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Comparative Analysis of Steel Structure with Rigid and Semi Rigid Joint UsingAnalysis Tool Etabs

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Abstract:
Generally, in sword structure the connection between ray and column are designed as moment connection and projected connection, but in factual condition the structure behaves between these two conditions, redounded intosemi-rigid condition which is intermediate stage between rigid and projected joints. Effect ofsemi-rigid connection onmulti-storymulti-bay frame is fulfilled in this Study. The present study introduces the effect of static and dynamic lading on high rise sword structure of G 12 story with 4m, 6m and 8m three bay span length. Structure is anatomized under two different condition of partial release ofsemi-rigid connections which is deduced by fixity factor of values0.5 and0.75 in this study. The analysis is done commercially available software ETABS. From thenon-linear analysis, the story relegation and story drift are attained. The overall performance of the structure from the analysis, semirigid joints display further story relegation and story drift compared to rigid joints. To overcome the results, bracing system is introduced at different position of fringe of structure.
These brace frame structure correspond of X- bracing and slant bracing. Again, relative analysis is to be performed in ETABS on these three- bay span lengths. It's set up that armedsemi-rigid frame structure perform relatively well as compared to unbraced frame structure

Keywords: Multi-story Multi-bay frame, Semi-rigid connections, Fixity factor, Brace frame,Rigid Connections.

Introduction:
preface utmost of the structures were having a normal grid of 3m x 3m column distance with a standard storey height of 3m. One important parameter concerned with the seismic geste is the storey drift which shouldn't exceed a admissible value. This fact is apparent from the addition of a clause related to specifying a admissible value of storey drift in all country canons related to earthquake engineering including the Indian law IS 1893, 2002. The current work aims to report the seismic performance of G 11 sword structure with X type bracings at corner.

Types of Steel Beam Connections

Steel beam connections can likewise be required for slanted joints, pillars unusual to sections and association with segment networks. These are classed as extraordinary connections and are treated separately. Steel beam connections come up with various sorts. Presently steeloncall have given the explanation of the considerable number ofsorts of steel beam connections in the below section.

1. Bolted framed connections

Fig 1.1 Bolted Framed Connections

2. Bolted seated connections

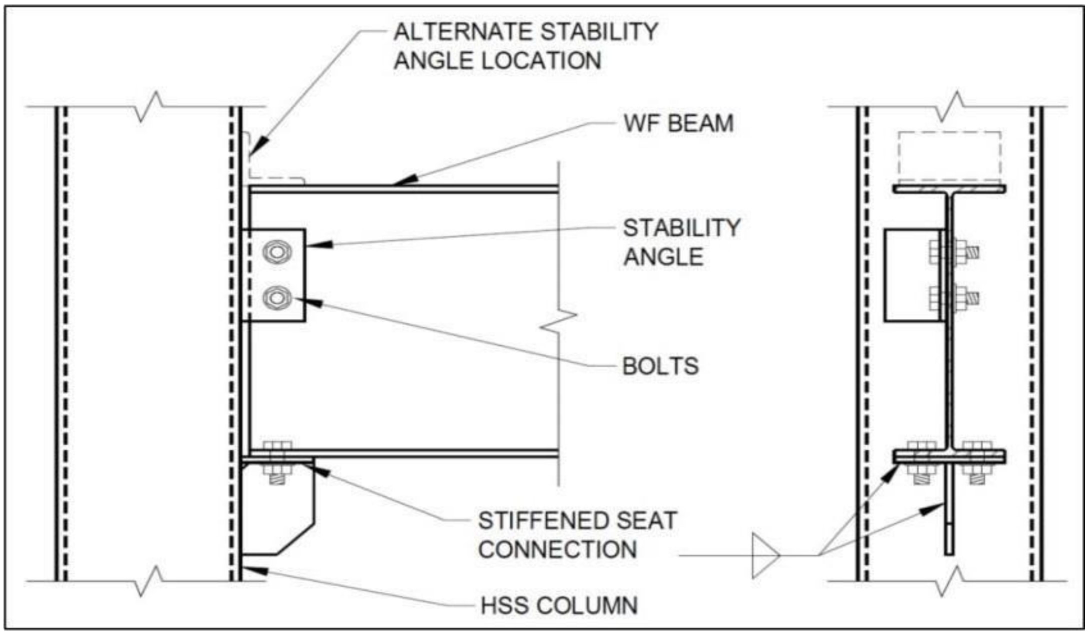

Fig 1.2 Bolted seated connections

3. Welded framed connections

Fig 1.3 Welded Framed Connections

4. Welded seat connections

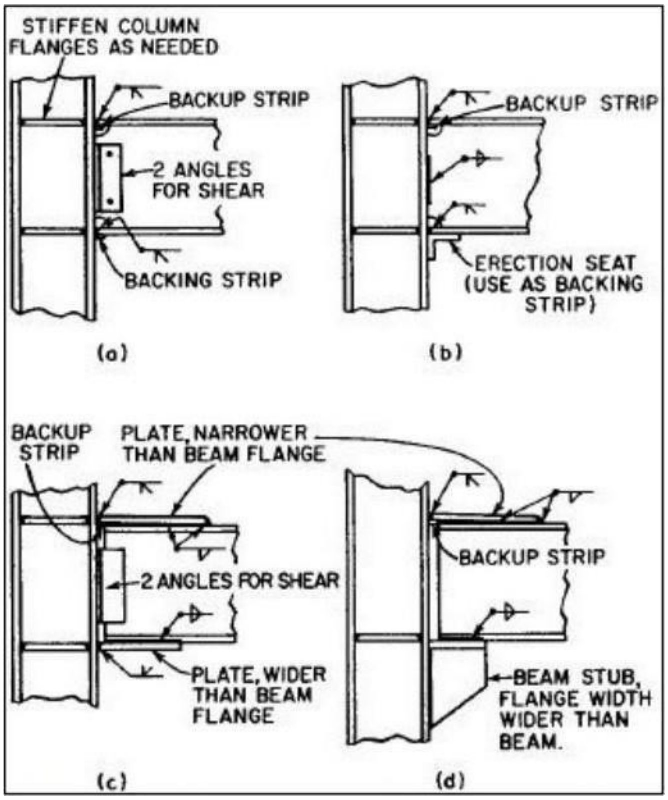

Fig 1.4 Welded Seat Connections

5. End Plate Connections

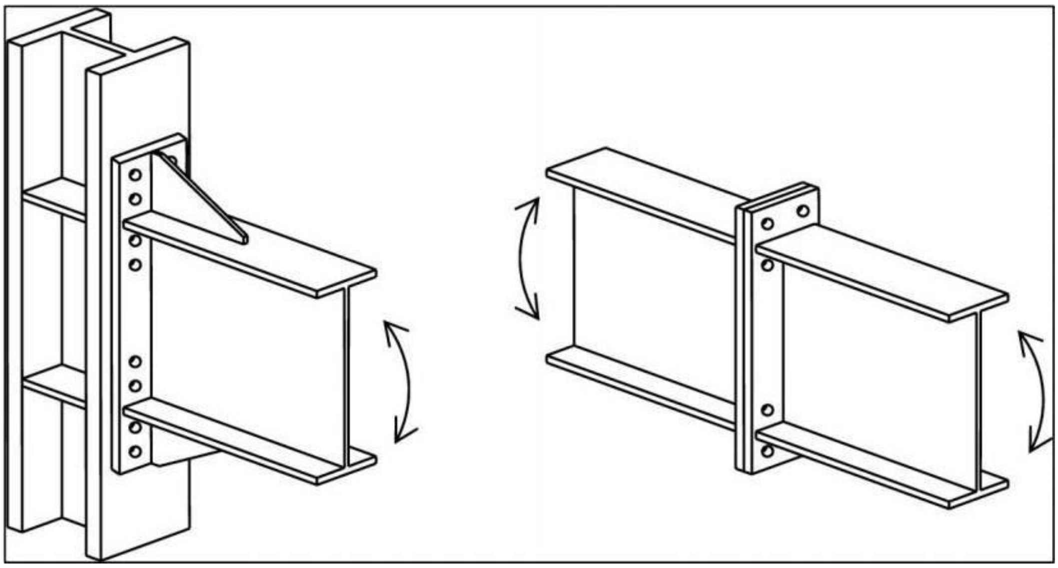

Fig 1.5 Extended End Plate Connection

Objective:-

It is proposed to carryout analysis of multistory multi bay steel structure considering ideally rigid, ideally pinned & semi-rigid beam end conditions in STAAD Pro using IS 800:2007. The following are the objectives of the proposed work.

- To determine the stability of structure with rigid and semi rigid joints
- To determine the utilization of analysis tool etabs in analysis of a high rise steel structure under seismic loading.
- To determine the variations in forces and stresses in both the cases in comparison.
- To determine the stability of structure with x type bracing at the corner.

Litrature review:-

Alfredo Reyes-Salazar et al (2014) research paper investigated nonlinear seismic responses of 3D steel buildings with perimeter moment resisting frames (PMRF) and interior gravity frames (IGF), explicitly considering the contribution of the IGF. The effect on the structural response of the stiffness of the beam-to-column connections of the IGF, which is usually neglected, was further studied. It is commonly believed that the flexibility of shear connections is negligible and that 2D models can be used to properly represent 3D real structures.

Results stated that the moments developed on columns of IGF can be considerable and that modelling buildings as plane frames may result in very conservative designs. The contribution of IGF to the lateral structural resistance may be significant. The contribution increases when their connections are assumed to be partially restrained (PR). The incremented participation of IGF when the stiffness of their connections is considered helps to counteract the no conservative effect that results in practice when lateral seismic loads are not considered in IGF while designing steel buildings with PMRF. Thus, if the structural system under consideration is used, the three-dimensional model should be used in seismic analysis and the IGF and the stiffness of their connections should be considered as part of the lateral resistance system.

M. Ghassemieh and A.R. Bahadori (2015) research paper aimed at investigating the seismic

performance of a steel moment frame considering influence of flexibility of its connections , hence, dealt with a spring-stiffness model called "the component method" to predict the real behaviour of steel moment connections (especially their momentrotation curves). The behavior of the frame with cover plate moment connections in both cases of including as well as excluding the flexibility of the connections is compared using nonlinear static pushover, and incremental dynamic analyses. In all models, P-Delta effects along with material andgeometrical nonlinearities were included in the analyses.
The results from the pushover analysis revealed that the initial stiffness and the ultimate strength of the cover plate frames with fully rigid connections are more than their counterpart frame with considering the flexibility of connections. In addition, considering the flexibility ofthe connection in the behavior of the structural frame made the period of the structure increases. Moreover, the maximum inter-story drifts in frame with considering the flexibility of the connections experience greater values than frames with fully rigid connections. And finally, conducting the incremental dynamic analysis revealed significant difference between the two seven story frames in terms of performance levels and indicated that overlooking the flexibility of beam to column moment connections may lead to inaccurate conclusions.
Dr B. A. Shah (2016) research paper considered a set ofG+3 to G+7 RC space frames having an overall plan dimension of 6m x 6m with four panels of 3m x 3m and having a column at each panel point. The mathematical models developed were considered to have four variations in the beam column joint rigidity varying from pinned to fixed and two variations in column cross section i.e. rectangular and equivalent square cross section. A combination of rigid and semi rigid joints was used to define a frame called hybrid frame for analysis under seismic loads. The storey drift values noted for all the mathematical models at performance point under push over analysis, carried out by using commercially available ETABS software,was used as a basis of seismic performance.
Results stated that for low rise frames having G+3 to G+7 storey, the seismic performance of a frame with square columns is found better than that having rectangular columns from the storey drift criterion. Also, the storey drift was found maximum at the first storey level regardless of the size, column shape or the joint rigidity for G+3 to G+7 storey frames. The hybrid frames show less drift as compared to semi rigid frames keeping all other parameters the same. Also, there is a negligible difference in storey drift when hybrid frames with a joint rigidity of 100000 kNm/rad is considered for G+5 storey frame having either square or rectangular shaped columns. Hence conclusion stated that the square shaped columns exhibit less drift as compared to the rectangular shaped columns. It is also found that the hybrid frames with internal beam column joint having an intermediate rigidity perform almost like a frame having all joints as fully rigid.
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Methodology:

Step l- The first step in general is to review research papers from different authors or to identify the problem statement and the remedies adopted from different researchers.
The review of the papers were summarized in section two.

Step 2- The grid system are defined from the predefined template or even provides the option to customize it as per the stature of the desired structure. The model is designed as per model initialization to define the unit and IS codes

Step 3- the grip matrix for the structure is designed as per the quick template available in analytical application ETABS. The grid is defined in X and Y direction whereas the storey height is defined in Z direction.

Step 4- this step involves the properties of material as here in this case, a steel structure is considered and the properties of steel is defined.

step 5- Defining section properties for the steel frame and steel slab where the sections are defined for steel beams and columns.

Step 6- Defining properties for Rigid Joints and Semi Rlgid Joints for the steel structure

Step 7- Analyzing the model on parameters of displacement, shear force, bending moment and Joint Analysis.

Step 8- This last step is to present the comparative analysis of steel structure with two different joints namely rigid and semi rigid joints. The results will be tabulated and presentedgraphically in section

Model analysis:
Here total three frames with same configurations except the connection types are modeled. The frames differ in the following manner.

Frame 1: G+ 1 1 frame with all rigid connections with rigidity factor 0.80 Frame 2: G+ 1 1 frame with all Semi-rigid connections with rigidity factor 0.80

Table 4.1 Parameters of developed steel frame models

Structuraltype	Commercial
Total stories	12 (G+ll)
al height of building	42 m
Size of column	ISWB 600 @ 145.1 kg/m
Size of beam	ISWB 300 @48.1kg/m, ISMB 400 @ 61.6 kg/m and ISMB 600 @ 122.6 kg/m
kness ofslab	150 mm
Floor height	3.5 m

ade of slab concrete	M25
Live load	4 kN/m2
Dead load	1.5 kN/m2
Seismic zone	
Soil Type	Medium
Importance factor	
Response reduction factor	5
Damping ratio	5%

Table 4.2 Rotational stiffness of members

Fixity Factor	Rotational Stiffness (kN.m/rad)			
	ISWB 250	1SWB300	ISMB300	ISMB400
0.5	9360.4	12375.22	13550.67	25777.6
0.75	26754.9	39188.18	42910.465	81629.02

Table 4.3 Section properties of beams

Section	Area (m2)	Modulus of asticity (E)(kN/m2)	of inertia (I)m4
ISWB 250 X 40.9	0.005205	210000000	0.000059431
ISWB 300 X 48.1	0.006133	210000000	0.000098216
ISMB 300 X 44.2	0.005626	210000000	0.000086036
ISMB 400 X 61.6	0.007846	210000000	0.000204584

Loading Parameters

Table 4.4 Seismic analysis data

AS PER IS 1893 2016 - PART 1	
USING RESPONSE SPECTRUM ANALYSIS	
Zone	
Response Reduction Factor(R	5 (Steel Structure with SMRF frame)
mportance Factor(l)	1
ombinationMethod	CQC method
Soil Type	Medium
Damping Ratio	0.05
(Sa/g)*(Z/R)	0.016 (X and Z direction)
Time	5.94 s
Acceleration	3.33426

RESULTS AND DISCUSSION:-

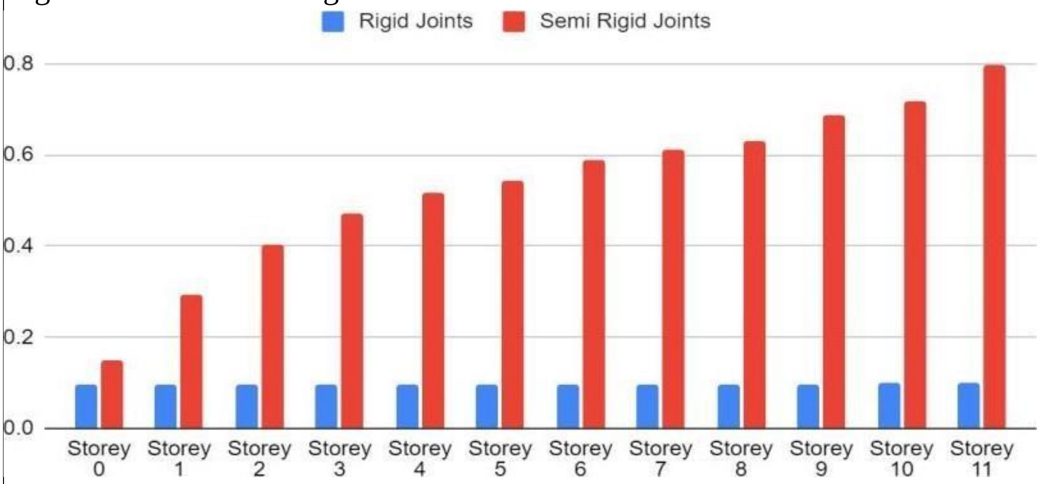
5.1 Maximum Displacement

Table 5.1 Maximum Displacement

Maximum Lateral Displacement		
Storey Number	Rigid Joints	Semi Rigid Joints
Storey O	0.09549	o. 1509
Storey I	0.09567	0.292
Storey 2	0.09581	0.4046
Storey 3	0.09591	0.472
Storey 4	0.09597	0.5154
Storey 5	0.096	0.542
Storey 6	0.09649	0.5873
Storey 7	0.09689	0.612
Storey 8	0.09701	0.632
Storey 9	0.0976	0.689

Storey 10	0.0992	0.717
Storey I I	0.0999	0.798

Rigid Joints and Semi Rigid Joints



Storey Number

Fig 5.1 Maximum Displacement

Discussion:

5.2 Drift Ratio

Drift Ratio

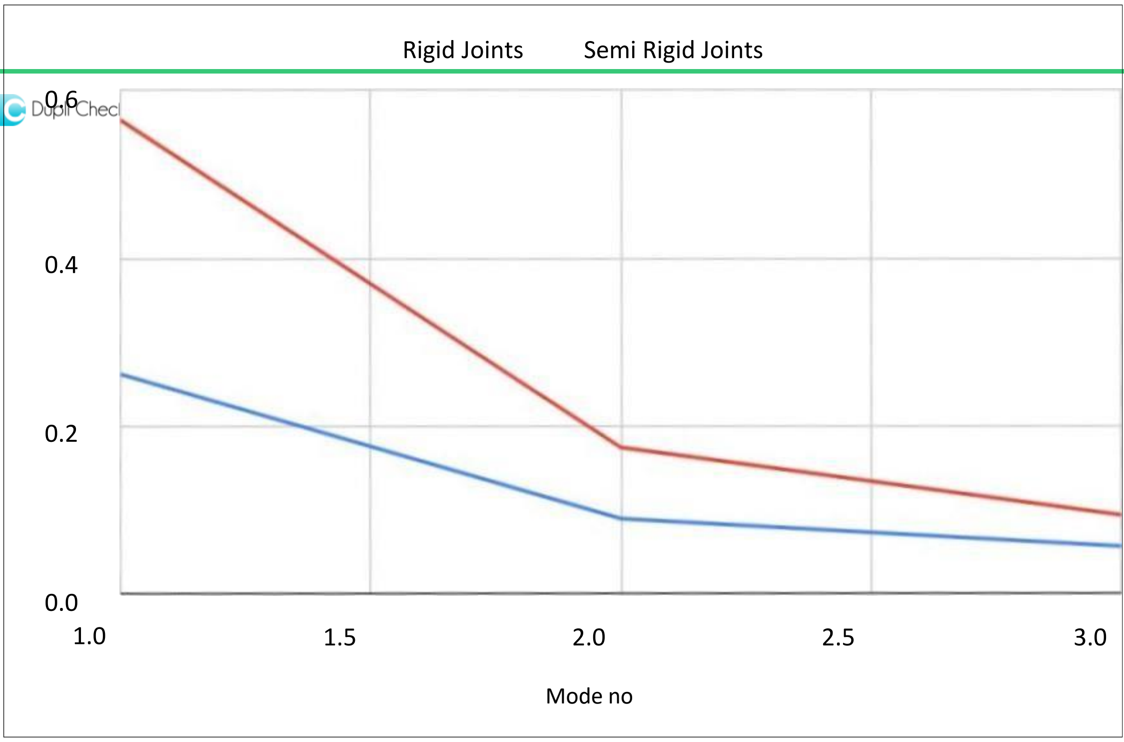
Drift Ratio of different Joint Connections		
Storey Number	Rigid Joints	Semi Rigid Joints
Storey O	0.09549	0.1509
Storey I	0.09567	0.292
Storey 2	0.09581	0.4046
Storey 3	0.09591	0.472
Storey 4	0.09597	0.5154
Storey 5	0.096	0.542
Storey 6	0.09621	0.559
Storey 7	0.09659	0.594
Storey 8	0.09697	0.618
Storey 9	0.09719	0.667
Storey 10	0.09754	0.699
Storey I I	0.09801	0.732

Discussion:

5.3 Modal Analysis

5.3 Time Period

Time Period in sec		
Mode no	Rigid Joints	Semi Rigid Joints
	0.26177	0.56511
2	0.08919	0.17413
3	0.05596	0.09313



Conclusion:

Semi rigid connections show enhanced performance to the number of way, advanced relegation, at a vastly lesser base shear which helps to prove analytically that semi rigid connections are better relief for depended and fixed connections which are down by 2 and 16respectively.It also indicates the collapse point of the colorful models analytically and it's shown that the collapse point for semi rigid structures are 2 advanced than the depended structures and further than 20 advanced than fixed structures.

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