

# Seismic Response of a Soft Storey Building with Gap Inclined Bracing System

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**Abstract** - Although soft-story mechanisms are generally undesirable for the seismic response of building structures, they provide potential benefits caused by the isolating effect they produce for the stories located above.

In this research, an approach for enhancing the seismic response of soft-story structures is proposed that takes advantage of the positive aspects of their response while mitigating the negative ones. To this end, an additional gapped-inclined brace (GIB) is introduced to reduce the impact of P-Delta effects on the displacement demands and to increase the deformation capacity of existing columns in soft stories without significantly increasing their lateral resistance. The mechanics of the proposed system are first defined, and theoretical relations and numerical models are then derived to verify the response.

**Key Words:** - Seismic response, soft storey, gap inclined bracing, p-delta effect, displacement.

## 1. INTRODUCTION

When designing building we provide lateral force resisting system. We protect the building and reduce the damage of the structure. Most of the buildings are damaged due to soft storey at ground floor. When stiffness of base is less than 70% compare to above storey. This storey is called soft storey. Generally brace, shear wall provide in soft storey building to reduce lateral force resisting building.

Gapped incline bracing is providing at ground storey. This gapped inclined bracing resist the lateral force acting on soft storey building. And reduce the damage of the structure.

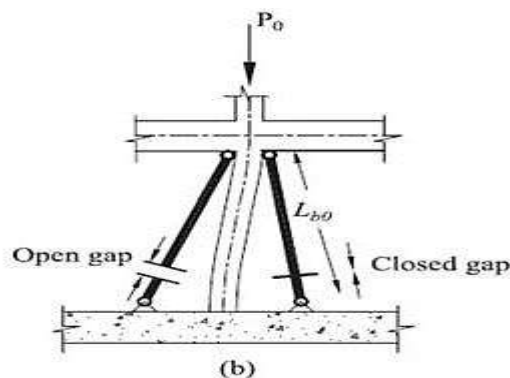


Fig.-1 GAP Inclined Bracing

## 1.1 Advantages of GIB

- GIB System is one type of lateral force resisting system in soft storey building.
- This steel bracing is economical, easy, occupies less space and has flexibility in design for meeting the required strength and stiffness.
- It is used in retrofit building with soft storey and increase it strength of structure.
- Also used in single to multi-storey building.
- It reduces the displacement, storey drift and P-Δ effect of building.
- It reduces the damage of the structure and better performs in soft storey building.

## 2. MODELLING

- This 23M X 23M geometry plan is consider for G+4, G+9, G+14 and G+19 storey building.
- We provide X-Brace, V-Brace, invert V-Brace, GIB System and Without Brace at soft storey for G+4, G+9, G+14, G+19 Storey building.
- This bracing provide inner side and outer side at soft storey means ground floor.
- Gap Inclined Brace (GIB) provides 10°, 20°, 30° at soft storey with different location such as inner side and outer side.

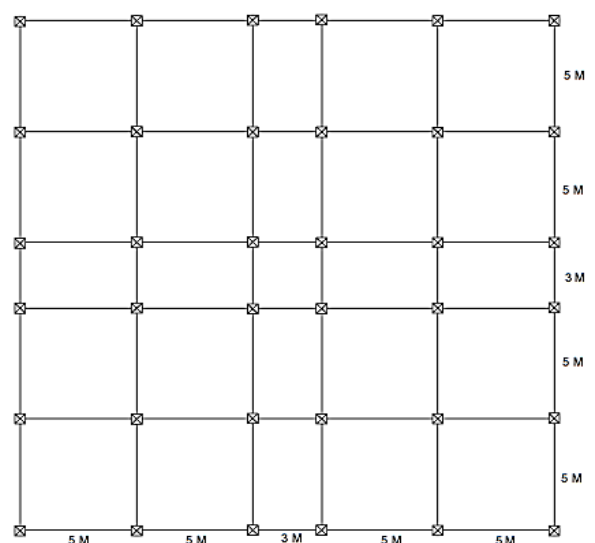


Fig.-2- Plan of building

### 3. RESULT AND DISCUSSION

- In present work in order to compare seismic response of RCC multistory building of different height using linear dynamic Response Spectrum analysis.
- For each model storey displacement, storey drift and base shear are compared.
- All loads are applied in model then define the response spectrum function.
- Then analysis the model in Etabs software.

After define soft storey building, Compare storey displacement, storey drift and base shear values when X-Brace, V-Brace, invert V-Brace, GIB and without brace provide at soft storey.

#### A. Seismic Weight

- For G + 4 storey building calculated seismic weight manually by seismic coefficient method and check the result with ETABS.

**Table-1: Seismic Weight**

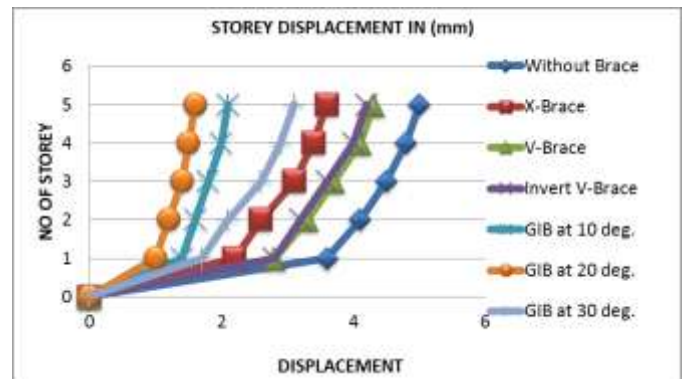
No.	Title	Calculated manually	Calculated by ETABS
1	Seismic Weight	19373.76 KN	18841.22 KN

#### B. Displacement

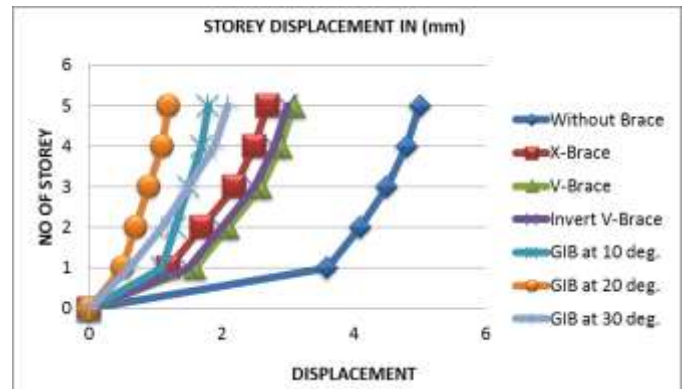
- Storey displacement depends on the lateral stiffness of the structure.
- When stiffness of the structure increases displacement decreases and vice-versa. Storey displacement limit as per IS 1893-2002 is 0.062m.
- Storey Displacement for G+4 Storey Building Model at Soft Storey Inner Side Brace System is given below.

**Table- 2: Displacement**

	Displacement (Brace at inner side)	Displacement (Brace at outer side)
Without bracing	3.6	3.6
X - Brace	2.2	1.2
V - Brace	2.8	1.6
Invert V Brace	2.8	1.5
GIB at 10°	1.4	1.1
GIB at 20°	1	0.5
GIB at 30°	1.7	0.6



(Chart-1: Brace at inner side)



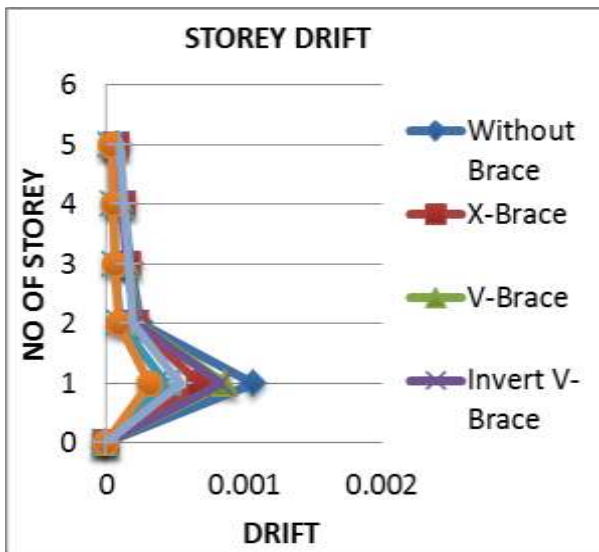
(Chart-2: Brace at outer side)

#### C. Storey Drift

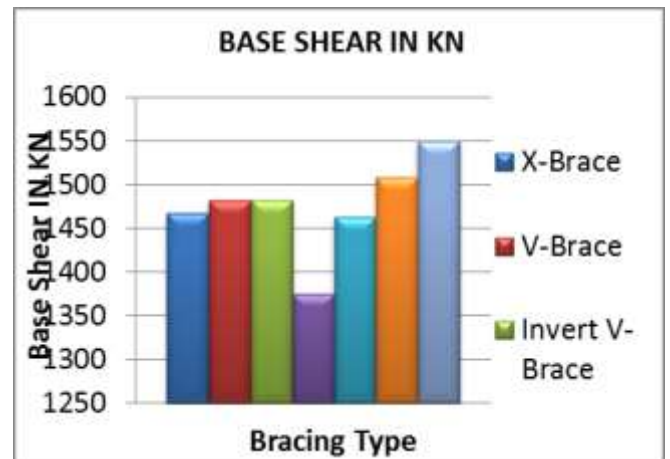
- Storey drift change with height of the building. This is the soft storey so that storey drift is more at soft storey and it reduce at upper storey. Storey drift limit as per IS 1893 (Part 1):2002 is 0.004 times the storey height. In our case study storey drift limit is 0.014.

**Table-3: Storey Drift**

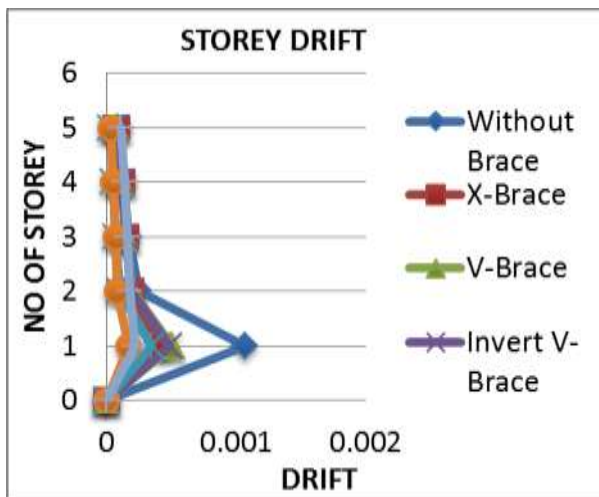
	Drift (Brace at inner side)	Drift (Brace at outer side)
Without bracing	0.0010	0.0010
X - Brace	0.00068	0.000402
V - Brace	0.00086	0.000504
Invert V Brace	0.00084	0.000486
GIB at 10°	0.000431	0.000343
GIB at 20°	0.000312	0.00012
GIB at 30°	0.000536	0.000216



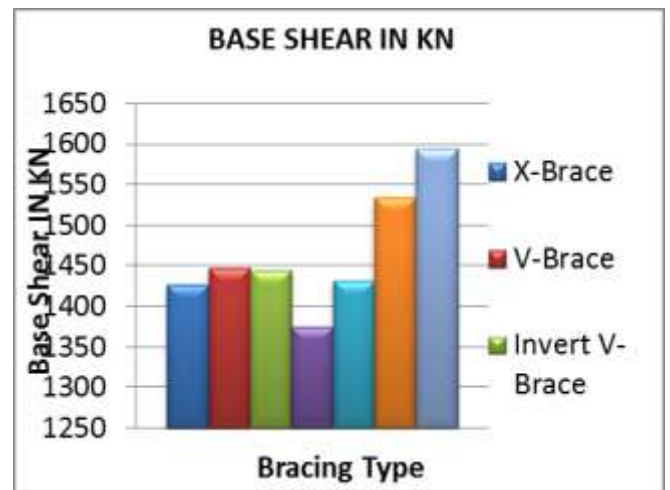
(Chart-3: Brace at inner side)



(Chart-5: Brace at inner side)



(Chart-4: Brace at outer side)



(Chart-6: Brace at outer side)

**D. Base Shear**

- The magnitude of the lateral force depends on the mass of the building lumped at each floor level. Here in this case inner and outer side provide bracing then resulting values for base shear are given below.

**Table-4: Base shear**

	Base shear (Brace at inner side)	Base shaer (Brace at outer side)
Without bracing	1374.98	1374.98
X - Brace	1467.49	1426.92
V - Brace	1482.41	1447.56
Invert V Brace	1481.69	1444.60
GIB at 10°	1463.23	1432.34
GIB at 20°	1508.08	1535.22
GIB at 30°	1549.85	1594.23

**4. CONCLUSION**

In this paper building with similar plans in G+4, G+9 and G+14 were modelled with different bracing system such as GIB, X-Brace, V-Brace and Invert V brace provide at soft storey building. By providing this type of gap inclined bracing it reduces storey displacement and storey drift at soft storey. Outer side location is better. Factor such as storey displacement, Storey drift, Seismic weight and base shear are explored and following results are obtained.

- Displacement and storey drift values for G+4, G+9, G+14 storey building are decreasing in GIB system comparing with other brace system.
- Displacement and storey drift values reduce by Gap Inclined Bracing compare with other brace system when the size of angle is increased.
- % Reduction in displacement comparing to without bracing system for G+9 soft storey building when all type of bracing are provided at inner side in order of X-Bracing, V-Bracing, Invert V-Bracing, GIB at 10°, GIB at 20° and GIB at 30° are 26.66%, 13.33%, 8.88%, 4.44%, 22.22%, 42.22%.

- % Reduction in displacement comparing to without bracing system for G+9 soft storey building when all type of bracing are provided at outer side in order of X-Bracing, V-Bracing, Invert V-Bracing, GIB at 10°, GIB at 20° and GIB at 30° are 55.55%, 44.4%, 46.6%, 20%, 57.77% and 75.55%.
- Storey drift for all types of bracing in model are within the limit as per clause no 7.11.1 of IS-1893(Part-1):2002.
- Gap Inclined Bracing provide outer side of the soft storey building at 20° is the best alternative to ensures good seismic behavior in building compare with other brace system.

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