Research Paper Engineering

Effect of Service Bridge on natural frequency of structurally coupled multistory building

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ABSTRACT

The paper entitled "effect of service bridge on natural frequency of structurally coupled multi storey building" is to locate the most effective location of the sky bridge connecting two building towers. In order to achieve the goal, the modeling and analysis of the building towers and the sky bridge was accomplished using the STAAD PRO Software. The maximum NATURAL FREQUENCY of the building towers was compared to determine the effectiveness of the sky bridge in terms of location. On the whole, this report presents the discussion and the results obtained from the research.

Keywords : sky bridge, natural frequency, Service Bridge.

Introduction

After11th September and the world trade center towers collapse the improved safety of tall buildings has became of prime importance across the world. The three recommendations for improve the safety in tall buildings are:-

1) Improvement of structural systems especially with respect to progressive collapse,
2) Improvement of fire proofing, to structure and fabric,
3) Improvement of evacuation systems connecting especially on vertical evacuation systems such as elevators and stairs

With this work we can make the tall buildings safer but it is perhaps not enough. As the risk to our cities increases- through terrorism, war or accident –we need to tackle the problem at a more fundamental design level, not as an alternative but in addition to the improved safety mechanism suggested above. One possible way of improving the safety of tall buildings is by introducing horizontal evacuation at height through use of a sky bridge connecting towers. The concept of being able to evacuate occupants at a level other than ground, should the building be at risk, seems sensible, especially if any emergency in a tall building effectively cuts of vertical evacuation routes and thus the connection to the ground plane.

For example:- In PETRONAS towers sky bridge providing an alternative escape route not only were evacuation times for a single tower significantly reduced, it was also possible to omit two fire escape stairs from the design which would otherwise have been needed. This was a significant space saving.

Creating this "pavement in sky" between towers however it is not without considerable challenge structurally, operationally, & psychologically as well as in design and occupant terms.

Optimum vertical placing of the sky bridge

The placing of the skylobbies vertically should occur at a level of lift zoning changeover and, furthermore, be placed so as to ensure maximum efficiency of evacuation circulation in the event of an emergency. Having the horizontal linkage too close to the ground plane, or too close to the top of the tower, would impede this efficiency since the vast majority of the occupants would need to travel significant distances vertically before they could discharge horizontally to the next tower. studies need to be done to understand the effects on circulation flow of differing configurations but common sense would tell one that the zone of primary efficiency would be somewhere around the middle of the tower Or, more precisely somewhere around the middle of the building mass/ number of occupants.

Problem identification

Most of the R.C.C. buildings in the country are not connected by the sky bridge and during the earthquake their behavior is well known to structural engineers to increase the performance of the building during earthquake the sky bridge can be implemented in the buildings so the originally separated buildings are act like a single complex building and their behavior during earthquake is completely change.

Hence, it's necessary to analyze and find out the behavior of structurally coupled building during earthquake with different combinations of sky bridge connections.

Here aim of the research is to study the effect of Service Bridge on a Natural frequency of twenty storey buildings connected by a sky bridge at different locations for three different plan, with one service bridge at a time on 1st floor,9th floor 10th floor 11th floor,18th floor 19th floor & 20th floor. Two bridges at a time on 1st&19th floor, 2nd& 18th floor, and 9th& 11th floor. Three bridges at a time on 5th 10th&15th floor. Also taking the combination of bridge at all even floors & all odd floors and finally Service Bridge are provided at every floor of the building. The length of Service Bridge is kept 10 meter constant and width of bridge if 5 meter constant.

Structural analysis

To, analyze S.T.A.A.D. PRO.2006 is used.
1) Square plan (40*40)
Area: - 3600 m2.
Numbers of column: - 166
Column size: - 900*900 mm
Size of beam: - 300*600 mm
Numbers of storey: - 20
Storey height:-3m constant

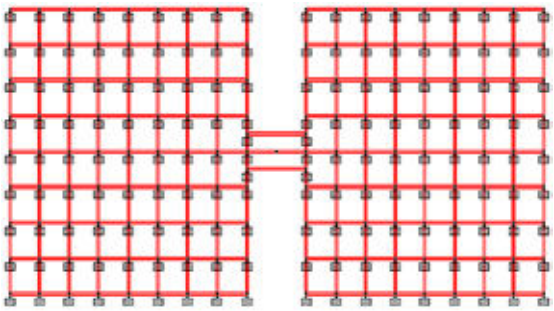
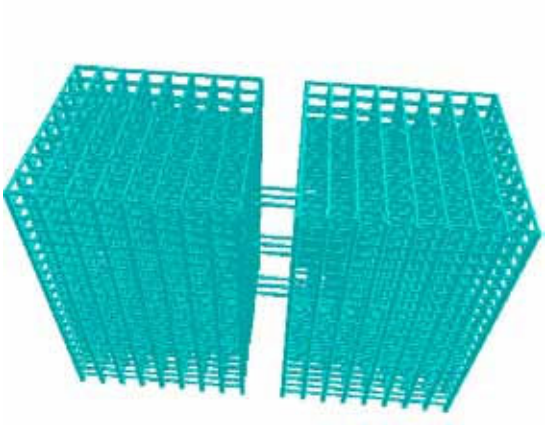


Fig. 1.1) plan (40*40)
Fig. 1.2) Elevation (40*40)
2) Rectangle plan (50*30)



Area:-3300 m2.
Numbers of column:-158
Column size: - 900*900 mm
Size of beam: - 300*600 mm
Numbers of storey: - 20
Storey height:-3m.

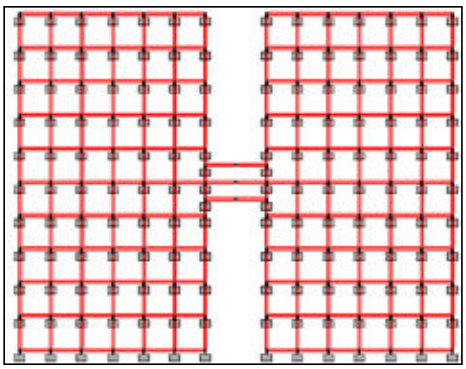


Fig. 2.1) plan (50*30)

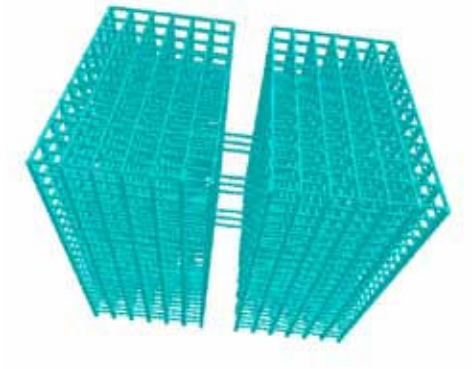


Fig. 2.2) Elevation (50*30)

3) Rectangle plan(30*50)
Area:-3500m2.
Numbers of column:-158
Column size: - 900*900 mm
Size of beam: - 300*600 mm
Numbers of storey: - 20
Storey height:-3m.

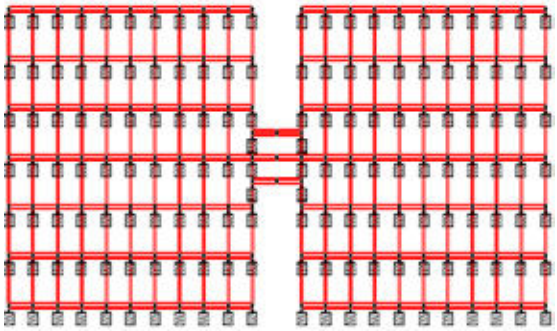


Fig.3.1) plan (30*50)

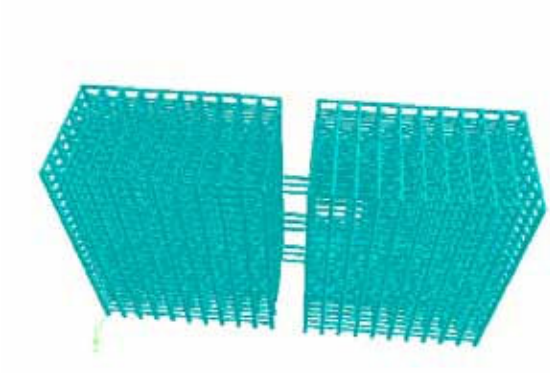


Fig.3.2) Elevation(30*50)

Load cases:-
1) Dead load
i) External wall:-
Wall thickness 230 mm
Load:-0.230*18*2.4 =9.936 KN/M

ii) Internal wall:-
Wall thickness 115 mm
Load:-0.115*18*2.4=4.96 KN/M

iii) Parfait wall: -
Wall thickness 230 mm
Load:-0.230*18*1=4.14 KN/M

iv) Floor load:-
Slab thickness 120 mm
Load:-0.12*25=3 KN/M

2) Live load :- 2 KN/M

3) Earthquake force
Zone:-V
Performance factor: - 5
Importance factor: - 1
Damping:-0.05%
Soil type: - medium
Support: - fixed

Rigidity provided by using master slave at each floor and dynamic analysis is carried out by using CQC method including torsion and accidental loads.

Result & discussion

TABLE: -1 RESULT 50*30

BRIDGE CONNECTION	FREQUENCY {X}HZ	FREQUENCY {Z}HZ
1st floor	1.318	1.402
9thfloorth	1.439	1.402
10thfloor	1.438	1.402
11th floor	1.435	1.402
18th floor	1.386	1.402
19th floor	1.378	1.402
20th floor	1.372	1.402
1st& 19th floor	1.41	1.402
2nd& 18th floor	1.427	1.402
9th& 11th floor	1.447	1.402
5th,10th& 15th floor	1.36	1.302
All even floor	1.469	1.399
All odd floor	1.469	1.399
All floor	1.348	1.283

The maximum natural frequency in x- direction is 1.469 when service bridge are provided at all even floors and also when we provide them on all odd floors while minimum natural frequency is 1.318 when service bridge is provided on first floor hence the percentage change in frequency due to location and numbers of service bridge is 11.456%.

TABLE: -2 RESULT 30*50

BRIDGE CONNECTION	FREQUENCY {X}HZ	FREQUENCY {Z}HZ
1st floor	1.447	1.237
9thfloorth	1.504	1.238
10thfloor	1.503	1.238
11th floor	1.502	1.238
18th floor	1.479	1.237
19th floor	1.476	1.237
20th floor	1.473	1.237
1st& 19th floor	1.49	1.237
2nd& 18th floor	1.498	1.237
9th& 11th floor	1.507	1.237
5th,10th& 15th floor	1.514	1.237
All even floor	1.515	1.235
All odd floor	1.515	1.235
All floor	1.512	1.232

The maximum natural frequency in x- direction is 1.515 when service bridge are provided at all even floors and also when we provide them on all odd floors while minimum natural frequency is 1.447 when service bridge is provided on first floor hence the percentage change in frequency due to location and numbers of service bridge is 4.69%.

TABLE: -3 RESULT 40*40

BRIDGE CONNECTION	FREQUENCY {X}HZ	FREQUENCY {Z}HZ
1st floor	1.395	1.336
9thfloorth	1.476	1.336
10thfloor	1.475	1.336
11th floor	1.473	1.336
18th floor	1.411	1.336
19th floor	1.436	1.336
20th floor	1.432	1.336
1st& 19th floor	1.457	1.336
2nd& 18th floor	1.468	1.336
9th& 11th floor	1.481	1.336
5th,10th& 15th floor	1.492	1.336
All even floor	1.474	1.312
All odd floor	1.494	1.334
All floor	1.471	1.31

The maximum natural frequency in x- direction is 1.494 when service bridge are provided at all odd floors while minimum natural frequency is 1.395 when service bridge is provided on first floor hence the percentage change in frequency due to location and numbers of service bridge is 7.09%.

Conclusion

Looking at the results it can be conclude that the effect of Sky Bridge on natural frequency in perpendicular direction of bridge is only due to variation in numbers of Service Bridge.

From the results it also seems when the sky bridge is in the middle floors frequency tends to increase & tends to reduced as we go above and below.

It can also stated " As the service bridge is provide away from the center of mass & stiffness of the building natural frequency decrease and tends to increase as the bridge is provided near the center of mass and stiffness.

REFERENCES

OH JOL DIH behavior of sky bridge ad joints R.C. building towers under wind effect UNIVERSITY OF MALAYSIANovember 2007.|ANTONY WOOD(U.K.)-pavement in sky the use of the sky bridge in tall buildings | Eric Lee Richards:- "application of symbolic computing in analysis of modalproperties of structurallycoupledtwin tall buildings"(2011) |KAVEH KUMARCI* Artificial neural networks in calculation of telecommunication towers natural frequency(December, 2010). |NUR HAMIZA BT ADENAN "mathematical modeling of earthquake induced vibrations on multistory buildings" university technologic Malaysia 2010 | IS :1893(PART-1)-2002criteria for earthquake resistant design of structures |S.D. Bharti, S.M. Dumne,M.K. Shrimali (Structural Engineering Department, MNIT, 302017 Jaipur, Rajasthan, India)Seismic response analysis of adjacent buildings connected with MR dampers (8 March 2010)