REPORT

Seismic Capacity and Strengthening Review

FOR

TRAMWAY HOTEL

AT

114 ADELAIDE ROAD, WELLINGTON

FOR

IPG CORPORATION LIMITED

Prepared by: Ignatius Black

Job Number 24223

Date	Version	Notes/Amendments/Issue Purpose
April 20	Rev A	FOR INFORMATION

1 BRIEF

Silvester Clark Limited have been commissioned by IPG Corporation Limited to review the seismic capacity of the existing URM building and to design concept seismic strengthening schemes for the existing building at 114 Adelaide Road.

2 EXISTING BUILDING DESCRIPTION

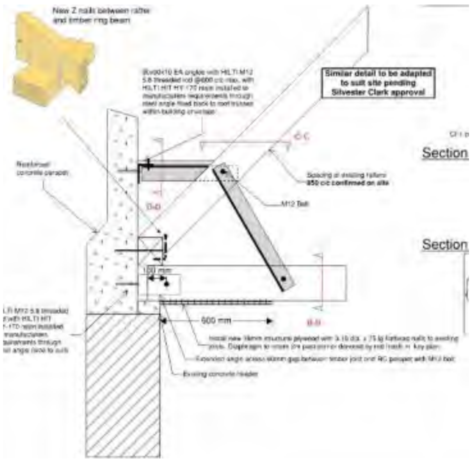
The original part of the existing URM Building at 114 Adelaide Road was constructed in 1899. There have been some additions made mainly on the south side of the original structure and some alterations made to the existing structure to allow connectivity to these additions. The additions to the existing structure have not been considered in this report.

The structure of the existing original building is as follows:

- Roof- corrugated steel on timber framing,
- First floor- timber framed support of URM and timber framed walls below,
- Ground floor- timber framed supported off timber piles and URM walls,
- Walls and parapets- URM.
- Foundations- concrete strips under URM walls and timber piles.

The primary lateral load resisting system are the URM walls.

In 2018 façade securing works were carried out that involved tying the URM parapet facades at roof level back to the timber frame roof structure.



The works meet the legal URM parapet and façade securing requirements but did not address the seismic capacity of the primary structure. The strengthening also did not address the out-of-plane capacity of URM walls on connection of URM walls at first floor and ground levels.

Apart from the 2018 façade securing works there has been no other seismic strengthening carried out to the original URM building.

EXISTING SEISMIC CAPACITY

A seismic review of the existing structure found the following parts of the structure to be identified as achieving less than 34%NBS:

- Roof diaphragm,
- First floor diaphragm,
- Connection between URM walls and first floor structure,
- All external URM walls out of plane,
- All external URM walls in plane.

To increase the seismic capacity of this building the capacity of all these items would need to be addressed.

Most likely the first failure mechanism would be the external URM walls that would failure out of plan. This failure would affect Adelaide Road and Drummond Road with the facades likely falling onto these roads.

GEOTECHNICAL CONSIDERATIONS

Geotechnical reports carried out for this site have identified the following:

i. Ground conditions under the site are likely to be:

- Made ground (fill)- 0-2m
- AND/OR, Alluvium, silt, peat, loess, including Haywards and Kaitoke gravels, subsurface moera gravel, sand, minor tephra- 0-10m
- Wellington Belt Greywacke- 5-10m+

From geological maps and the site topography, Adelaide Road runs down the centre of a “gully” feature with the land rising to the east and west.

ii. Earthquake Liquefaction Risk- Moderate

iii. No obvious signs of settlement under the building have been observed.

CONDITION OF EXISTING STRUCTURE

From survey work we carried out in 2017 we identified the follow issues in a report we prepared:

Inspection and Findings:

Silvester Clark have attended site on 26 July 2017 to evaluate the current condition of the exterior and interior condition of the structure. The exterior façade of the building is unreinforced masonry which is in good condition given the age of the building. There are minor cracks around the window arches that is a typical failure mode for unreinforced masonry buildings with arch window construction. It was noted that there is vegetation growth on the higher levels of the building faced between the bricks. If not treated the vegetation can push out some of the brickwork and fall on passing pedestrians. The masonry wall on the single storey area has been weakened severely due to the partial failure of the roof in the area.

The internal floors on the ground floor have undergone timber decay in certain areas in the two storey area due to the occupancy use as a bar at some stage. The timber floor in the single storey area also has timber decay due to failure of the roof in the area. The ground floor to the western side of the *building has either failed due to seismic movement of the foundations or floor joists/bearers due to timber decay. The floor is uneven and is lacking stiffness. Most of the first-floor members are in place for the double storey are with only on area as identified on site that has missing floorboards.*

The roof is a lightweight system with timber rafters and metal roof sheeting for both the double and single storey. The roof for the double storey is still in a fair condition. The roof over the single storey has failed and is both unstable and unsafe in its current condition.

The existing building has not had any remedial work carried out to address these conditions. The main deterioration issue is timber decay. Decay of timber members will have worsened since 2017. This will reduce the seismic capacity of the building.


To remedy the timber decay issue, affected members would need to be removed and replaced including timber piled foundations.   This would be a very involved process, propping of the facade would likely be required to allow for the replacement of damaged timber structure in the first floor.

Note that addressing the timber decay issue will not increase the seismic capacity to above 34%NBS. i.e. if the timber decay issues are addressed this building would still be earthquake prone.

3 STRUCTURAL ATTRIBUTES OF EXISTING BUILDING

A brief summary of the positive and negative attributes of the existing building are tabulated below. Whilst we have listed positive attributes these contribute little in the way of meaningful resistance to seismic loadings whereas the negative aspects have a major impact on the performance of the building in a seismic event.

Positive attributes;

i. Seismically separate from buildings on neighbouring properties,
ii. No signs of ground settlement,
iii. URM appears to be in reasonable conditions.

Negative attributes;

i. Nature of the structure- heavy façade with light weight floors and roof,
ii. Age of structure,
iii. Plan irregularity due to layout being "L" shaped,
iv. Inadequate diaphragm capacity at roof and first floor levels,
v. Inadequate out-of-plane capacity of URM walls,
vi. Inadequate in-plane capacity of URM walls. This capacity is particularly reduced on the Adelaide Road and Drummond Street dues to the number of window and door openings.

Traditional URM buildings have the very undesirable feature of having most of their seismic weight in the exterior URM walls. The lightweight timber structure that makes up the floor and roof diaphragms are much lighter and weaker in proportion. They also behave as flexible diaphragms. Modern buildings are usually the reverse with the exterior walls being much lighter in proportion to the floor structures.

4 SEISMIC STRENGTHENING CONCEPTS

To seismically upgrade the existing building structure to greater than 34%NBS the issues noted in the previous sections would need to be addressed. Conceptually we see this as involving the following:

Item	Description of strengthening option(s)
Diaphragm strengthening (roof and first floor levels)	Either strengthening with: a) Steel cross bracing in the plane of the roof and floor structures, or b) Remove existing floorboards and replace with structural plywood. In both cases the connectivity between the strengthened floor diaphragm and external URM walls and new bracing element would require specific strengthening design to ensure transfer of in-plane and out-of-plane demands.
URM out-of-plane strengthening	To strengthen URM walls against out-of-plane failure mechanisms the following works will be required: a) Strengthening the URM walls between levels with either steel or timber posts installed internally or with sprayed concrete. Note posts would be a preferable option as sprayed concrete would add considerable seismic mass to the buildings, or b) strengthen URM walls with carbon fibre reinforcement. Note this would be required on both the internal and external faces, and c) strengthen the connections between the external facades and the strengthening diaphragm structures at first floor and roof level.
In-plane capacity	To protect the URM walls, and to increase the overall seismic capacity of the structure in-plane seismic strengthening will be required. This could involve the strengthening using one of the following: 1) steel cross bracing members, 2) sprayed concrete, 3) carbon fibre reinforcement Of these three options we consider option 1) the most practical as it will not add seismic mass to the building like option 2). Also, option 1 will be likely achieve greater capacity than option 3) and will be more economical to install.
Foundations works	Due to the wall not being long enough there is not enough weight to resist uplift demands on bracing elements. To overcome this issue ground anchor foundations will be required. Ground beams will also be required to transfer the demands from the structure above to the ground anchor and to tie the building together at ground floor level.

These works are illustrated in the attached sketches (Attachment 1).

In addition to these seismic strengthening works, remedial works to decayed timber members will be required.

Constructability

Whichever of the seismic strengthening options are selected there will be significant construction challenges. These would include the following:

i. The need to remove of the existing timber ground floor structure in its entirety to allow for the installation of ground beams and anchors,
ii. The removal of a significant portion of the first floor to allow for;
    a. The boom of drill rigs that will install the ground anchor piles,
    b. Strengthening the first-floor diaphragm,
    c. Construction of in-plane seismic strengthening between ground and first floor,
    d. Improvement of connectivity between the URM walls and the first-floor diaphragm,
iii. Possible removal of parts of roof structure to allow for diaphragm strengthening at roof level and strengthening the connectivity between the strengthening diaphragm and new bracing structure below and new structure to strengthen the URM walls out-of-plane.
iv. Temporary propping of URM walls while construction occurs. For practical reasons this propping should occur on the exterior of the building. Locating temporary propping internally would be a significant obstacle to work around when constructing strengthening within the building footprint. The temporary propping that would provide out-of-plane restrain would require ground anchors or significant mass concrete pads to provide uplift resistance.
v. Possible underpinning of existing URM wall foundations while works occur to ensure stability. Further Geotech investigation would be required to confirm if this is a requirement.

Effectiveness of seismic strengthening

Due to the nature of URM building, despite being strengthened, the building will likely be damaged during a significant seismic event. The strengthening works would achieve ultimate limit state requirements to prevent collapse types failures. However, there will still likely be damage, both to the primary structure and cosmetic, that will require repair. This repair may be costly.

Cost implications and functionality

We are not Quantity Surveyors and cannot provide a precise cost estimate for these works. However, it appears the strengthening works will be greater that the cost to demolish and reconstruct an equivalent sized building. This is due to the significant amount of strengthening works required and the challenges of constructing these within the constraint of an existing building envelope.

Even after strengthening there will still be functionality limitations due to the constraints of the existing building and the location of the strengthening structure. i.e. the strengthened building would not be as functional as a new building of the same size.

Strengthening level, 34%NBC verses 70%NBS or greater

If this building was to be seismically strengthened, we recommend strengthening to at least 70%NBS for the following reasons;

i. This will allow for a possible change of use. Usually a change of use requires strengthening to as near as is reasonably practical to 100%NBS. However, achieving 100%NBS is not practical. We would hope WCC would accept a minimum of 70%NBS.
ii. This would future proof the building for possible future changes to the seismic hazard coefficient for Wellington.
iii. This would make the building more tenantable as 70%NBS is far more desirable to tenants who consider that 70%NBS is a minimum capacity at which they are satisfying their health and safety obligations.
iv. We understand banks will not lend money for buildings that achieve less than 70%NBS.
v. We understand that insurance premiums increase significantly for buildings that achieve less than 70%NBS.
vi. As this building is adjacent to a significant arterial road, we consider that strengthening to just above 34%NBS is not appropriate as this does not remove the risk that the structural could fail by falling onto the Adelaide Road.

Strengthening to 100%NBS

We do not consider 100%NBS to be feasible as this is a URM building. This is simply “a bridge too far” with too many parts of the structure requiring strengthening. It may be possible to achieve in the range of 80-100%NBS.

5 OTHER STRENGTHENING OPTIONS CONSIDERED

Reinforced sprayed concrete;

- This option would involve new sprayed concrete behind existing URM walls.
- The sprayed concrete would be similar deflection compatibility to the URM. That is, the URM would not be damaged by displacement before the concrete resisted the seismic demands.
- New foundations and strengthening of the floor and roof diaphragms would be required.
- Out-of-plane strengthening of URM walls with steel posts would not be required as the sprayed concrete would perform this function.
- This option is not considered appropriate as it would add considerably seismic mass to the structure, much more that strengthening with steel cross bracing.

Traditional Structural Steel K Frames;

- This option is very similar to the proposed option that would involve cross braced frames.
- Foundation, diaphragm and URM wall out of plane strengthening would be required.
- The K-frames would be more intrusive internally than steel cross braced frames.

Traditional Structural Portal Frames;

- Portal frames are a more flexible than the URM walls. The URM walls would need to fail before the building would displace enough for the concrete frames to resist the seismic demands.
- Due to this deflection incompatibility this option was not considered further.

Fibre Reinforced Plastic, (FRP) Enhancement;

- This tends to be a more "modern" solution to strengthening and tends to be less invasive than most of what can be considered to be the more traditional methods,
- The issues with this building is that the front elevations which are the most important aspects of the building to be strengthened, are very heavily profiled and the wrapping of the piers is therefore very difficult, if not impossible,
- To fulyl encapsulate the piers also requires the strengthening to fully enclose the piers which would have required the removal and reinstatement of all of the windows,
- This method of strengthening is not likely to be able to achieve greater than 70%NBS which is the appropriately level to strengthen to.

Enhancement of Existing Structure

- The existing structure cannot be enhanced to an appropriate level (greater than 70%NBS) without the introduction of significant new structure.

Base Isolation;

- We do not consider this option practical. New foundations would be required. The façade would need to be cut at just above ground level and then re-supported off isolators that are support off new foundations. A new structure would need to be built behind the façade that is also supported off isolators of new foundations.

Other Alternatives to strengthening

Demolish and rebuild with a new modern building of equivalent size;

- Removes the life safety risk posed by this URM building,
- Would likely be more cost effective than strengthening the existing,
- Would achieve better utilisation of this site by providing a more functional building.

Maintain the URM facade and construct a new building behind;

- Reduces, but does not eliminate, the life safety risk posed by this URM building,
- Would require significant temporary works to support the facades during construction,
- Would achieve better utilisation of this site by providing a more functional building that could both utilise the full footprint as well as extending up vertically to more than the current two stories.

6 SUMMARY

The existing URM building at 114 Adelaide Road is earthquake prone and will require considerable works to seismically strengthening to make the building no longer earthquake prone.

The most appropriate level to strengthen this building to is at least 70%NBS.

We have prepared concept schemes to strengthen this building that are indicated in Attachment 1.

There will be many challenges to safely constructing strengthening works.

There are other options that could be used to strengthening this building, but all methods of strengthening will have similar significant construction challenges.

The strengthening works will be costly to construct and, in our opinion, are likely to exceed the cost to demolish the existing URM building and reconstruct with an equivalent sized modern building.

Even if this building was strengthened, due to the nature of the URM structure, it would still be prone to damage in a moderate to significant seismic event.

Regardless of the strengthening scheme selected this building would have functionality limitations due to the current layout and shape.

An alternative to strengthening would be to demolish and replace with a modern building designed to current codes. This would completely remove the risk posed by the URM.

Another alternative that would minimise, but not remove, the risk posed would be to retain the façade but demolish the structure behind and replace with a new structure purpose design structure.

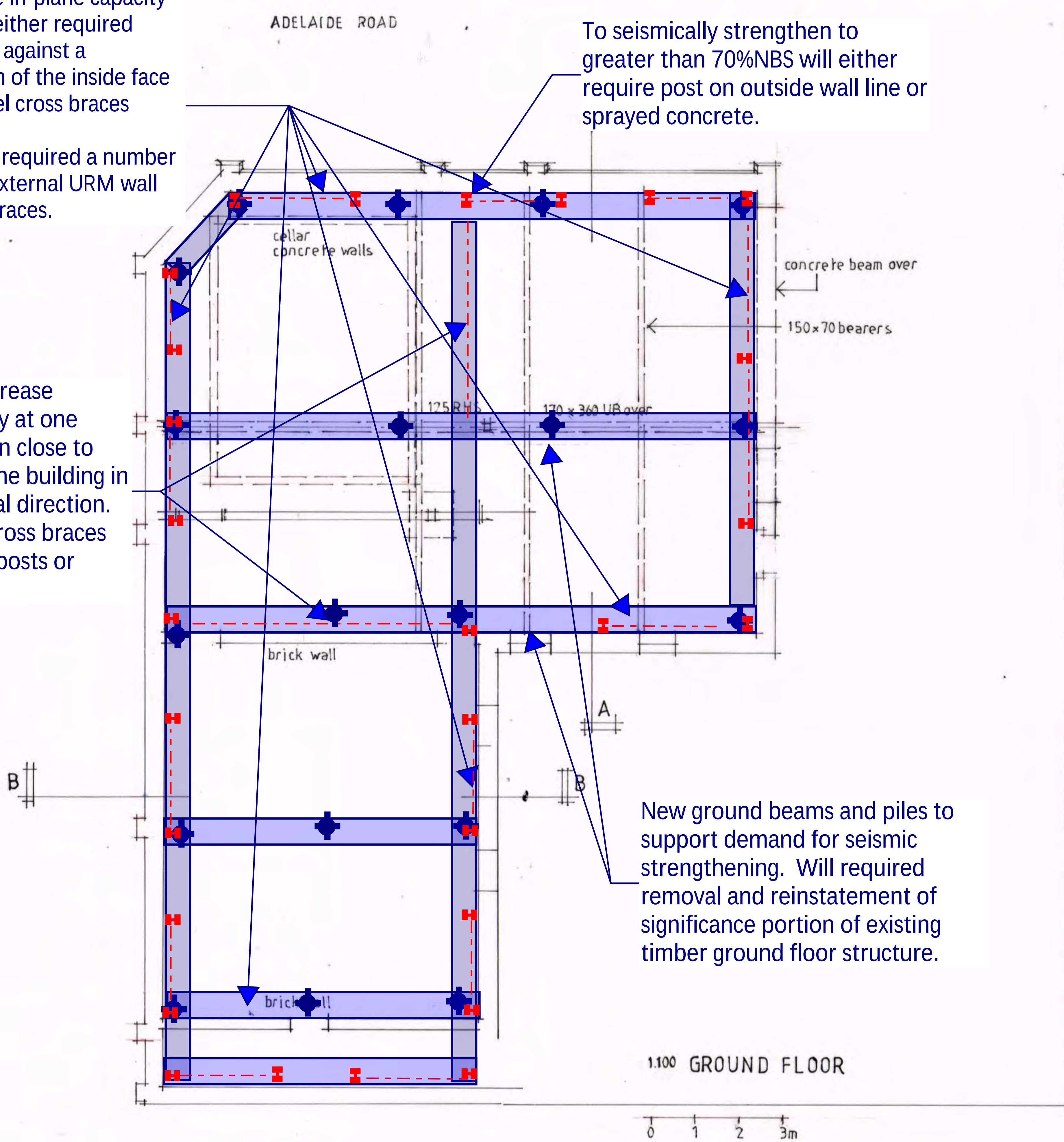
Attachment 1- Sketches indicating concept seismic strengthening work

To strengthen the in-plane capacity of URM wall will either required sprayed concrete against a significant portion of the inside face of the wall or steel cross braces between post.
If cross bracing is required a number of bays on each external URM wall line will require braces.

To seismically strengthen to greater than 70%NBS will either require post on outside wall line or sprayed concrete.

Will require increase bracing capacity at one internal location close to the middle of the building in each orthogonal direction. This could be cross braces between steel posts or concrete walls.

New ground beams and piles to support demand for seismic strengthening. Will required removal and reinstatement of significance portion of existing timber ground floor structure.



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PROJECT:	114 Adelaide Rd		
JOB #	21614	DRAWING #	2020-2-5-SK1
DRAWN BY:	IPRB	DATE:	5/2/2020
COMMENTS:	PLAN- Ground floor level- marked up to show concept seismic strengthening works.		

NOTES:

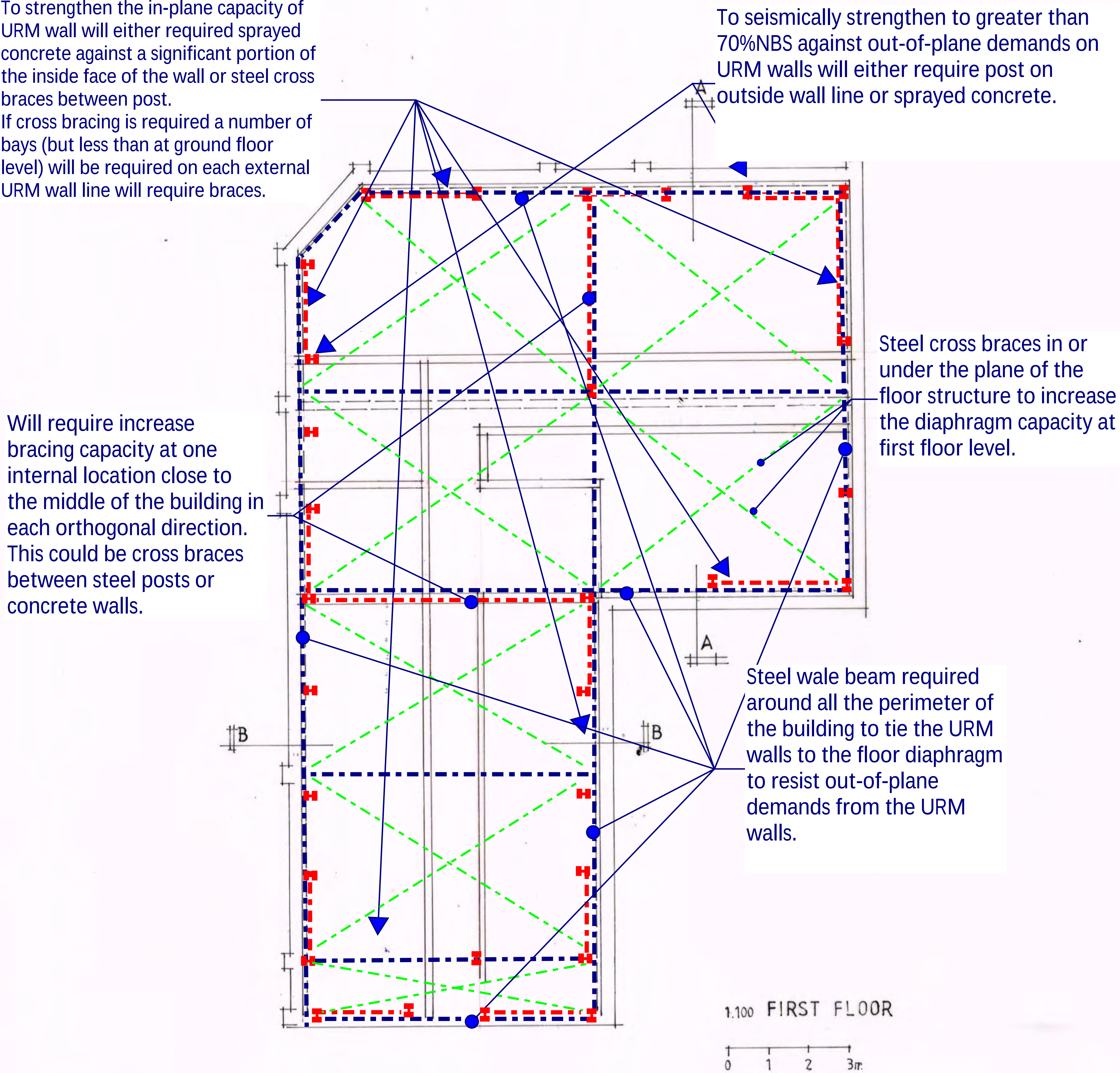
1/ The strengthening works indicated are conceptual and will require detailed design.

2/ A detailed geotechnical investigation and advice will be required. However, based on geotech advice to date the structure will need to be supported off piles that found at least 3m below ground level. To take out base shear the piles will likely need to be fixed head piles and moment connections into the ground beams.
To install these piles sections of the floor, and maybe even the roof, will likely need to be removed to allow for the pile boom.

3/ To allow for the ground beams and new piles a significant portion of the existing timber floor will need to be removed.

4/ The location of internal bracing elements (cross bracing or concrete walls) will to be coordination to minimise the effects on functionality.

5/ As a general comment from a structural perspective steel post with braces is preferable to concrete as concrete will significantly increase the building's seismic weight.



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PROJECT:	114 Adelaide Rd		
JOB #	21614	DRAWING #	2020-2-5-SK2
DRAWN BY:	IPRB	DATE:	5/2/2020
COMMENTS:	PLAN- First floor level- marked up to show concept seismic strengthening works.		

NOTES:

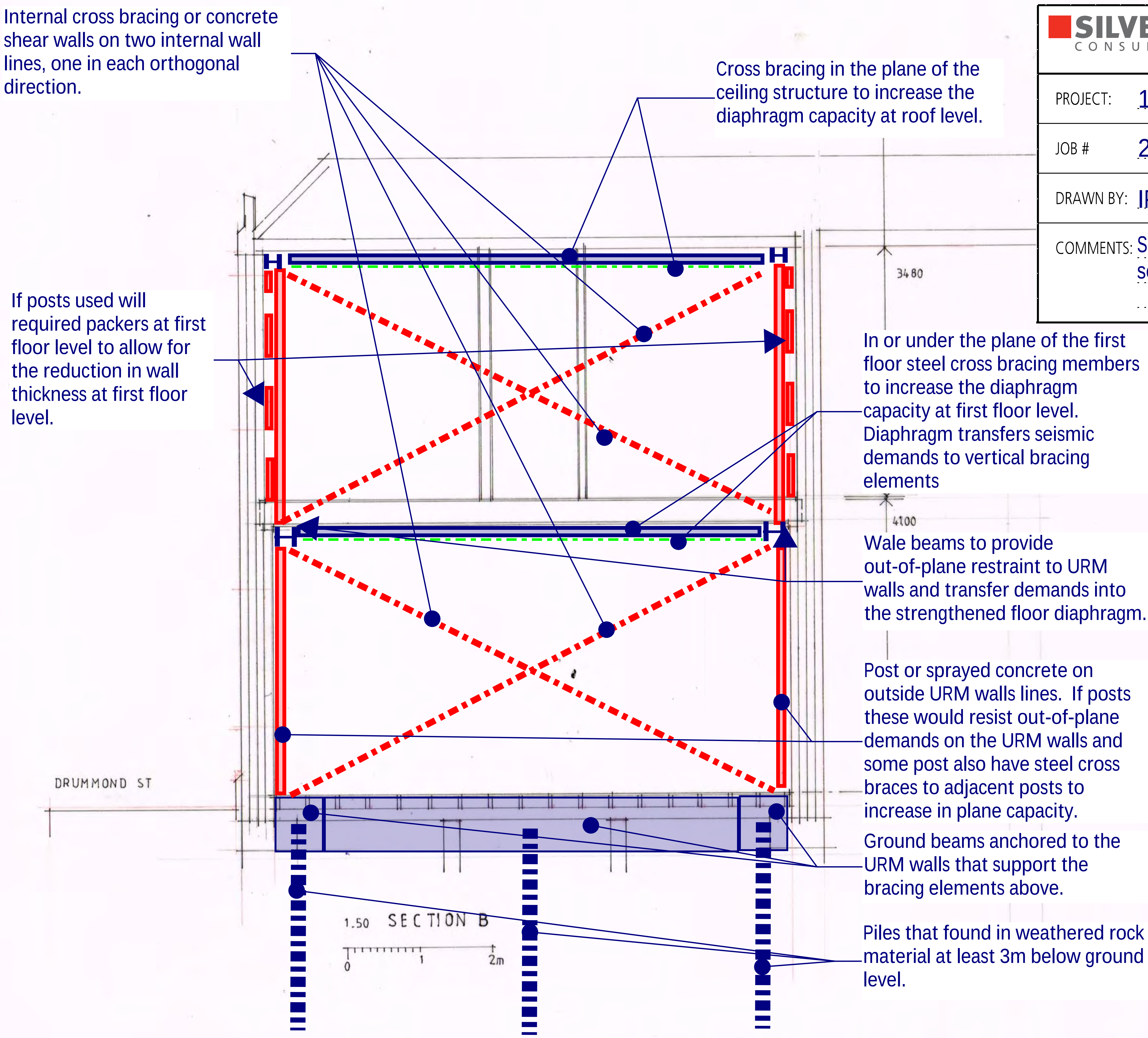
1/ The strengthening works indicated are conceptual and will require detailed design.

2/ To allow for diaphragm strengthening, wale beams and continuity of lateral load resisting structure between ground and first floor significant portions of the first floor will need to be removed and reconstructed.

3/ Similar diaphragm strengthening will be required at roof level. The previous 2018 facade securing works were only to >34%NBS and involved some but not significant strengthening of the diaphragm at roof level.

4/ The location of internal bracing elements (cross bracing or concrete walls) will to be coordination to minimise the effects on functionality.

5/ As a general comment from a structural perspective steel post with braces is preferable to concrete as concrete will significantly increase the building's seismic weight.



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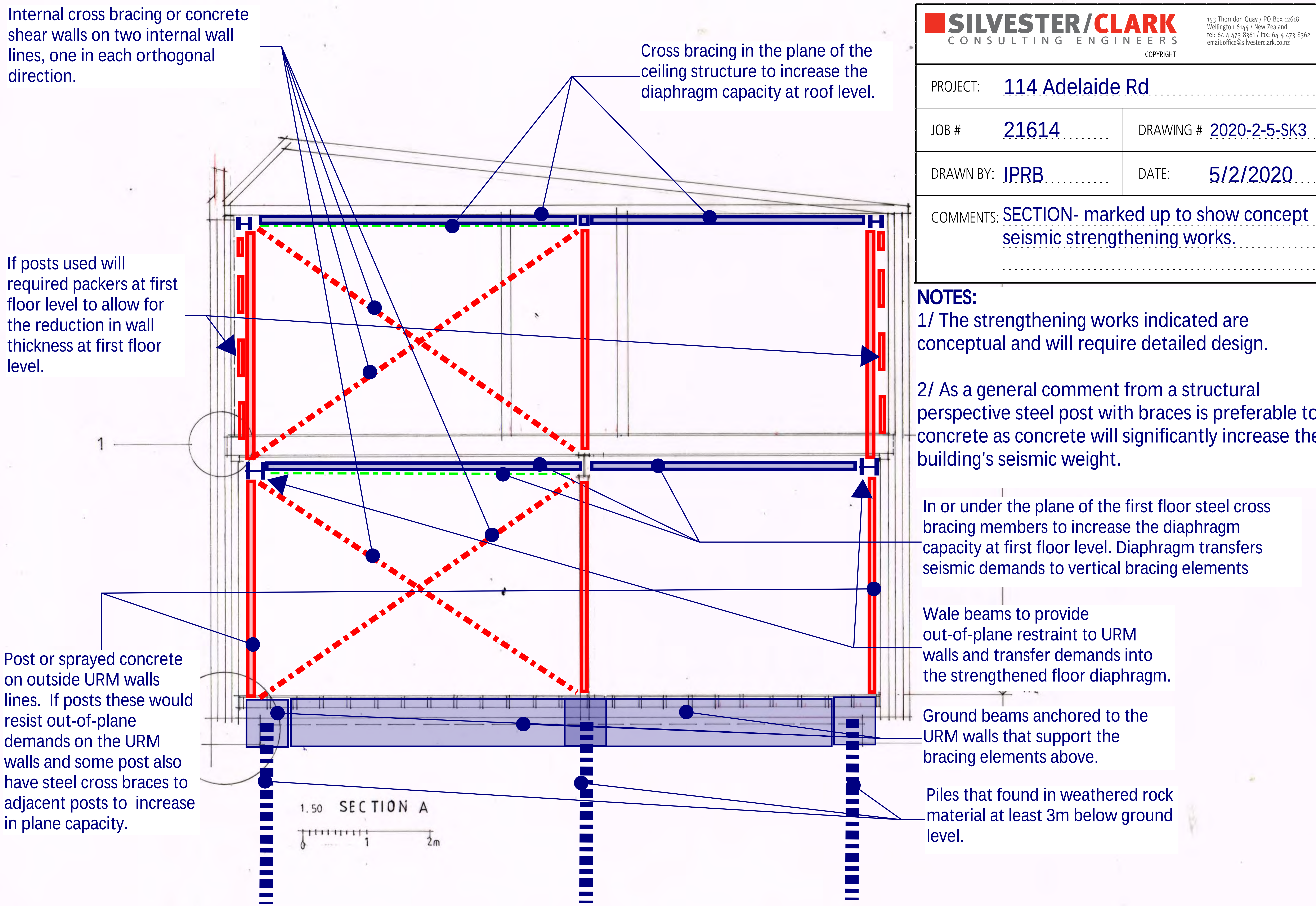
PROJECT:	114 Adelaide Rd		
JOB #	21614	DRAWING #	2020-2-5-SK3
DRAWN BY:	IPRB	DATE:	5/2/2020
COMMENTS:	SECTION- Marked up to show concept seismic strengthening works.		

NOTES:

1/ The strengthening works indicated are conceptual and will require detailed design.

2/ As a general comment from a structural perspective steel post with braces is preferable to concrete as concrete will significantly increase the building's seismic weight.



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PROJECT:	114 Adelaide Rd		
JOB #	21614	DRAWING #	2020-2-5-SK3
DRAWN BY:	IPRB	DATE:	5/2/2020
COMMENTS:	SECTION- marked up to show concept seismic strengthening works.		

NOTES:

1/ The strengthening works indicated are conceptual and will require detailed design.

2/ As a general comment from a structural perspective steel post with braces is preferable to concrete as concrete will significantly increase the building's seismic weight.