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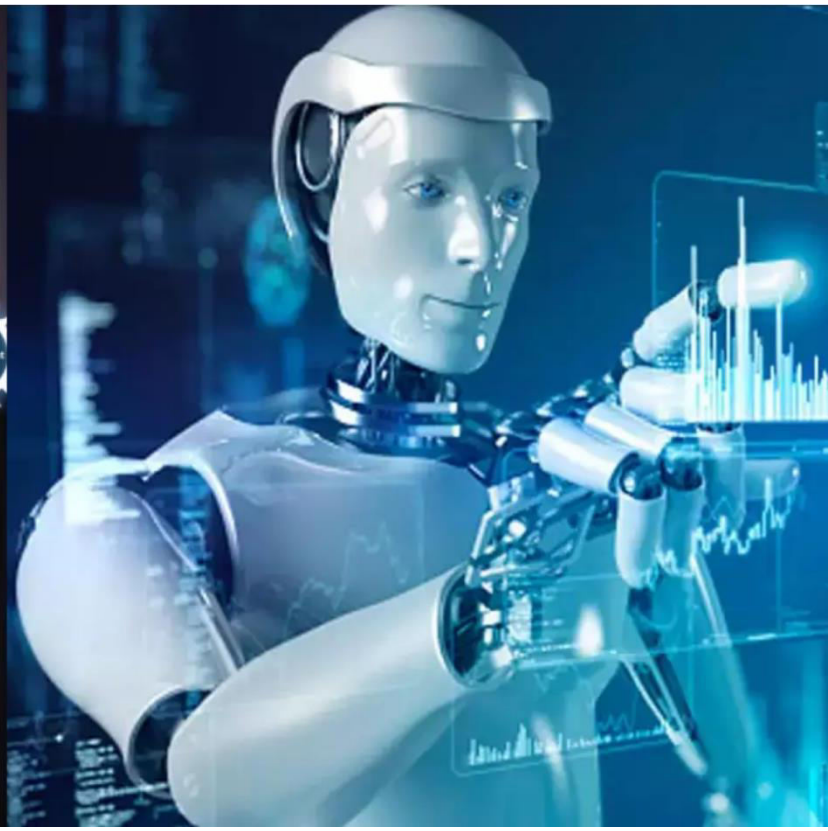

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Vibration Performance Study and Design of Interconnected Concrete High-Rises via Skybridges

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ABSTRACT: It is well known that high-rise buildings act as very important roles in modern cities. First of all, tall buildings can be effectively used to meet the requirements of modern society and solve the problem of limitation of construction site resources. On the other hand, they are the signals of economic properties and civilization. Nowadays high-rise buildings rise higher and higher, with more and more complex and individual plan and elevation, such as multi-tower buildings. “Sky Bridge”, “skywalks” or “elevated walkway” bring up images of a narrow, glass walkway connecting two towers usually commercial the only purpose of which, is to let people go from one meeting to the next without having to travel up and down or through fresh air. Dynamic actions are caused on buildings by both wind and earthquakes. But, design for wind forces and for earthquake effects are distinctly different. In this research analyze twin tower structure of G+ 25 with having steel sky walker bridge at 20th floor , the structure analyze for seismic forces, and design steel sky walk bridge for the same by using Staad-Pro.

KEYWORDS: Sky Bridge, Seismic, Steel Design, Wind Forces, High-Rise Building.

I. INTRODUCTION

Many high-rise buildings around the world have been designed with a phased evacuation strategy in mind; i.e., evacuating a number of floors at a time and leaving the majority of the building occupants in place.[5] Given the high public profile of the events of the World Trade Center Towers’ collapse, it is now doubtful that tall building occupants will feel comfortable to remain in a tall building in an emergency situation, as is required of this phased evacuation approach.[3] The alternative simultaneous evacuation strategy, where all building occupants are evacuated at once, would have a huge impact on the design of tall buildings; e.g., increasing the number and width of fire stairs, the consequential impact on floor space, and retrospective incorporation in existing buildings.[5]

Incorporation of physical connections at height throws up considerable challenges: structurally, operationally, and psychologically as well as in design and occupant terms. If sky bridges are to become a realistic proposition for the improved safety of tall buildings in dense cities such as Hong Kong, the following implications should be studied. [7]

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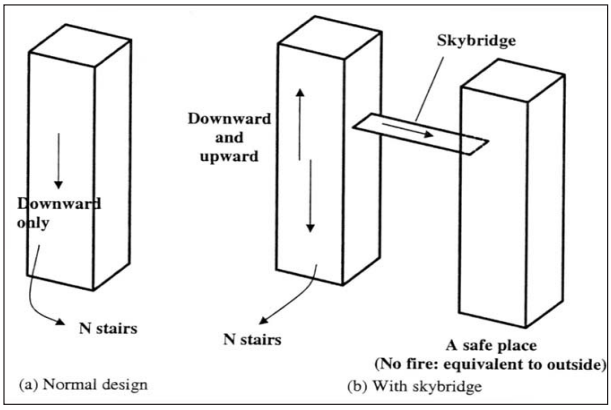

Fig 1 Evacuation in high-rise building

II. AIM AND OBJECTIVES

Aim:
To analyze and evaluate the dynamic response of reinforced concrete twin-tower buildings connected by a skybridge under lateral loads, with a focus on improving structural performance and stability through advanced modeling and analysis techniques.

Objectives

- To study benefits, feasibility of skywalk bridge for twin tower buildings
- To analyze the sky Walk Bridge with different type of truss patterns by response spectrum method.
- To design skywalk for the twin tower building using Staad Pro Software.
- To determine structural performance of twin tower building at various levels.

III. PROBLEM STATEMENT

The Sky walk bridge analyses with effective span 30m with different type truss patterns. The results of Sky Walk Bridge are analysed for the response spectrum analysis method for Pratt and how each type of truss gives better performance than Pratt truss. After then analysing the Howe type of truss for two different types of spans, one with a 5 m span and the other with a 2.5 x 2.5 m span, according to the results, no major difference was found after changing the span. After analysing the different type truss patterns Howe type of bridge need to Design economic structure of Skywalk for the Twin Tower Building with using Stadd Pro Software analysis As per IS800 for wind and vibration loads.

Bay Frame Size

- Bay Frame = 40 x 35 m
- Column Size = 300 x 750
- Beam Size = 300 x 650
- Grade = M25
- Steel Grade = Fe 500

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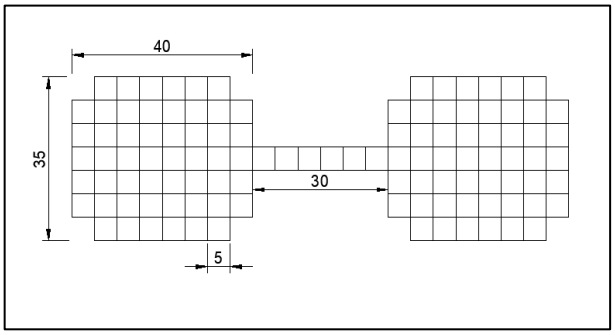

Fig 2 Building Plan

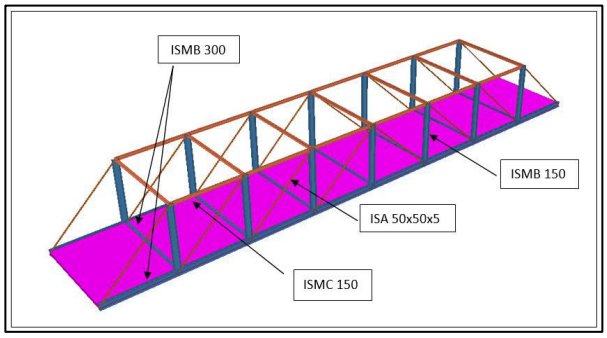

Fig 3 Truss sizes Used for Analysis

IV. METHODOLOGY

Study of vibration analysis of Sky Walk Bridge is carried out. From literature survey it is found that which work was done on this type of bridge and which works are limited or not done. Vibration analysis of Sky walks bridge with seismic load done by Finite Element Method by using Staad Pro. In this method partial differential equations are generated and solved. The response of Sky Walk Bridge under forced vibration will be determined. The results of Sky Walk Bridge are analyzed and design sky Walk Bridge for twin tower.

- Collection of relevant research data from national and international journals, web source, textbook, reference book to get acquainted with past research.
- Identification of scope of research with regard to twin tower and sky walk bridge
- Study the applications of Dynamic Forces with Response Spectrum analysis.
- Study the properties Different type of Truss patterns use for sky walk bridge
- Prepare Modelling with Different type of Truss and width in Staad.Pro software
- Analyse models of Response Spectrum analysis
- Find economic truss pattern useful for the sky walk from the Response spectrum analysis with different Design Parameters Such as Deflection, Natural Frequency , time Period
- Prepare Modelling of twin tower structure With Sky Walk Structure
- Design Sky Walk Bridge for Wind Load, Dead Load, and Live Load.

Model in staad pro

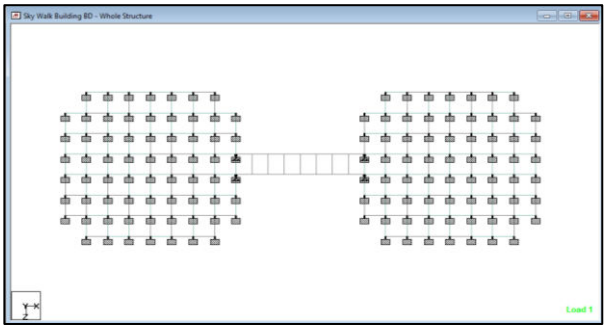

Fig 4 Top view of Model in staad pro

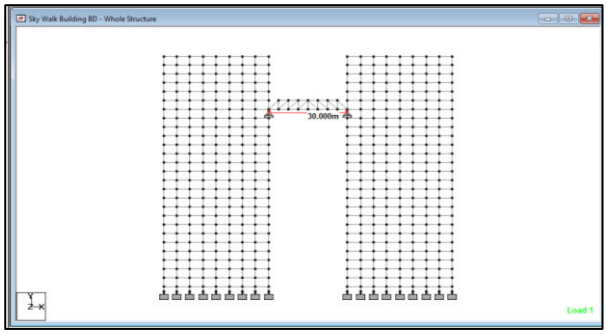

Fig 5 Side view of Model in staad pro

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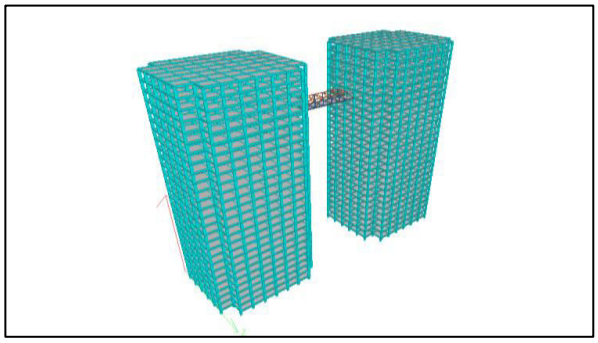

Fig 6 3D view of Total Model in staad pro

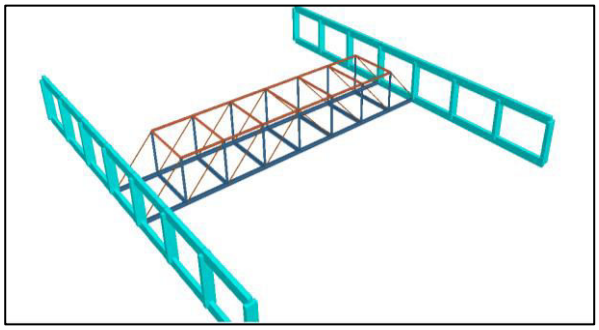

Fig 7 3D view of Bridge Model in staad pro

V. RESULTS AND ANALYSIS

Wind load intensity are applied on model which are calculated, wind loads are applied by X, -X, Z and –Z directions.

Seismic load –

- Zone – III -0.16
- Response Factor- 5
- Importance Factor – 1.5
- Soil Condition - Medium

Properties of Failure element ISMB 300

- Properties of Bottom span section = ISMB300
- Revised Property of Section = ISWB600H

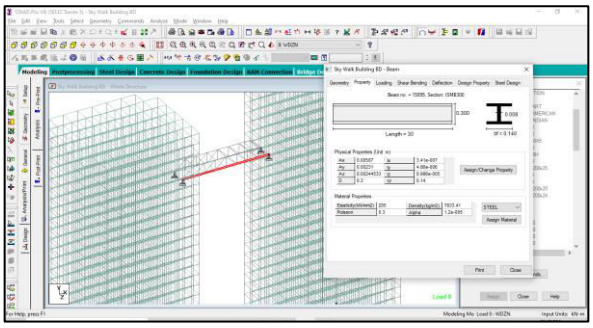

Fig 8 Properties of Failure element ISMB 300

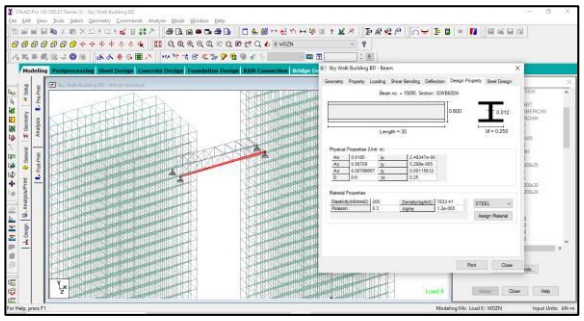

Fig 9 Properties of Revised element ISWB600H

Properties of Failure element ISMC 150

- Properties of top span section = ISMC 150
- Revised Property of Section = ISMC 400

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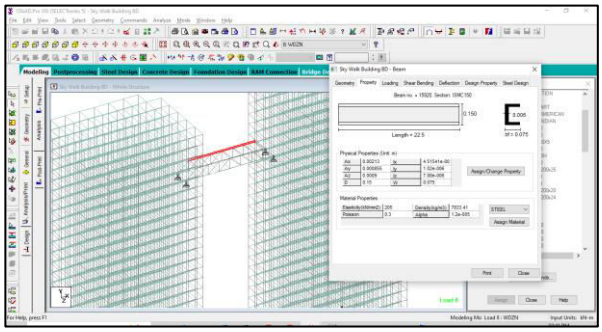

Fig 10 Properties of Failure element ISMC 150

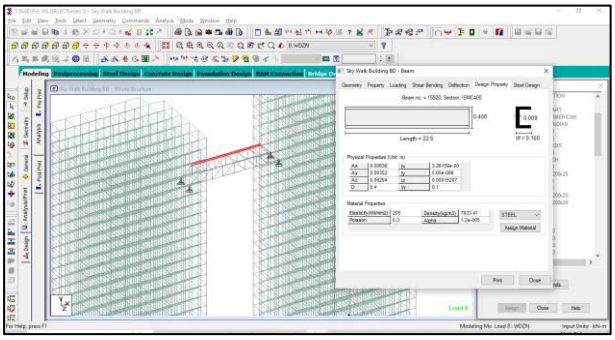

Fig 11 Properties of Revised element ISMC 400

Properties of Failure element ISMB 150

- Properties of Side Vertical section = ISMB 150
- Revised Property of Section = ISWB600H
- Revised Property of Section = ISHB 300

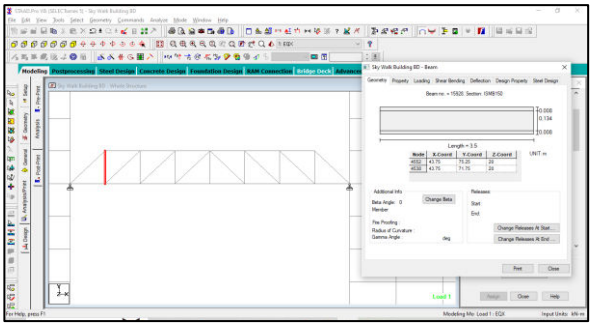

Fig 12 Properties of Failure element ISMB 150

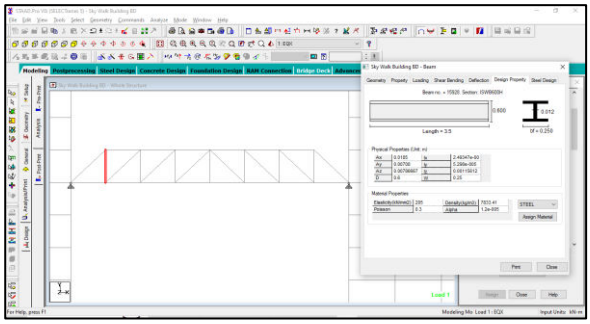

Fig 13 Properties of Revised element ISWB600H

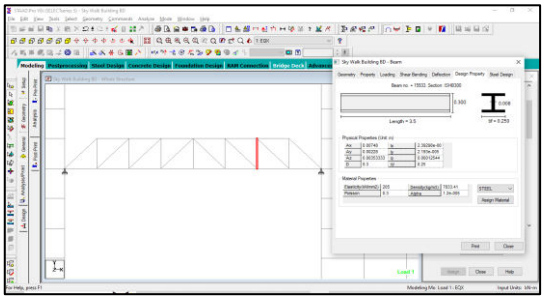

Fig 14 Properties of Revised element ISHB 300

Properties of Failure element ISA 50 x 50 x 5

- Properties of Angles = ISA 50 x 50 x 5
- Revised Property of Section = ISA 200 x 200 x 25

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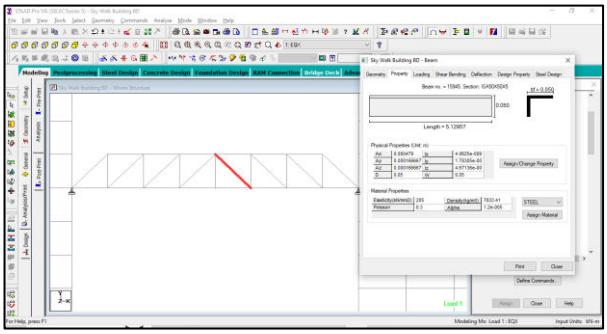

Fig 15 Properties of Failure element ISA 50 x 50 x 5

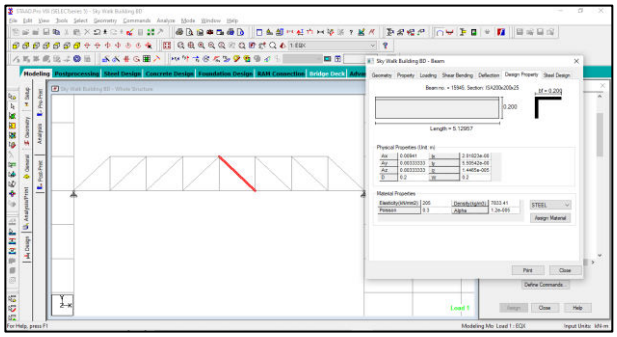

Fig 16 Properties of Revised element ISA 200 x 200 x 25

Sections before Design

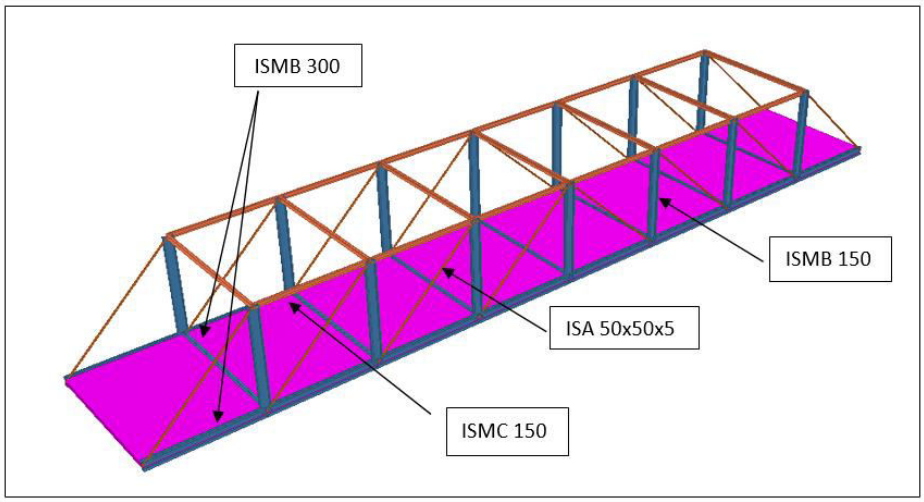

Fig 17 Sections before Design

Sections after Design

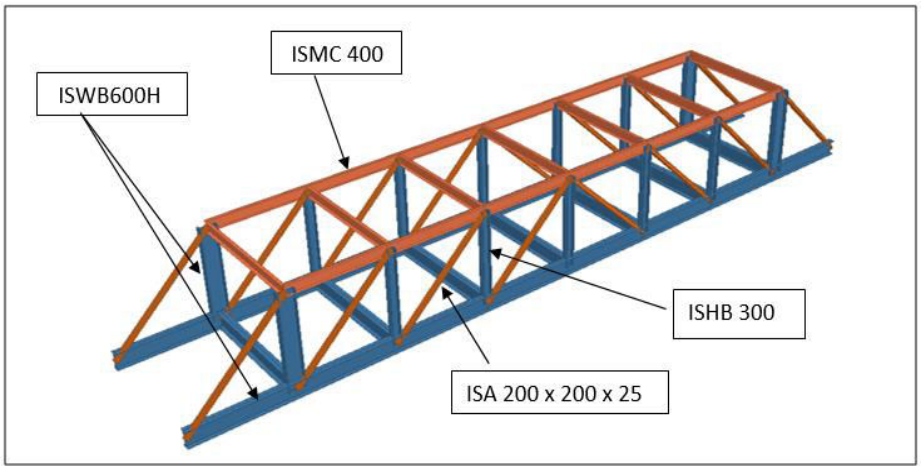

Fig 18 Sections after Design

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Sky Bridge at Various Levels

To investigate the vibration performance and structural behaviour of interconnected twin high-rise concrete buildings by providing skybridges at different floor levels, namely the 10th, 15th, and 20th floors, and comparing their dynamic responses to identify the most effective skybridge location.

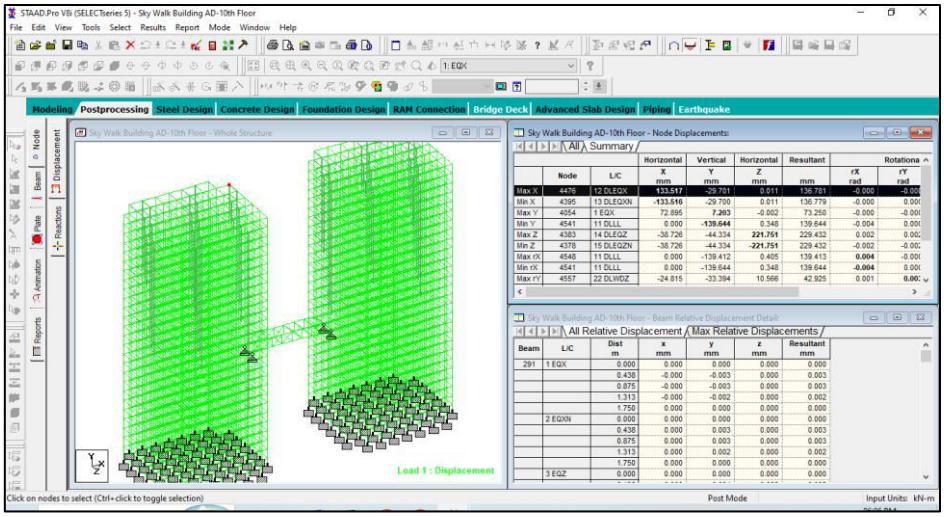

Fig 19 Displacement - Skybridge at 10th Floor

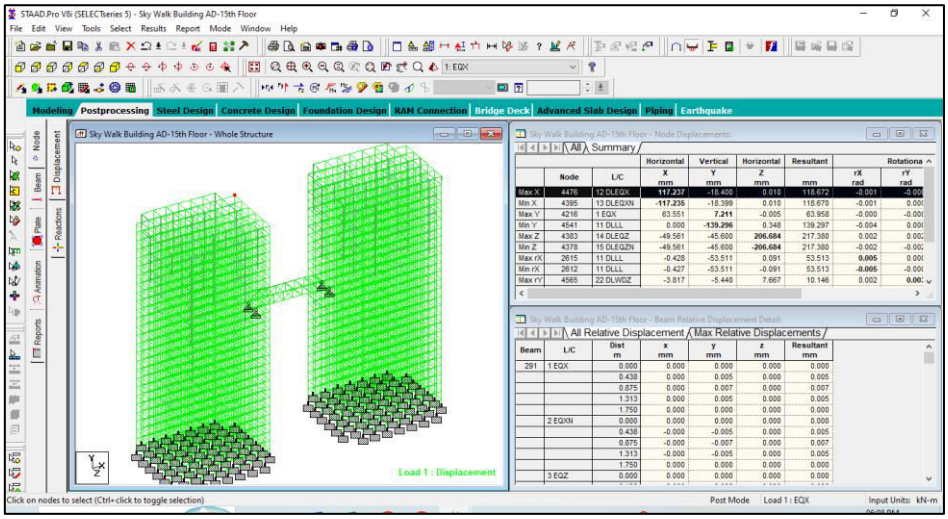

Fig 20 Displacement - Skybridge at 15th Floor

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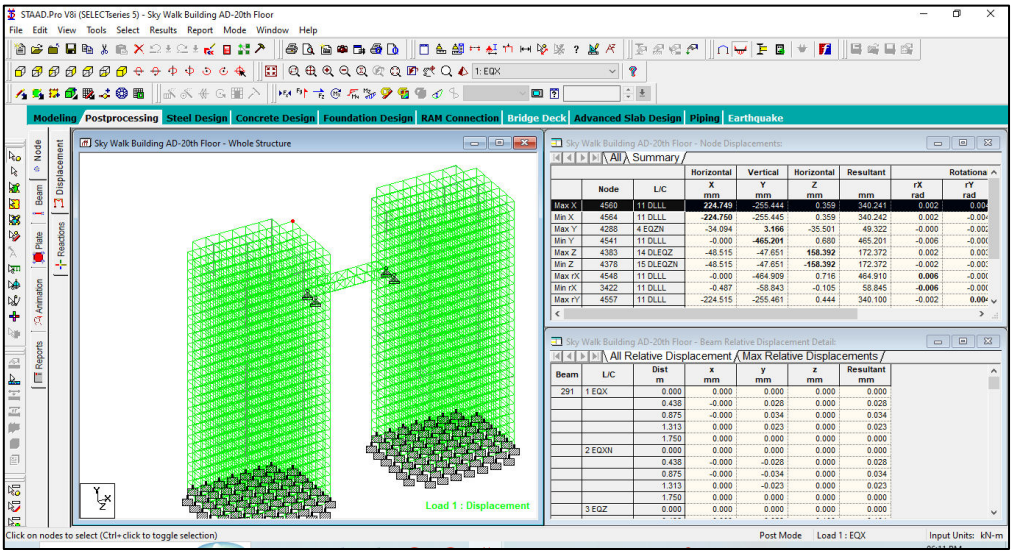

Fig 21 Displacement - Skybridge at 20th Floor

Table 1 Max. Displacement mm

Displacement mm		
10th Floor	**15th Floor**	**20th Floor**
133.51	117.23	224.74

The maximum displacement values indicate that the skybridge location has a significant influence on the lateral displacement behaviour of interconnected twin high-rise concrete buildings. The skybridge positioned at the 15th floor exhibits the minimum maximum displacement of 117.23 mm, followed by the 10th-floor configuration with 133.51 mm. However, the skybridge located at the 20th floor shows the highest displacement of 224.74 mm.

The results indicate that the 15th-floor skybridge configuration provides better displacement control among the three configurations considered. The 20th-floor configuration exhibits comparatively higher lateral displacement, indicating that the vertical location of the skybridge plays an important role in the dynamic performance of interconnected twin towers.

VI. CONCLUSION

- Buildings connected by sky bridges exhibit varying structural behavior based on their location, stiffness, and connection to neighboring buildings. Rollers, hinges and stiff connectors are among the connections used to attach the sky bridge to the building. The design and construction of such a structure must consider a variety of issues, including wind load, seismic load, and safety rules. In this analysis of the Sky Walk Bridge, we consider two types of bridges: Howe trusses and Pratt trusses.
- The Sky Walk Bridge data are examined using the response spectrum analysis method for Pratt and Howe trusses. In the analysis The Howe type of truss performs better than the Pratt truss. After evaluating the Howe type of truss for two different spans, one with a 5 m span and the other with a 2.5 x 2.5 m span, the results showed that there was no significant difference after changing the span.
- For the maximum displacement of the model before and after the design of the bridge, it is concluded that the model reduces the displacement after the design of the bridge; it is ISWB600H; for the mid-vertical section,
- After the design of the Howe Truss, the bottom span portion is ISWB600H, the top span section is ISMC 400, the side vertical section is ISHB 300, and the angles are ISA 200 x 200 x 25.

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