iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** VII **Month of publication:** July 2025

DOI: https://doi.org/10.22214/ijraset.2025.73006

Seismic Analysis of G+20 Story Horizontal Sky Bridge Building and Conventional Building

Hemanshukumar A. Patel[1], Dr. V. R. Patel[2]
[1]Post Graduate, Structural Engineering Student, Department of Applied Mechanics & Structural Engineering, Faculty of Technology & Engineering, The Maharaja Sayajirao University of Baroda, India – 390001
[2]Assistant Professor, Department of Applied Mechanics & Structural Engineering, Faculty of Technology & Engineering, The Maharaja Sayajirao University of Baroda, India – 390001

Abstract: Seismic analysis of adjacent buildings linked through Horizontal sky bridges using ETABS 2021.This project aims to carry out the Seismic analysis of adjacent buildings connected at different levels with Horizontal sky bridges. The study assesses selected alternatives by changing the position of Horizontal sky bridges at three sections in height, mid-height (1/2), three quarter-height (3/4), and the top of the buildings. Both static and dynamic earthquake loading cases are imposed, based on the seismic codes, to evaluate inter-story drift, base shear and joint displacements. Buildings with and without sky bridges are compared to measure the effect of Horizontal sky bridges. The study reveals the effectiveness of Horizontal sky bridges on improving the seismic behaviour by judiciously locating Horizontal sky bridges as Lateral displacement and storey drift are typically reduced when Horizontal sky bridges are included.

Keywords: Sky Bridges, High-Rise Buildings, Lateral Loads, Seismic Analysis, Base Shear, story drift, Story Displacement, ETABS.

I. INTRODUCTION

The fast pace of worldly population both contributed with the urban migration has raised the requirement for all the more living and working spaces. Urban areas, which are already suffering from a scarcity of land and a hike in land prices, encounter great difficulty in meeting this increasing demand. Therefore, high-rise has become the alternative to the second line of development. These high-rises are not just a way to efficiently use the land, but a combination of structural engineering, cutting-edge architecture and urban planning. The skyscrapers of today are more than just tall buildings. They represent a more modern and advancing urban life and respond to the increasing demand for sustainable living.

Consistent with such a trend, connecting two or more tall buildings by a sky bridge have been featured as had been implemented in many modern high-rise architectures. Sky bridges offer a whole range of benefits, such as better building connections, safety advantages, increased usability, and aesthetic allure. These high-level connections are particularly convenient in facilitating pedestrian movement between high-rise towers, which diminish dependence on elevators, and provide other evacuations routes in the event of emergency. And they also helps cities thermodynamically by reducing ground level congestion, noise, pollution and traffic problems. In terms of their structure, sky bridges can be built with struts, reinforced concrete, or steel frames, depending on the function and constructional vocabulary of the connected buildings. An outstanding example is the Petronas Twin Towers, where the sky bridge is an important aesthetic feature, as well as an integral part of the fire safety strategy. The Sands Sky Park, which is a gateway-joined sky bridge on the 57th storey, forming a cantilever segment, accomplished as a truss structure, spanning the total three hotel towers within 340 meters with the roof extended to cover and straddle the tops of each integrated tower. The Sky Park- an exceptional “boat-shaped” platform 200 meters above ground The Shanghai World Financial Center, situated in Shanghai, China The sky bridge of SWFC is a crucial connection between either tower and plays a critical role in its structural integrity and iconic image. The 94th-floor sky bridge links several parts of the tower and makes the structure more functional.

II. NUMERICAL STUDY

The study involves the seismic analysis of two 20-story buildings, each with a height of 61.5 meters, connected by a reinforced cement concrete (RCC) sky bridge. The buildings are modelled using ETABS 21 software and are situated in Seismic Zone IV. The sky bridge is placed at three different heights: at half the building height (1/2H), at three-fourths of the building height (3/4H), and at the top of the building (H). To assess the seismic response, two analysis methods are used: the Static Equivalent Method and the Response Spectrum Method.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

A. Details Of Building Mode

Table 1 Building Details

Floor Height	3m
Stories	20
Tower Height	61.5m
Plan Dimensions	25m*25m
Space B/W Tower	15m
Slab Thickness	120mm
Shear wall Thickness	250mm
Column Size	750mm*750mm
Beam Size In Tower	300mm*500mm
Beam Size In Sky Bridge	300mm*750mm
Bracing	ISMB 250
Length Of Sky Bridge	15m
Width Of Bridge	5m
Steel Grade	Fe500
Concrete Grade	M30
Density Of Brick Masonry	20 kN/m3
Structural Element	MOI
Slab	0.25 Ig
Beam	0.35 Ig
Column	0.7 Ig

Table.2 Load Specifications

Dead Load	IS:875(p-1)
Live Load	
Roof	1.5 kN /m^2
Other Floor	2.5 kN /m^2
Sky Bridge	4 kN /m^2
Floor Finish	0.5 kN /m^2
Wall Load	
Roof Wall	1.5 kN /m
Outer Wall	13.8 kN /m
Earthquake Load	IS1893:2016 (p-1)
Seismic zone	IV
Importance factor	1
Soil conditions	Medium
Damping	5%
Response Reduction Factor (SMRF)	5
Model Combination Method	CQC
Directional Computation Type	SRSS

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

Table.3 Legend Clarification

Symbol	Meaning
SCB	Skybridge Configuration
W/O, H10, H15, H20	Horizontal skybridge at storey Without,10th , 15th , 20th floor
EQx/EQy	Static earthquake loading in X/Y direction
RSx/RSy	Dynamic response spectrum results in X/Y direction

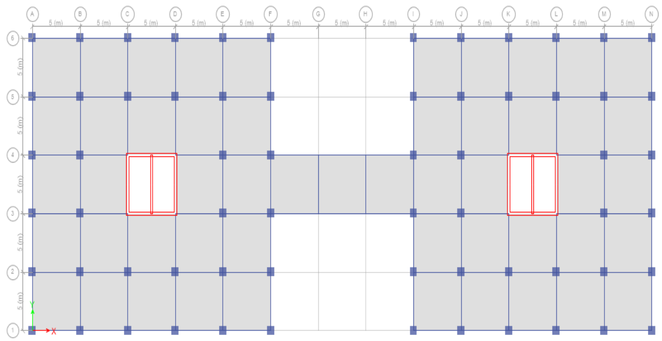

Figure 1 Building Plan

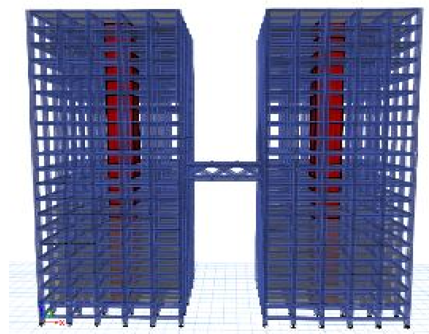

Figure 2 Building 3D view

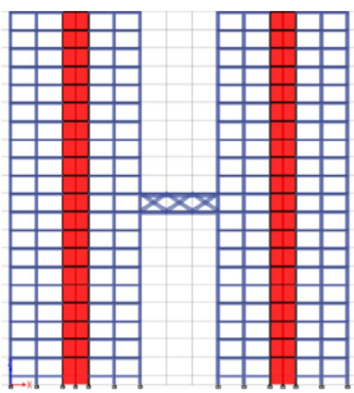

Figure 3 SCB H10

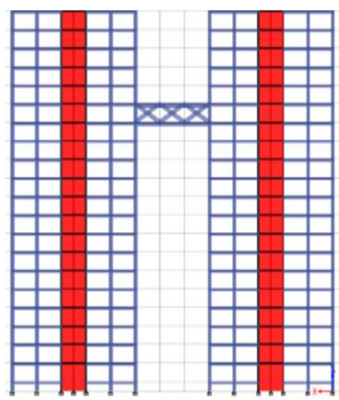

Figure 4 SCB H15

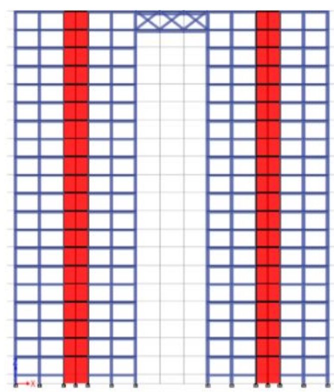

Figure 5 SCB H20

III. RESULTS

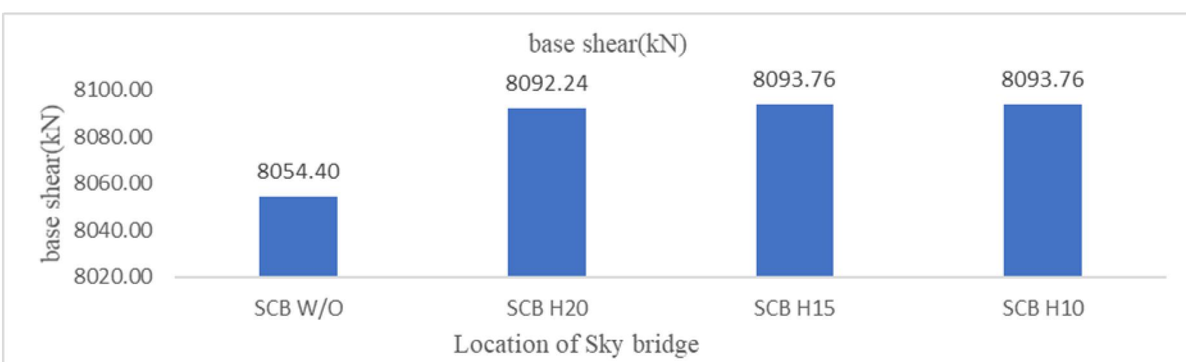

Figure 6 Base shear of buildings

- In 20 floor building connecting by one sky bridge horizontal at 10th ,15th and 20th floor base shear of building is increasing 0.47% to 0.48%.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

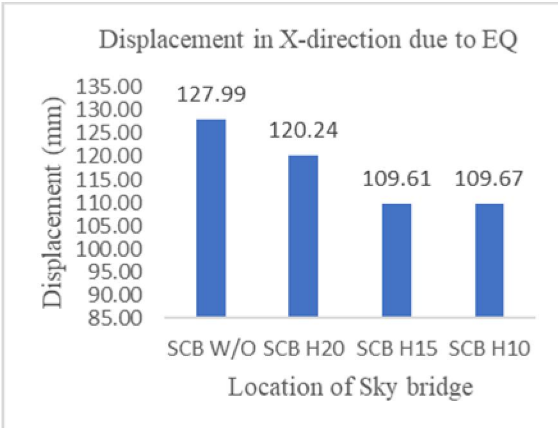

Figure 7 Displacement in X-direction due to EQ

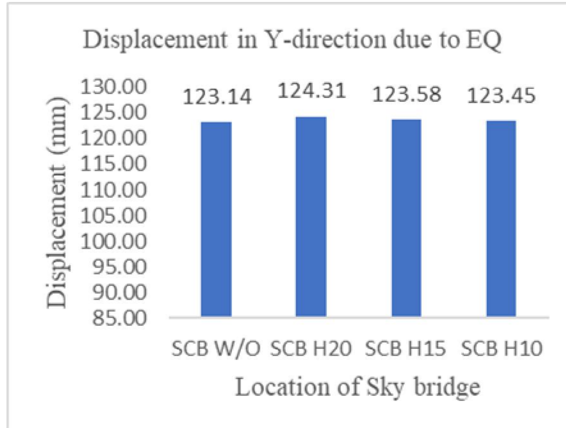

Figure 8 Displacement in Y-direction due to EQ

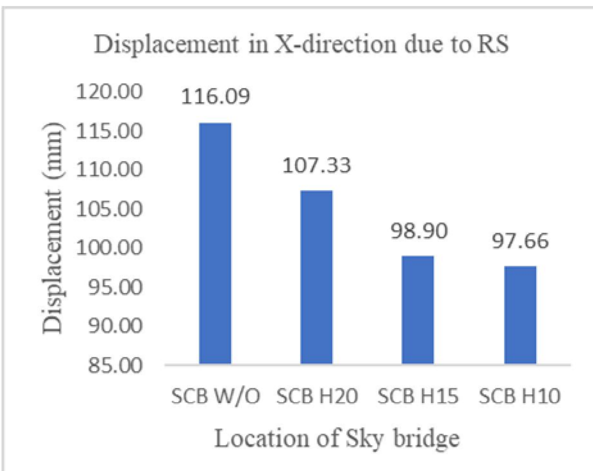

Figure 9 Displacement in X-direction due to RS

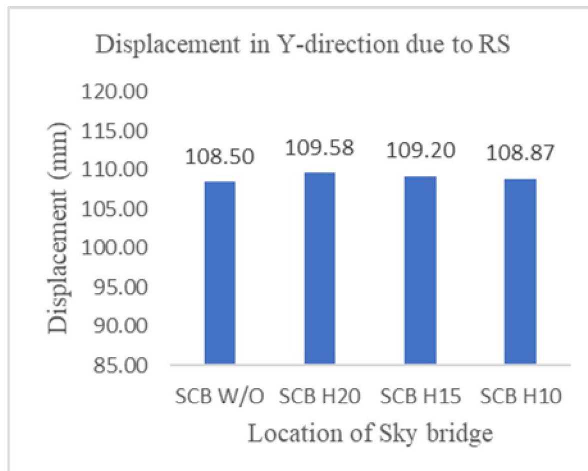

Figure 10 Displacement in Y-direction due to RS

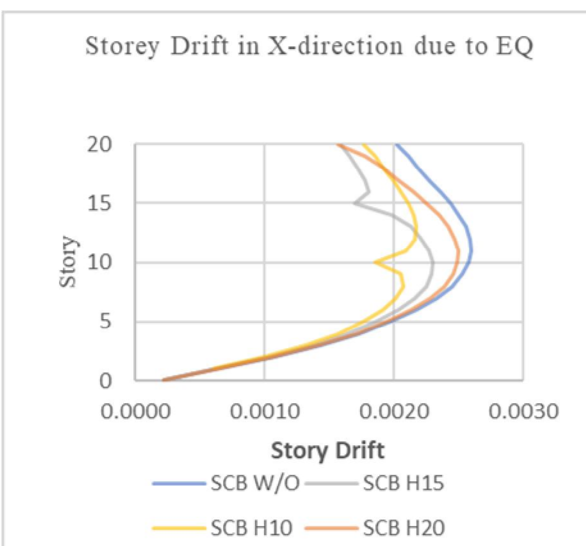

Figure 11 Storey Drift in X-direction due to EQ

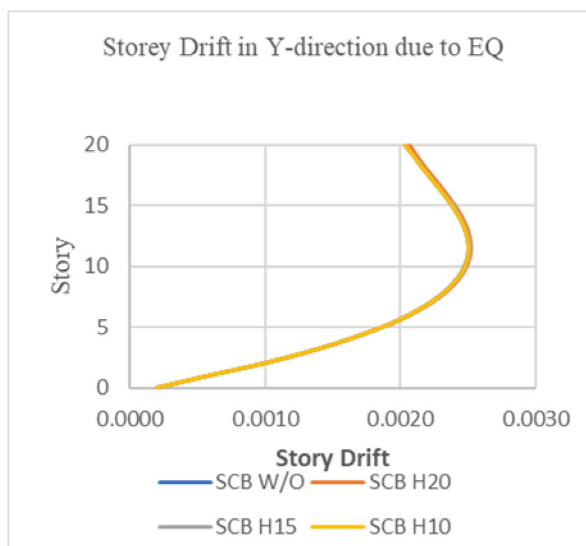

Figure 12 Storey Drift in Y-direction due to EQ

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

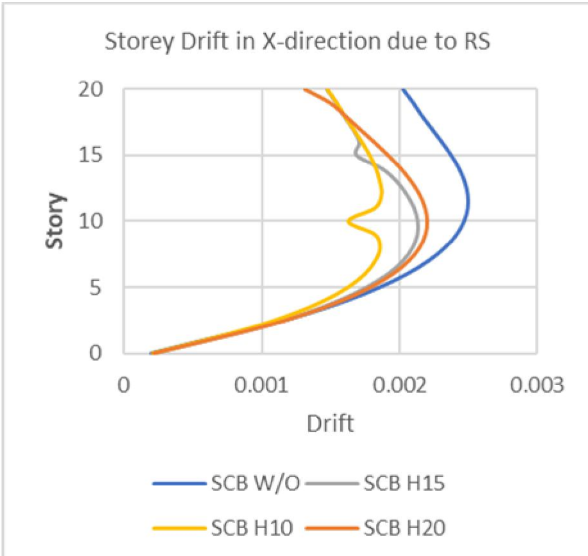

Figure 13 Storey Drift in X-direction due to RS

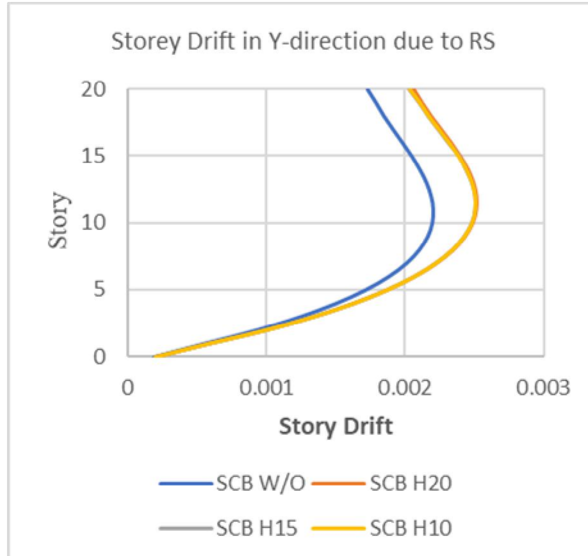

Figure 14 Storey Drift in Y-direction due to RS

- In 20 floor building connecting by one sky bridge horizontal at 10th ,15th and 20th floor max story displacement of building is decreasing 6 % to 14% in the direction of the bridge.
- In 20 floor building connecting by one sky bridge horizontal at 10th ,15th and 20th floor max story displacement is increasing 1% along the across side.
- In 20 floor building connecting by one sky bridge horizontal at 10th ,15th and 20th floor max story displacement of building is decreasing 7% to 15% in the direction of the bridge.
- In 20 floor building connecting by one sky bridge horizontal at 10th ,15th and 20th floor max story displacement is increasing 0.3% to 1% along the across side.
- In 20 floor building connecting by one sky bridge horizontal at 10th ,15th and 20th floor story drift of building is decreasing 53% in the direction of the bridge.
- In 20 floor building connecting by one sky bridge horizontal at 10th ,15th and 20th floor story drift is decreasing 7% along the across side.
-

IV. CONCLUSSION

From results of the seismic analysis of two buildings connected by a skybridge, utilizing both the Static Equivalent Method and the Response Spectrum Method in ETABS software. The analysis focused on comparing the seismic performance of buildings with and without a skybridge connection, as well as evaluating the effectiveness of horizontal.

A. *Impact on Base Shear*

- The addition of skybridges generally increases the base shear of the connected buildings compared to standalone structures.

B. *Effect on Maximum Story Displacement*

- Skybridges are generally effective in reducing the maximum story displacement
- while a horizontal skybridge (SCB H15) shows reductions, such as 14.36% in EQX and 14.81% in RSX, with slight increases in EQY and RSY.

C. *Effect on Story Drift:*

- At floor where building is connected by horizontal sky bridge drift is decease than other floor in direction of sky bridge while in across direction slight increase.
- In 20 floor building connecting by one sky bridge horizontal at 15th floor story drift of building is decreasing 30.46% in the direction of the bridge with slight increases in EQY and RSY.

Among the different configurations studied, the sky bridge located at 15th floor (SCB H15) is identified as the optimal location for the sky bridge based on the significant reductions observed in both maximum story displacement and story drift in the direction of the bridge.

REFERENCES

[1] IS 1893:2016 (Part-1) Criteria for earthquake-resistant design of structures.

[2] IS 875:2015 (Part-3) Design Loads (other than Earthquake) for Buildings and Structures-code practice

[3] IS 456:2000, Plain and Reinforced Concrete – Code of Practice, Bureau of Indian Standards, New Delhi, India.

[4] Nisarg Patoliya, Indrajit N., Agrawal, Vimlesh V., "Seismic Analysis of Tall Buildings Connected with Sky Bridge", International Advanced Research Journal in Science, Engineering and Technology, 2023. 10.17148/IARJSET.2023.10446

[5] Nahid Islam Romel, Md. Mohiuddin Ahmed, Quazi Reduanul Bari, Badhan Chakma, "Optimum Location Determination of a Horizontally Connected Steel Bridge for a G+10 Storied RCC Building Under Lateral Loads", School of Applied Sciences & Technology, SUST, Sylhet, January 2023.

[6] Kiran M.U, Shivananda S.M, Mahantesha O., "A Study of Lateral Drift Controlling Between Two Buildings by Connecting Sky Bridge", International Journal of Civil and Structural Engineering Research, 2016.

[7] Chandan Ahir, Neeraj Singh Bais. "Research on the Effect of Horizontal Walkway Location Connecting Two High-Rise Buildings (G+20) Under Seismic Loading," International Research Journal of Engineering and Technology (IRJET),2024

[8] D.C.P. Ng, M.P Anwar, T.L. Lau, W. Elleithy, A.A. Mohammed, J. Jayaprakash, "Dynamic Response Analysis of Skybridge Connected Reinforced Concrete Buildings under Lateral Loads", International Journal of Civil Engineering and Technology,2024.DOI 10.1063/5.0180660