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Effect of Sky Bridge on Lateral Drift of Twin Building

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***Abstract*— The present work investigates the effects of structural links on the modal properties and seismic-induced responses of a linked building system (LBS) The LBS in this work refers to a system consisting of twin buildings horizontally connected by structural links such as sky bridges or sky gardens. The analytical model for the LBS is formed by assembling the rigid diaphragm model of the building. The LBS in this work refers to a system consisting of twin buildings horizontally connected by structural links such as sky bridges or sky gardens. The analytical model for the LBS is formed by assembling the rigid diaphragm model of the building Results showed that the connections of the linking bridge have a significant effect on the overall dynamic response of the bridge in both longitudinal and transverse directions. In order to achieve the goal, the modelling and analysis of the building towers and the sky bridge was accomplished using SAP2000 software. The maximum horizontal deflection of the building towers at the topmost level under serviceability limit state as well as storey drifts of building towers was compared to determine the effectiveness of the sky bridge in terms of location and number of links.**

***Index Terms*— Sky bridge, Fast Non-linear Analysis (FNA), Linked building system, Lateral drift, Time History Method.**

I. INTRODUCTION

For functional reasons, architects have expressed interest in creating one or more distinct levels that connect nearby buildings and make it easier for people to walk between them. In high-rise structures, this is more usually required. Sky bridges have the significant benefit of improving escape efficiency without adding more steps to each structure. According to architectural design, sky bridges are frequently employed in buildings at more than one storey. Naturally, these bridges are impacted by the numerous stresses, such as wind load, seismic load, and temperature variation that act on the bridge and buildings. These bridges must be carefully designed in order for them to securely withstand the internal forces brought on by such loads. This essay focuses on different design scenarios for sky bridges. The fact that the sky bridge connecting these structures is not designed to transmit pressures from one building into the other gives them a distinctive feature. The sky bridge cannot transfer forces from one building to another or allow one building to assist in the resistance of pressures placed on the other building because it is designed to slide or move independently of the buildings. The bridge and connected buildings interact when subjected to dynamic loads, such as earthquakes. This indicates that the movement of the two structures has an impact on the bridge in a reciprocal manner. The system's dynamic characteristics and seismic reactivity may also be altered by the bridge. The seismic performance of sky bridge-connected buildings and facilities was a topic of many studies.

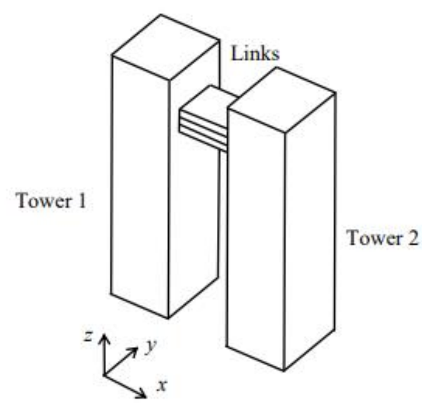


Fig. 1: Simple illustration of twin building

II. OBJECTIVE OF STUDY

1. To compare the lateral displacement of linked building structure with that of the individual buildings.
2. To find out the optimum position as well as number of the links.
3. To compare performance of high-rise RC

Structure with and without Fluid Viscous Damper for storey displacement and storey drift. To compare storey drift of buildings for different ground motions.

III. MODELLING AND MATERIAL PROPERTIES

The analysed system is composed of G + 19 Reinforced Concrete (RC) building, as shown in figure 3.1. This system is 60 m high (19 floors), and has a typical structural plan and a vertical plane of full symmetry. In all analysed cases, building is kept with the same plan size of 30×30 m and with the column and beam arrangement shown in figure3.2 (the floor is made of a reinforced concrete slab). For all structural elements, M25 grade concrete will be used. However, higher M30 grade concrete is used for central columns up to plinth, in ground floor and in the first floor. He building will be used for exhibitions, as an art gallery or show room, etc., so that there are no walls inside the building. Only external walls 230 mm thick with 12 mm plaster on both sides are considered. Seismic loads will be considered as per IS 1893 -2016, acting in the horizontal direction (along either of the two principal directions) and not along the vertical direction, since it is not considered to be significant. The building belongs to Zone V and situated om Medium Soil. Live load (4 kN/sqm) and dead load calculated as per IS 875 (Pat 1 -3) – 1987.

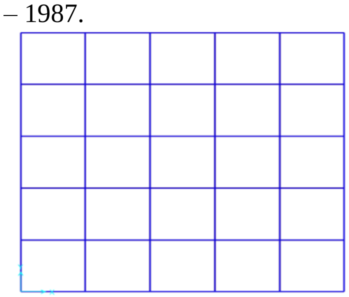


Figure 3.1: Plan of G + 19 Reinforced Concrete (RC) building

Member Properties as per Design:

Table II: Beam Section Properties

Group	Location	Size
Internal	Up to 5th floor	700x700 mm
	6th floor to 10th floor	600x600 mm
	11th floor to 15th floor	500x500 mm
	16th floor to 20th floor	400x400 mm
Peripheral	Up to 5th floor	700x700 mm
	6th floor to 10th floor	600x600 mm
	11th floor to 15th floor	500x500 mm
	16th floor to 20th floor	400x400 mm

Table III: Column Section Properties

Group	Location	Size
Interior	Up to 5th floor	700x700 mm
	6th floor to 10th floor	600x600 mm
	11th floor to 15th floor	500x500 mm
	16th floor to 20th floor	400x400 mm
Periphery	Up to 5th floor	700x700 mm
	6th floor to 10th floor	600x600 mm
	11th floor to 15th floor	500x500 mm
	16th floor to 20th floor	400x400 mm
Corner	Up to 5th floor	700x700 mm
	6th floor to 10th floor	600x600 mm
	11th floor to 15th floor	500x500 mm
	16th floor to 20th floor	400x400 mm

Modelling of twin building:

Number of models have been prepared by connecting the sky bridge at different locations as mentioned below:

Model 1: G + 19 Reinforced Concrete (RC) building

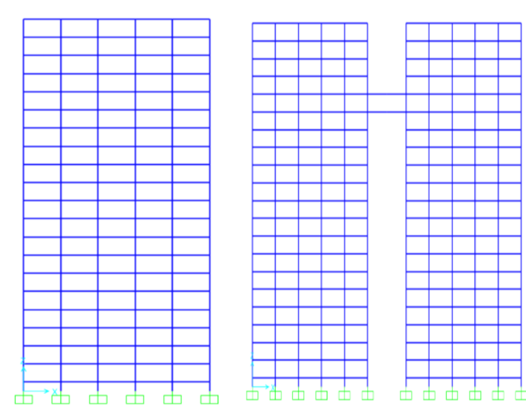
Model 2: G + 19 Reinforced Concrete (RC) buildings connected at 16th floor

Model 3: G + 19 Reinforced Concrete (RC) buildings connected at 20th floor

Model 4: G + 19 Reinforced Concrete (RC) buildings connected at 11th floor

Model 5: G + 19 Reinforced Concrete (RC) buildings connected at 11th & 20th floor

Model 6: G + 19 Reinforced Concrete (RC) buildings connected at 11th, 16th & 20th floor



Model 1 Model 2

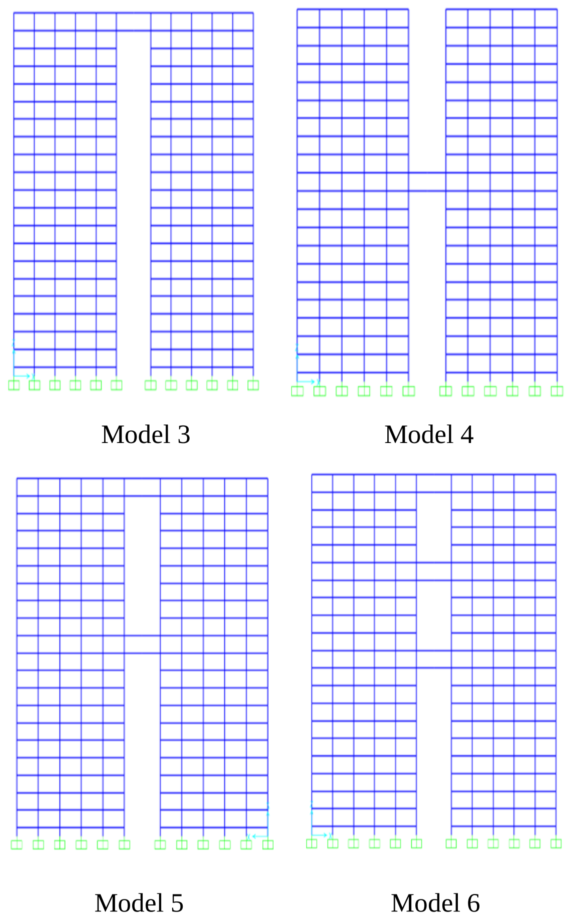


Fig. 2: Elevation of the RCC frame building models

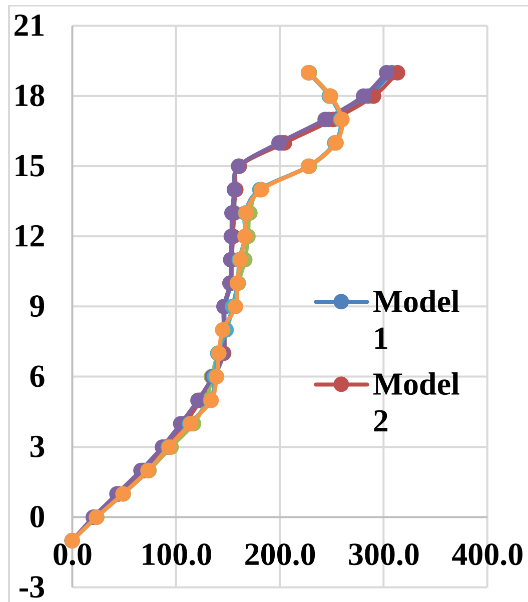
IV. RESULTS AND DISCUSSION

This chapter illustrate discuss and conclude the findings obtained from research. The six different models of twin buildings are prepared and analyses. Various results are obtained to analyze the changes in structural behavior building such as displacement drift etc. This study analyzed the time-history response of two adjacent RC buildings connected by a sky-bridge at different story levels under various ground-motion records such as

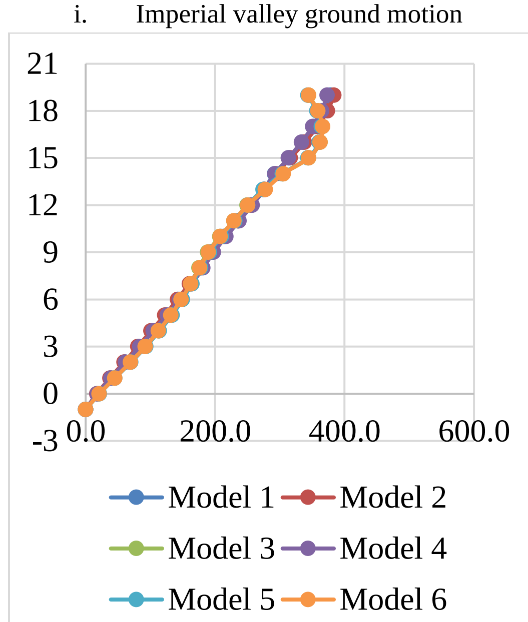
Earthquake	Location	Recording Station	Magnitude	PGA (g)
Imperial Valley	USA: October 15, 1979	UGS 5125	6.5	0.315
Kobe	Japan: January 16, 1995	KAKUGAWA (CUE90)	6.5	0.344
Big Bear	California: January 17, 1992	Elizabeth station	6.46	0.568
Victoria	Mexico 1980	Victoria, Mexico	6.33	0.319

Storey Displacement:

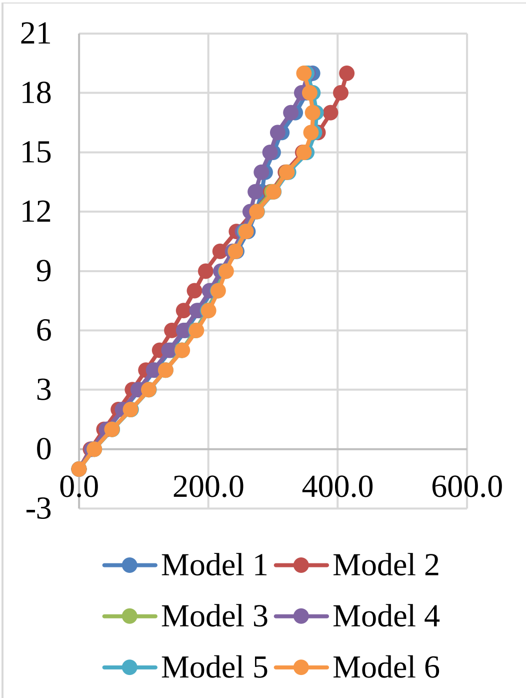
Responses of 6 models mentioned above are taken from the software for different ground motions. Displacements of the models for the load cases as per IS codes are shown in graphical form below.



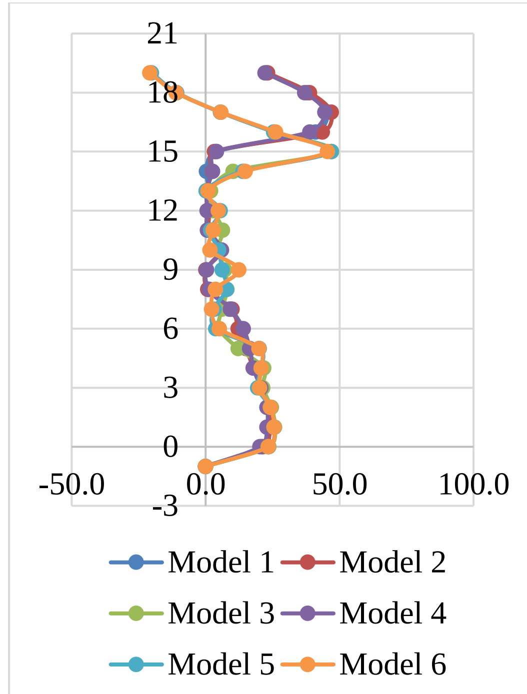
i. Imperial valley ground motion



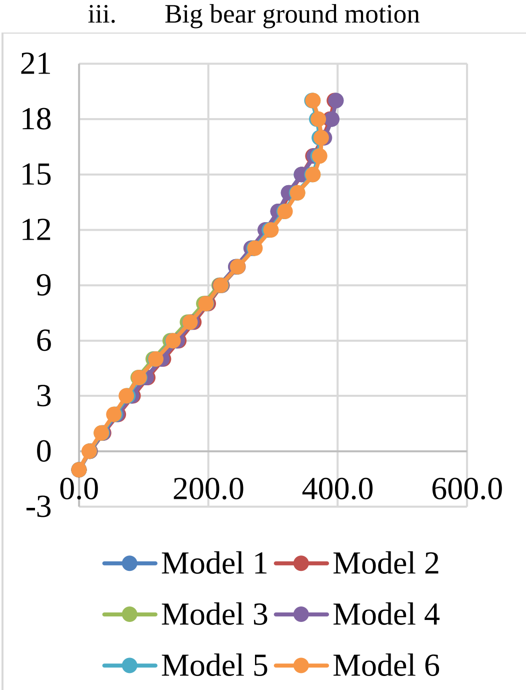
ii. Kobe ground motion



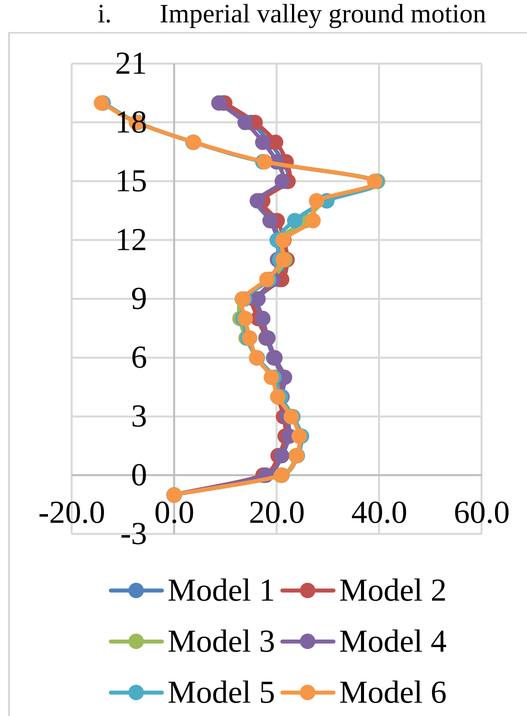
iii. Big bear ground motion



i. Imperial valley ground motion



iv. Victoria ground motion

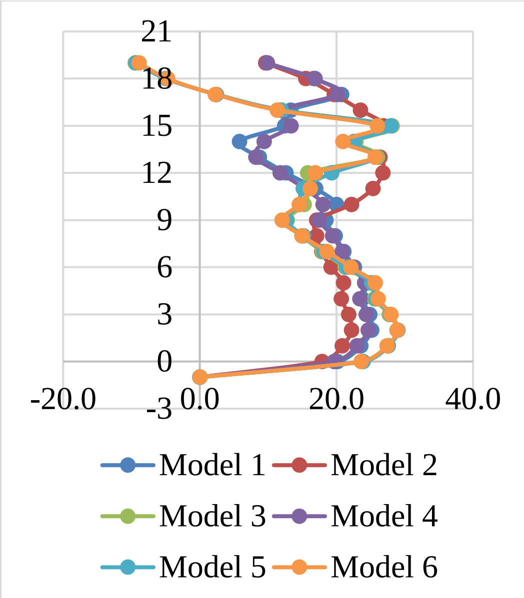


ii. Kobe ground motion

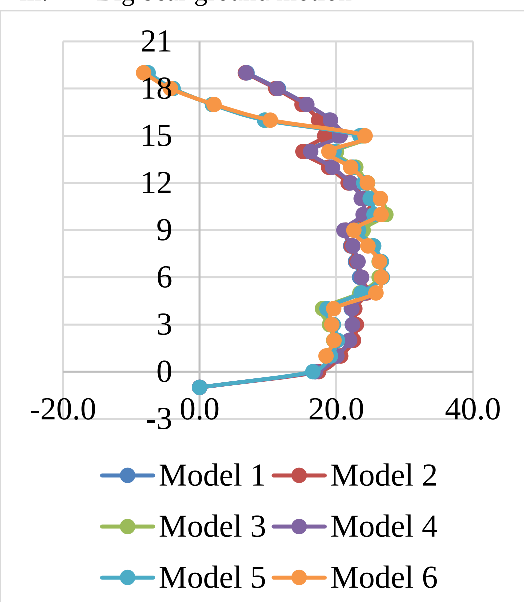
Fig. 3: Comparison of storey displacement in mm

Storey Drift:

Responses of 6 models mentioned above are taken from the software for different ground motions. Displacements of the models for the load cases as per IS codes are shown in graphical form below.



iii. Big bear ground motion



iv. Victoria ground motion

Fig. 4: Comparison of storey drift in mm

V. CONCLUSION

In this study, the sky bridge is considered as a structural member used to connect two individual buildings and the effect of these linkages is studied under nonlinear time history analysis. G+20 building of symmetrical geometry is modelled using SAP2000.Four different ground motions are applied to the structure to compare the behaviour of structure with Sky Bridge at different locations to the individual buildings. Analysis is done by applying ground motions in both perpendicular directions to get the results.

The conclusion are as follows,

1. According to the results, if the bridge is constructed at proper location, then it can help reduce overall building displacement and drift.
2. For individual building max displacement is 307.85 mm and 418 mm in X and Y direction respectively for Imperial Valley ground motion. For model 3, model 5 and model 6 this displacement is reduced by 25.75, 26.06& 25.98 percent respectively in X-Direction and displacement is reduced by 20.2, 20.88& 23.56 percent respectively in Y-Direction.
3. For individual building max displacement is 378.51 mm and 396.38 mm in X and Y direction respectively for Kobe ground motion. For model 3, model 5 and model 6 this displacement is reduced by 8.93, 9.26 & 8.98 percent respectively in X-Direction and displacement is reduced by 16, 15.75 & 15.34 percent respectively in Y-Direction.
4. For individual building max displacement is 361 mm and 432 mm in X and Y direction respectively for big bear ground motion. For model 3, model 5 and model 6 this displacement is reduced by 3.18, 2.43 & 3.69 percent respectively in X-Direction and displacement is reduced by 15.8, 15.38 & 15.32 percent respectively in Y-Direction.
5. For individual building max displacement is 397.3 mm and 382 mm in X and Y direction respectively for Victoria ground motion. For model 3, model 5 and model 6 this displacement is reduced by 8.91, 9.34 & 8.88 percent respectively in X-Direction and displacement is reduced by 12.12, 12.5 & 13.14 percent respectively in Y-Direction.
6. Thus, from following observations it can be seen that arrangement made in model 3, model 5 and model 6 is the most effective of all.
7. When sky bridge is connected at top storey drift at that given storey is reduced significantly. For model 3 storey drift at top storey is reduced by 20.4mm,13.93mm, 9.44mm & 7.6mm for imperial valley, Kobe, big bear &Victoria ground motion respectively in X direction as well as drift reduces by 6.08mm, 1.28mm, 2.54mm & 2.917mm respectively.

REFFERENCES

[1] Ji Dongyu and Li Xiaofen, "Seismic Behavior Analysis of High-rise Connected Structure.". International Conference on Mechatronics, Electronic, Industrial and Control Engineering (2014) 1167-1170

[2] M. R. Willford and R. J. Smith, "Performance based seismic and wind engineering for 60 storey twin towers in Manila.", International journal of civil and structural engineering research. ISSN 2348-7607 Vol. 4, Issue 1,(2016)266-273.

[3] Mina R. F. Eskander, Ahmed H. Youssef and Osman M. O. Ramadan - " Seismic Performance of Steel Buildings Connected by a Sky Bridge" - Al-Azhar University Civil Engineering Research Magazine (CERM) Vol. (42) No. (3) (Oct2020) 34-47

[4] Mr. Kiran M .U, Mr. Shivananda S., Mr. Mahantesh "A Study Of Lateral Drift Controlling Between Two Buildings By Connecting Sky Bridge. "International Journal of Civil and Structural Engineering Research. ISSN 2348-7607. (2016)266-273.

[5] Francisco López-Almansaa, Alireza Kharazianb – "Parametric study of seismic pounding between RC buildings with aligned slabs" - Soil Dynamics and Earthquake Engineering 125 (2019)

[6] Qichao Xue , Jingcai Zhang , Jian He, Chunwei Zhang, Guangping Zou (2007)– "Seismic control performance for Pounding tuned massed damper based on viscoelastic pounding force analytical method" - Journal of Sound and Vibration 411 (2017) 362-377

[7] Jamal ahmad alomari - "conceptual seismic analysis of two R.C.Buildings with different dynamic properties connected by skybridges" - Journal of Engineering Science and Technology ,Vol. 16, No. 3 (2021) 2610-2628.

[8] Surendra Chaurasiya1, Sagar Jamle - "Twin Tower High Rise Building Subjected To Seismic Loading" - International Journal of Advanced Engineering Research and Science (IJAERS) Vol-6, Issue-4, (Apr- 2019) 324-328.

[9] Andrew Luong– "Finding Structural Solutions by Connecting Towers"-CTBUH Journal, Issue III.(2012) 26-31.

[10] Federico Caldi,Pietro Croce,Jenna Wong – "Evaluating the Modal Response of Linked Tall Buildings." - CTBUH Journal, Issue I,(2020) 34-41.

[11] Antony Wood,Wan-ki Chow, Dean McGrai – "The Sky bridge as an Evacuation Option for Tall Buildings in High-Rise Cities in the Far East" - Journal of Applied Fire Science Vol 13 Issue II . (2005) 113-124.