters:

- Method of fastening- Bolted and welded
- Connection rigidity- Simple, rigid or semi-rigid.

Turbine building superstructure members are connected by combinations of the above classifications. Bolts of property class 8.8 shall be used and requirements of welds and welding shall conform to IS816. Connection shall be designed for the factored loads as per the guidelines given in Section 10 of IS 800. Single shear bolt connection design Cross Sectional Area, A = 353mm

RESULTS AND DISCUSSION:

From Equivalent static analysis, the displacement at a sin- gle node is considered. below shows the nodal displace- ment for both Equivalent static and response spectrum analysis respectively.

Displacement at node (ESA)

SL NO.	TYPE OF BRACING	DISPLACEMENT AT NODE(MM)
1.	X- Bracing	76.98
2.	K- Bracing	110.64
3.	V- Bracing	319.21

Displacement at node (RSA)

SL NO.	TYPE OF BRACING	DISPLACEMENT AT NODE(MM)
1.	X- Bracing	279.02
2.	K- Bracing	345.55
3.	V- Bracing	1078.63

CONCLUSION:

The results obtained from both the analysis are shear at storey height, displacement at storey height and displace- ment at a common node.

•When the X-Bracing system is used, there is a reduction of 25 percent of the nodal displacement when compared to K Bracing. The deflection for V- Bracing system is 120 percent more than that of K – Bracing System.

•Shear forces are more at V bracing and K bracing com- pared to X bracing system. There is a decrease of 20 % shear due to the usage of X bracing.

•Displacement in different height levels is also consid- erably less in the case of X bracing system. There is a decrease of 17% displacement in X bracing when com- pared to K bracing and 56% decrease when compared to V bracing.

•Combination of different types of bracing will yield a more economical result as per the requirement criteria

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