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THE IMPORTANCE OF INCLUDING BEARING STIFFNESS IN STRUCTURAL ANALYSIS

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Many buildings that include building base isolation have devices to control uplift and horizontal force. If the structural analysis is undertaken with no allowance for bearing stiffness then the forces calculated can be significantly higher than in reality. This paper case studies a residential building in London where structural analysis was carried out with and without the bearing stiffness and huge differences in loads were seen. The results of the case study provided the opportunity for the bearing design to be significantly simpler and cheaper.

Keywords: ground-borne noise, vibration, buildings, trains

1. Introduction

9 Marylebone Lane is a new-build high quality residential building comprising 2 basement levels, lower ground, ground and seven upper floors. The site is located in between Oxford Street and Wigmore Street (see Figure 1 below):

Figure 1: Site Location for 9 Marylebone Lane[1]

The Jubilee Line runs directly beneath the site and the acoustic consultant, Hoare Lea, specified that the building needed to be supported on elastomer bearings with a maximum natural frequency of 15Hz.

Figure 2: Plan showing route of Jubilee Line beneath site[1]

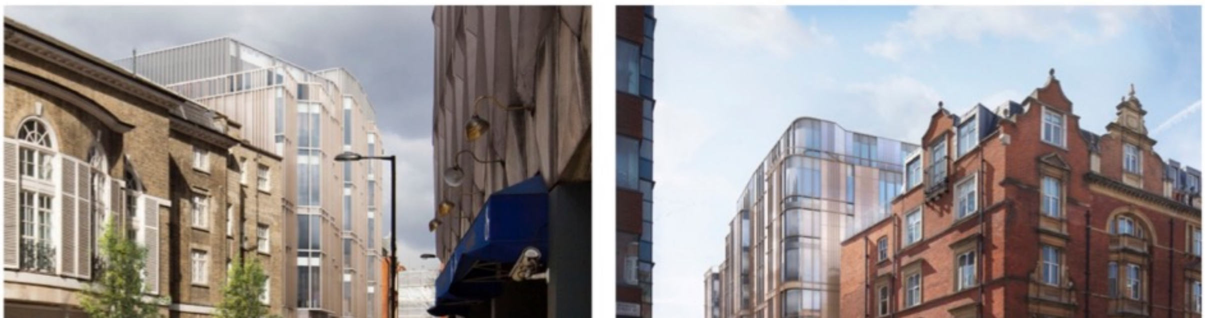

Figure 3: Architectural Impressions of Completed Buidings[1]

2. Description of Structure & Loading Information

The building is isolated at the base of columns and walls on top of the ground floor slab. Sensitive areas on the ground and lower ground floors are isolated using box-in-box constructions.

The structural design relies heavily on the main core to provide stability under wind loading (see Figure 4).

Initial loading information was given assuming that the building was not isolated and this showed that the main core was in uplift even under static loading conditions (see Figure 5 - for simplicity this paper only looks at 2 walls on the main core).

When the maximum wind load was applied the uplift at the ends of each of these 2 walls was as high as 1500kN.

When bearings were inserted into the WSP model uplift disappeared, even under the maximum wind loading condition.

Figure 6 shows the loads on the bearings under DL+LL for 13Hz CDM-VHS elastomer bearings (blue) and 3.2Hz CDM-CHR spring bearings (green).

The observation is that the softer the bearings the more the load is spread evenly between supports.

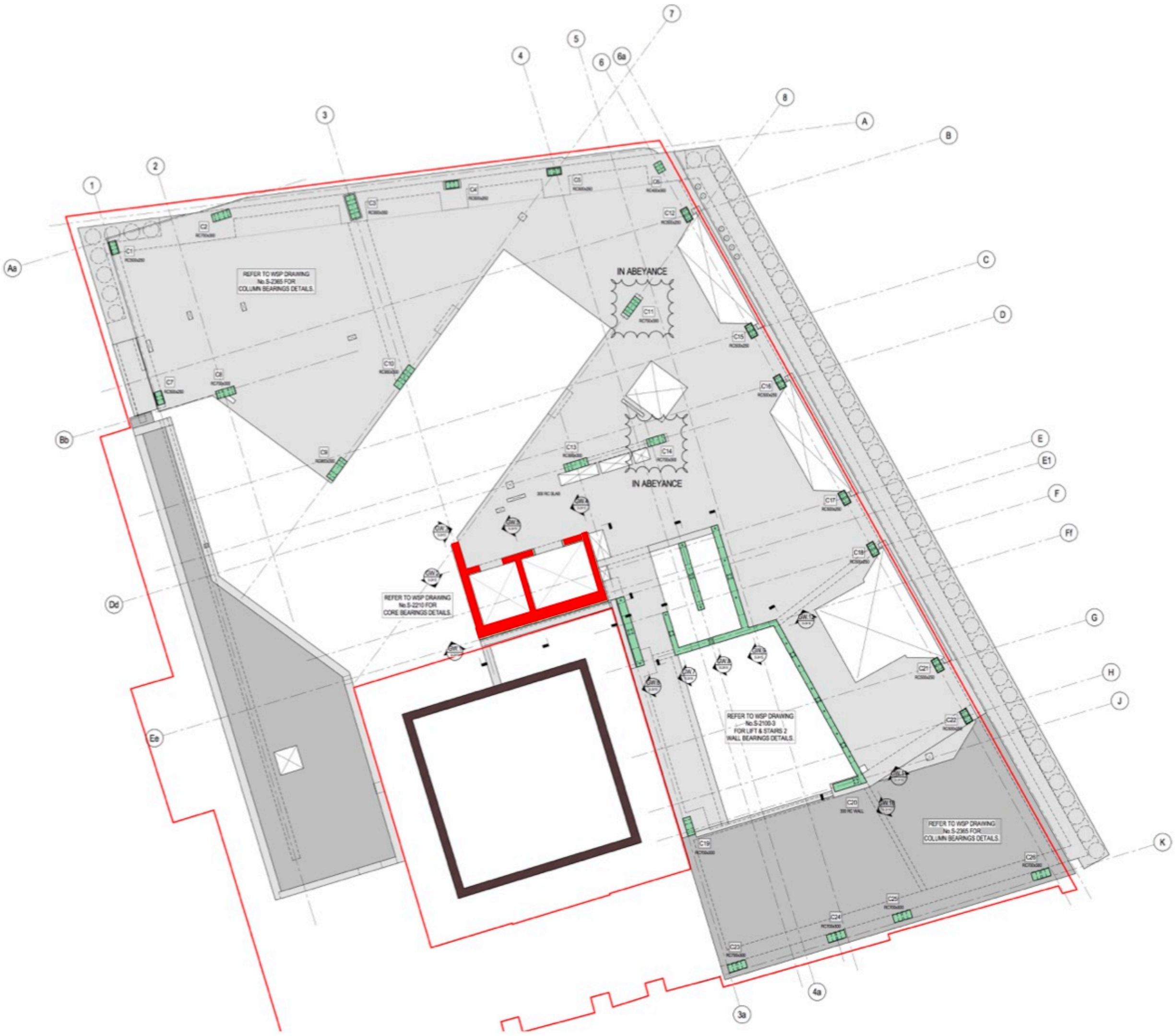

Figure 4: Plan of ground floor – main core shown in red[2]

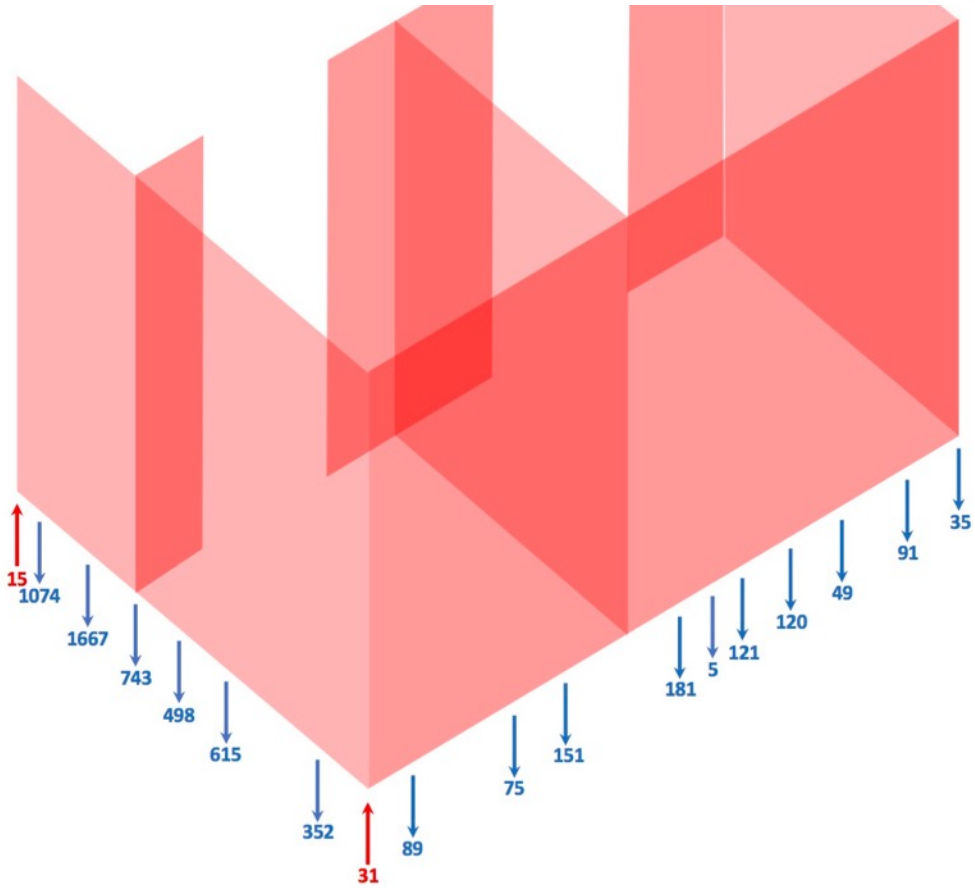

Figure 5: Loads in kN under DL+LL with rigid supports – red arrows denote uplift; blue downforce[3]

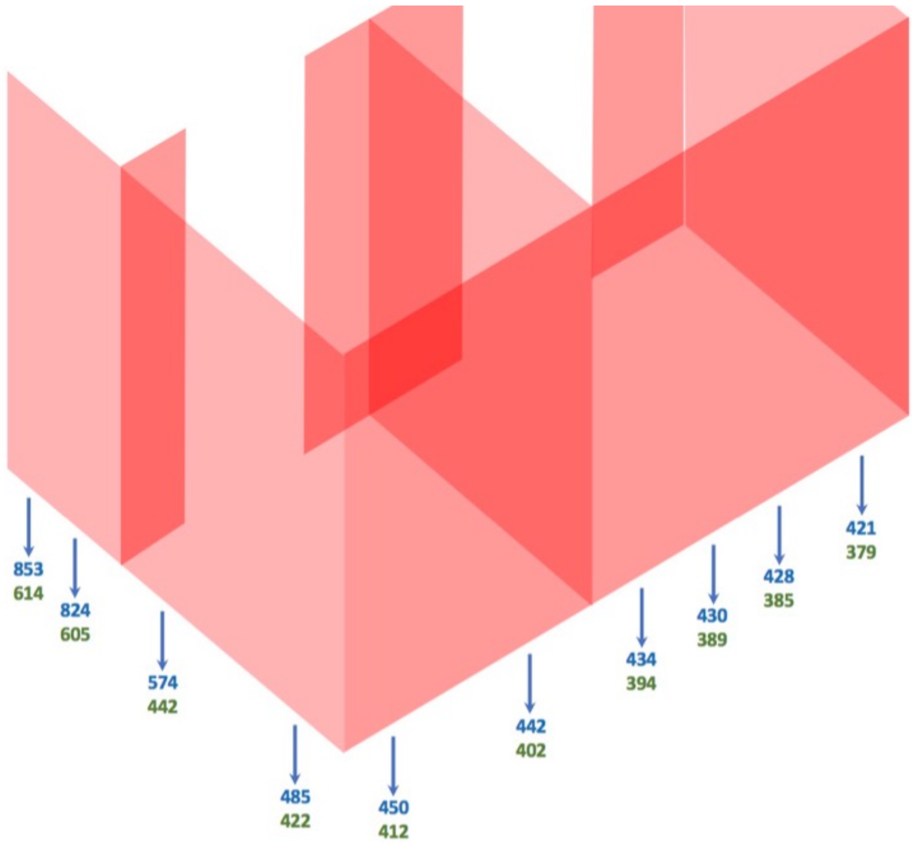

Figure 6: DL+LL Loads, kN: 13Hz Elastomer bearings (blue) and 3.2Hz Spring bearings (green)[3]

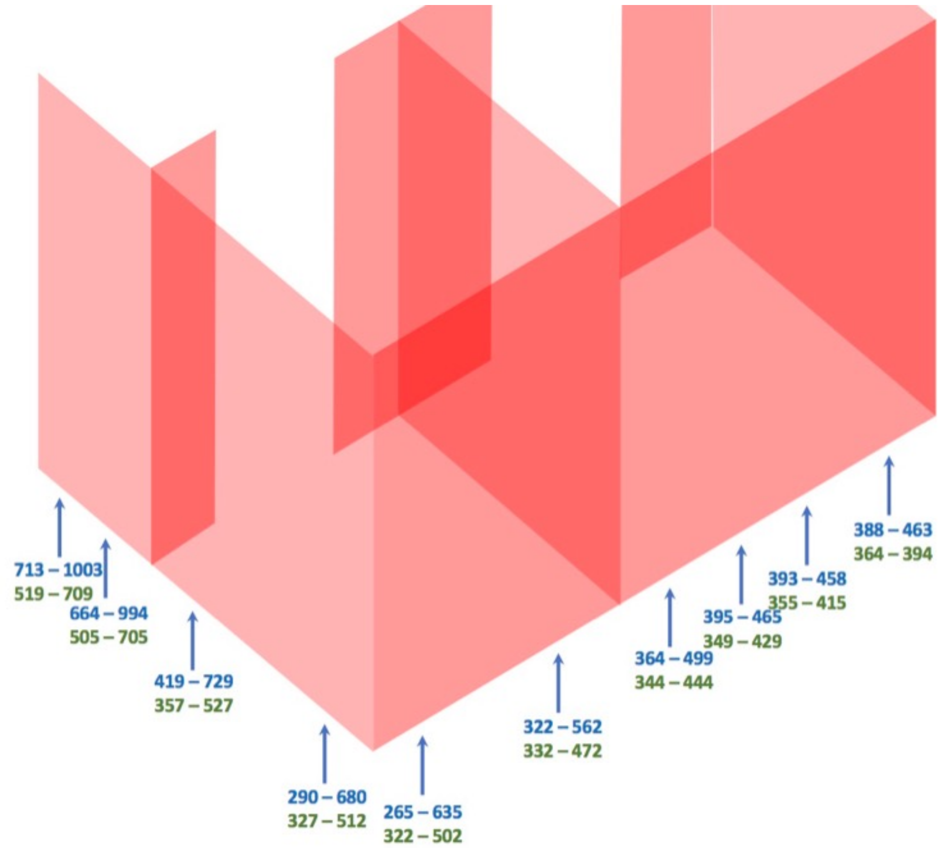

Figure 7: Min-Max Total Loads including wind, kN: 13Hz Elastomer bearings (blue) and 3.2Hz Spring bearings (green)[3]

Figure 7 above shows the minimum and maximum loads including worst case wind loads. This again demonstrates that the softer the bearings the better the load distribution.

3. Conclusion

The conclusion is that it is essential to include the stiffness of isolation bearings in the structural analysis of an isolated building. This will enable the most cost effective isolation solution to be achieved.

Another conclusion is that load is more evenly distributed if the bearings are softer.

4. Acknowledgements

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- The Client: Clivedale
- The Architect: DSDHA
- The Structural Engineer: WSP

REFERENCES

1 DSDHA, *9 Marylebone Lane - Stage E Report*, (May 2014)

2 WSP, *Drawing 'S 2100-2_C1'*, (September 2016)

3 WSP, *Taken from structural analysis*, (September 2016 - April 2017)