NEW ZEALAND SOCIETY FOR EARTHQUAKE ENGINEERING
2019 Pacific Conference on Earthquake Engineering
TURNING HAZARD AWARENESS INTO RISK MITIGATION
4 – 6 April | SkyCity, Auckland | New Zealand

Kennedy Building – Strengthening of a four-storey URM heritage façade in a prominent Wellington location

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ABSTRACT

This paper describes the strengthening of the four-storey unreinforced masonry (URM) Kennedy Building, with its heritage façade, from the perspective of both an architect and engineer. The Kennedy Building, located on 33-39 Cuba Street in Wellington, was constructed in 1905 and is listed as a Category 2 Historic Place for its Edwardian architecture. Following the Kaikoura Earthquake in 2016, MBIE set up an initiative to secure URM parapets and facades in high seismic risk areas. This was implemented in Wellington and required buildings that have street facing parapets and facades on busy, high-traffic areas (pedestrian or vehicles) that are vulnerable in an earthquake to be strengthened. Previous strengthening has been done to the building in 1992 and 2002. However, this was not sufficient for current standards. Investigations of the existing building included performing a drone survey to the front façade. Strengthening had to consider heritage values, access to site, disruption to occupants, and had to be completed in a tight time frame. The solution consisted of horizontal trusses at the first, second and third floor to tie the façade to the return walls of the building. The parapet was further enhanced by providing additional restraint that is tied back into the roof and truss at third floor. Strengthening improved the parapet and façade's rating to above 67%NBS and a false wall behind the parapet was introduced to encapsulate the strengthening and improve the weathertightness of the building.

1 INTRODUCTION

The Kennedy Building is located on 33-39 Cuba Street in Wellington and was constructed in 1905 (Fig 1.). The building is listed as a Category 2 Historic Place and is scheduled as a Heritage Building in the operative Wellington City District Plan in recognition of its aesthetic, historic and social value with a high level of authenticity. Cuba Street is a prominent pedestrian thoroughfare in Wellington that is lined with cafes and retail shops in buildings that forms a registered historic area with over 40 heritage buildings along the street.

The Kennedy Building is a four-storey unreinforced masonry (URM) building that is a good example of Edwardian Classical style architecture with little change since the building was constructed for the Kennedy family.

The building has been assessed as earthquake prone, and under the Hurunui/Kaikōura Earthquakes Recovery Order 2017 is required to have the façade and parapet secured to a minimum of 34% NBS within a strict deadline.

Figure 1: Site plan – Kennedy Building highlighted red

Figure 2: Exterior View of Kennedy Building

1.1 Architecture and Heritage Significance

Some of the following text is sourced from the Wellington Heritage website (http://wellingtoncityheritage.org.nz/buildings/1-150/71-kennedy-building).

Today, the building forms part of the Cuba Street Heritage Area and is one of four key prominent Edwardian buildings on the block between Manners Street and Wakefield Street in the Wellington CBD. Cuba Street is a prominent pedestrian thoroughfare in Wellington lined with cafes and retail shops. It is home to icons such as the bucket fountain and hosts the annual Cuba Street Carnival. This end of the street is known as Lower Cuba Street, and although cars have access to the street for parking, the area is highly pedestrianised and is frequently closed to traffic for markets and events. The building is enclosed on the north, east and south by adjacent buildings which are of similar height. The west façade faces Cuba Street (Fig. 2).

The building stands four stories with high stud (nearly equal to the six floors of the adjacent Civic Chambers) and is notable for its symmetrical and strongly modelled street façade, characterised by the very deeply set windows, all embellished with pilasters, architraves and keystones, the very prominent cornices at each floor level finished with large blocks above corbels. The carefully judged neo-Classical composition of the elements which diminish in scale at the top floor helps create a sense that the building is even taller than it is. Overall, this is a well-proportioned facade that contributes a satisfying play of void and solid to the local townscape.

The original plans show that the building was designed with two shops on the ground floor, and with a two-part division of the open floors on the three upper levels, suggesting a manufacturing and storage usage. The building is currently in commercial use with two retail units on the ground floor and businesses on the floors above.

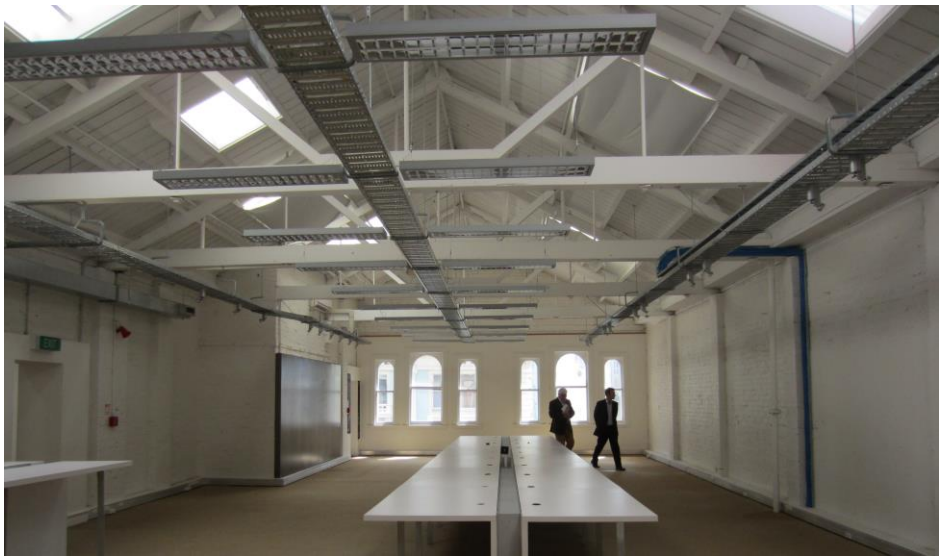


Figure 3: Interior of Level 3 looking towards the heritage façade, showing the exposed timber trusses

1.2 Structure

The Kennedy family commissioned Wellington architect James O'Dea, who designed many commercial buildings on and around Cuba Street. It was built by contractors, Campbell and Burke. The building is of URM construction and much of the original fabric remains to date. The building has a rectangular floor plate and has pop outs to the rear of the building that formerly housed the toilets and strong rooms (Fig. 4).

The lateral loads are resisted by the URM walls to the perimeter of the building and the central intertenancy wall. The brick thickness varies from 2 wythes (9") at the roof to 5 wythes (22.5") thick at the ground floor.

The roof is constructed from trusses overlain with sarking and these span between the exterior wall to the central wall (Fig. 3). The suspended floors are timber framed with herring bone strutting and span between the exterior wall to the central span. There is a mid-space steel beam that spans onto cast iron columns. This beam evenly divides the span of the suspended timber joists.

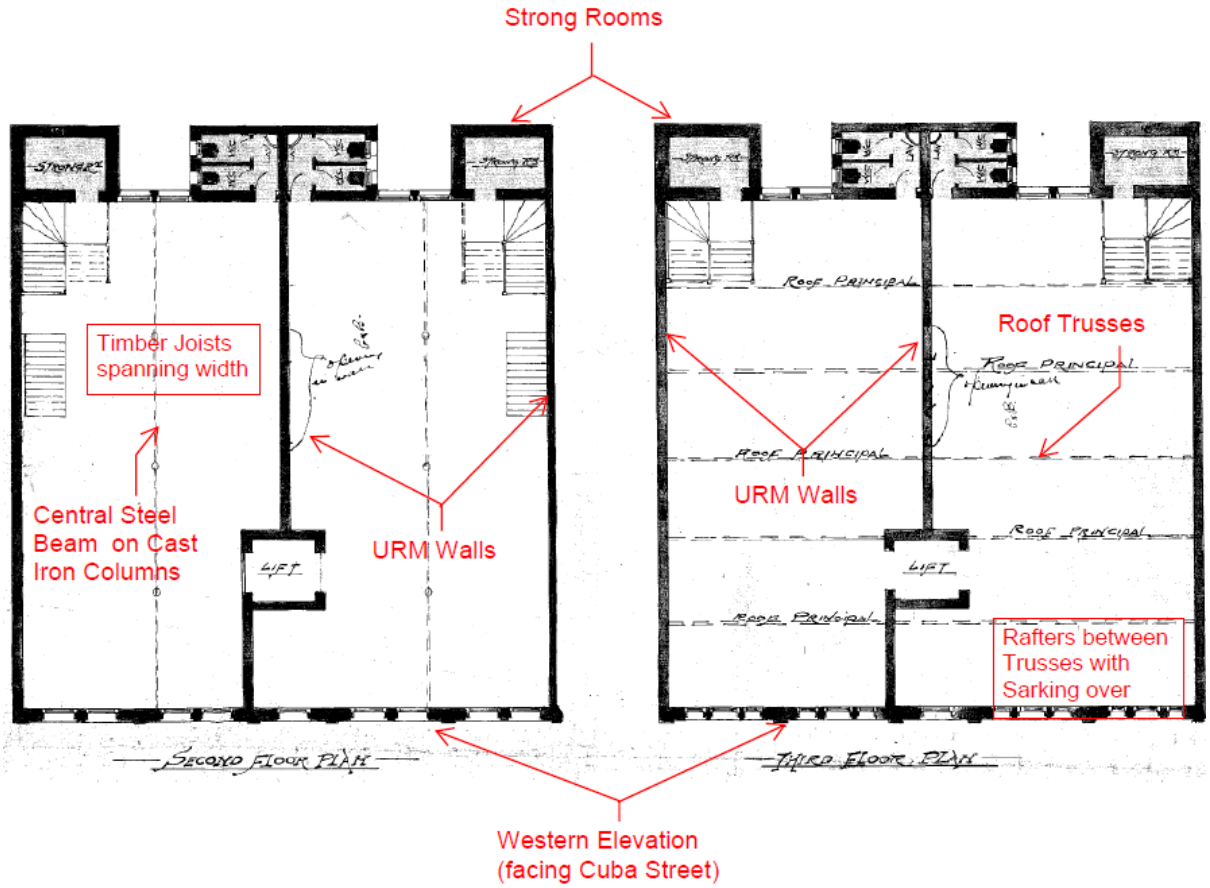


Figure 4: Typical Floor Plan

1.3 The Hurunui/Kaikōura Earthquakes Recovery Order 2017

The Hurunui/Kaikōura Earthquakes Recovery Order 2017 relates to buildings in Wellington City, Hutt City, Marlborough District and Hurunui District Council that have one or more URM parapets or façades that are <34% NBS. These URM elements are at a high risk of falling onto one of the public roads listed in the Order Schedule during a moderate earthquake event, therefore requires urgent URM securing works.

In 2017, the Kennedy Building was identified by Wellington City Council (WCC) as potentially falling within the parameters of the parapet and facade securing requirements. WSP Opus were commissioned to assess the façade and parapet in accordance with the requirements of the Order. It was found that, while in-plane and out of plane strength of the Cuba Street façade is relatively high, the diaphragm connection between the façade and the timber floors achieved a rating of 20-30% NBS, and the parapet above roof line achieved a rating of 25% NBS.

The façade and parapet securing works were required to be complete in a very tight deadline, with fines up to $200,000 and evacuation of the building and surrounding street being enforceable by WCC if the time limit wasn't met. The team were required to assist the building owner in engaging contractors, complete the detailed design, and construction to be finish within an 18-month (initially 12 month) time frame.

2 SEISMIC STRENGTHENING DESIGN

2.1 Strengthening Target and Methodology

The key objective was to strengthen the façade and parapet within the time limit and in such a way that the remainder of the building can be strengthened in the future. The design required consideration of particular construction details to de-risking the pressures of the programme. It was also important for the exterior of the building to remain unchanged, to preserve its heritage visual features.

The securing works are limited to the western (Cuba Street) façade and parapet of the building, and include:

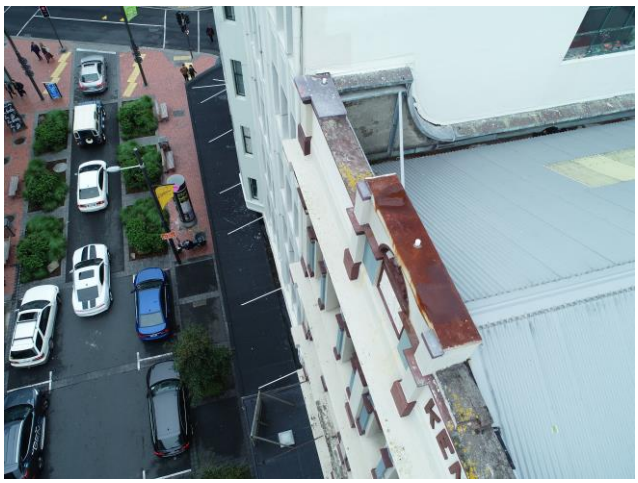
- strengthening the connection of the façade to the restraining diaphragm at levels 1, 2, and roof;
- improving the load path between the façade and return walls at levels 2, 3 and roof;
- improving behaviour of the parapet.

2.2 Architectural Commentary

Under the Hurunui/Kaikōura Earthquakes Recovery Order, the strengthening works are exempt from all consent requirements. The design however, still requires consideration of the heritage values, to the extent that is reasonably practicable in the circumstances, and the implementation of the strengthening should also not adversely affect the current use of the building when finished.

A site visit involving the building owner, contractors, and consultants, confirmed the need for intrusive investigations to finalise the detail of the design and confirm contractor methodology. This included access to the ceiling voids and to the roof area to inspect the parapet. For urgency and safety reasons, a drone survey of the façade, parapet and roof was undertaken. The information gained from the photos, videos and 3D model of the façade and parapet was used to establish the extent of the strengthening and the weather tightness remediation at the connection between the roof and parapet (Figs. 5 and 6). The data gathered during this exercise was invaluable during the detailed design phase as much of the concept was based off assumptions and dimensions taken from the original drawings.

Online viewing of the drone scan can be found here: https://skfb.ly/6ySIn



Figures 5 and 6: Images of the roof and parapet from the drone survey

The seismic strengthening was not to alter the exterior of the building due to its heritage and visual character. Pattress plates were initially considered, but the form of the roof behind the parapet was so irregular in comparison to the façade; the placement of the plates would have no relationship to the façade detailing.

2.3 Structural Commentary

2.3.1 Existing Strengthening

Previous strengthening schemes were completed to the original building in 1992 and 2002 to the relevant codes of the day.

- In 1992 the floor plates were tied into the exterior URM walls. Steel angles were introduced to connect the URM walls into the timber floors. Steel work was added to the parapet to provide some restraint. This was connected into the roof diaphragm and to the return walls at either end.
- In 2002 post tensioning strands were placed to the front façade of the building from the first floor to the roof. This clamping force improved the out of plane behaviour of the URM façade. Reinforced concrete columns were added to the ground floor to provide a lateral load path to the foundations, and arrays of dowels epoxy fixed through the brick from the inside to above and below the windows

2.3.2 Strengthening Scope

Two designs were provided to secure the front façade to the building structure. These were for design levels of >34% and >67%NBS. The two were developed to demonstrate to the building owner what the possible difference was between the two design levels and ensure the emergency securing works wouldn't nullify any additional strengthening required to the building.

To the third-floor level and parapet the same design levels of securing were utilised as there were seen to be areas of high risk both during construction and operation.

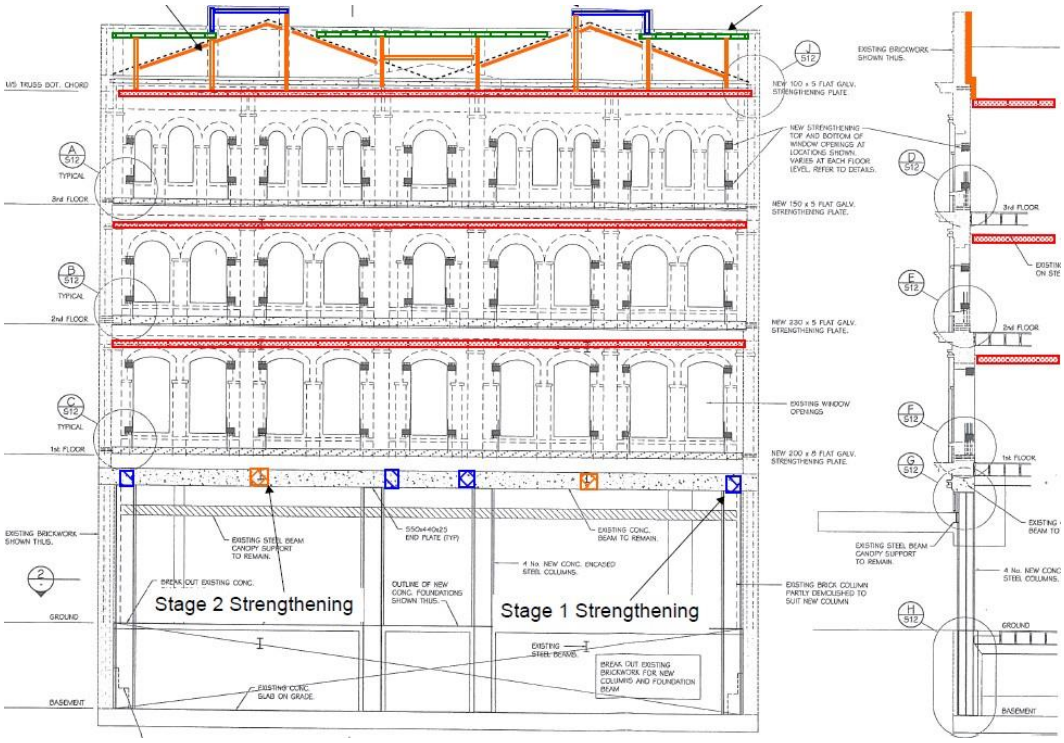


Figure 7: Outline of Strengthening of Facade

The main differences between the schemes are to the first and second levels of the building. The 34%NBS scheme consisted of a whaler beam that spans between mid-span beams and perpendicular URM walls. The 67%NBS scheme utilises the whaler beam and compliments it by adding additional members to create a horizontal truss that can span between walls in a similar manner to the third floor. The main advantages of the scheme are that there is no reliance on the existing timber floors to act as a diaphragm and there are lower deflections with the truss reducing movements in out of plane behaviour of the URM wall (Figs. 7 and 8).

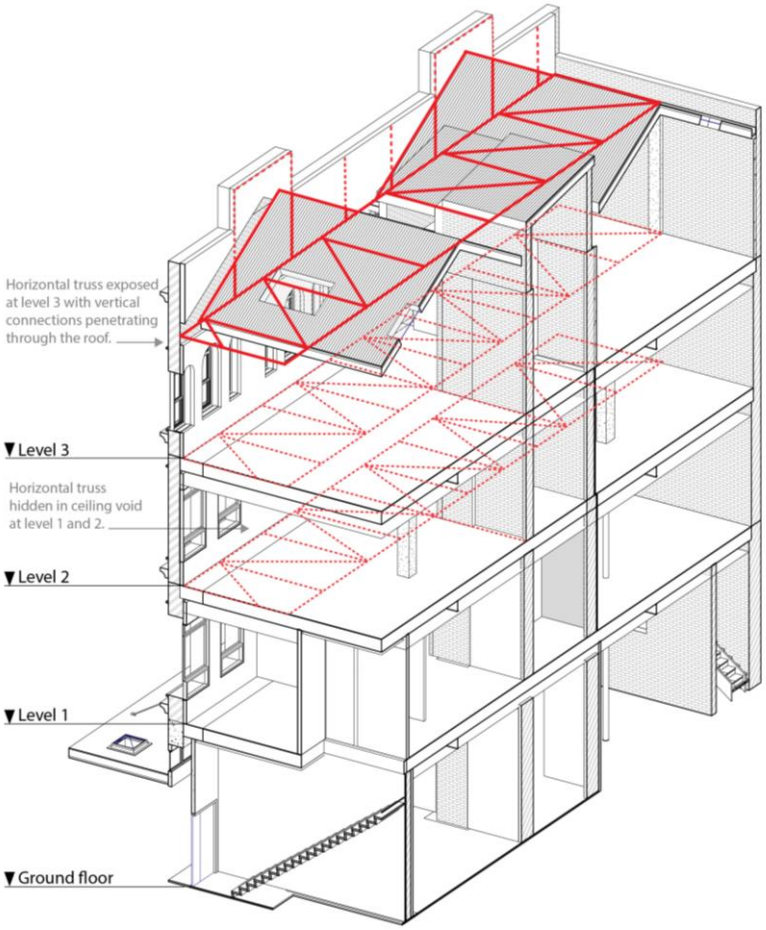


Figure 8: Outline of Truss to Levels 1, 2 and 3

With consideration of constructability during the design period, elements used had to be transportable and able to be lifted in place with use of minimal mechanical assistance. Elements also had to be lifted in place and manoeuvred into to place overhead. Welding was to be avoided due to proximity of truss to timber structure, hence connection were all to be bolted. A truss was an effective system as it allowed the steel structure to be broken up into elements that could be handled on site, and the members work efficiently to distribute the load.

2.4 Challenges

Although it was a reasonably conventional strengthening design, several construction challenges were enounced.

The tight timeframe meant the construction contract was established and set up based on a strengthening concept design. Due to this, a cost reimbursement contract was utilised, and as a result of the complexity of the steel work design, two contractors were engaged. The main contractor was responsible for the enabling works, temporary protection, and site health and safety. The second contractor was engaged as a separate contractor responsible for the measure, supply and installation of the steelwork.

Managing expectations of the tenants and the tailoring the methodology of the construction around their needs was required. Tenancies include a tattoo studio, and a photography and modelling studio, both requiring strict control of dust and minimal disruption during working hours.

The team was required to work within the council regulatory requirements which included fortnightly inspections, reporting on progress, and submitting all the necessary documentation prior to the deadline.

Strengthening an existing building also involves working around existing in ceiling services. The strengthening steel on levels 1 and 2 was designed to be within the ceiling void. The designed placement of the steel members clashed with existing sprinkler pipes which required draining and penetrating through the new steelwork before being recommissioned.

3 CONSTRUCTION OBSERVATIONS

The works to strengthen the parapet and connections between the façade and main structure of the building occurred at all levels. As this is carried out while the building remains in use, work to each level would be done sequentially, removing prolonged disruption to each of the tenants. During construction the building owner decided that the >67%NBS solution would be implemented as this proved to have a similar disruption to the building operation and would provide a more resilient solution.

The construction commenced at level 3 with a site measure for the steel work as this level has no ceiling. Enabling works progressed on the lower levels.

The Level 3 installation of the truss was straight forward as it was an open area which allowed contractors to work above and below the truss line. The outer frame and interior struts were installed first as these dimensions could easily be ascertained from site measure. A template was made for the diagonals to ensure that these elements could fit in place with the steel that has been installed in place. Due to the visual impact of the connections on this level, there was little room for error.

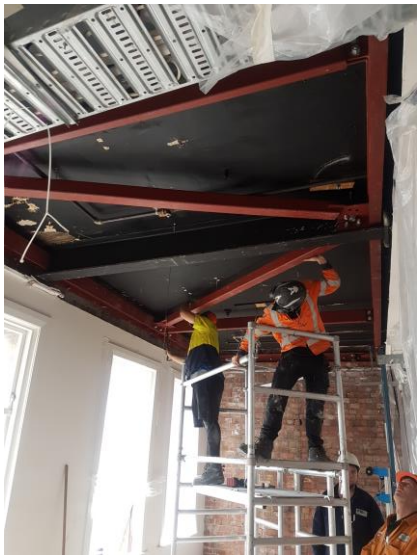
The visible strengthening on the third level is incorporated into the existing fabric. The materiality of the strengthening works is different to the original, but with consideration given to colour, texture, composition, dimensions and detailing, the strengthening elements are successfully blended with the existing structure (Figs. 9 and 10).

Figure 9 and 10: Steel Installation on Level 3

Once the ceilings were removed on Levels 1 and 2 the existing structure could be observed and generally it was as expected. Some services had to be temporarily moved to ensure that the steel could be installed in place. The steel truss elements had a sequence of installation and a series of site measurements done in a similar manner to level 3. The main whaler sections to the front of the building were the heaviest and longest elements. These had to be craned in through the windows of the heritage façade and mechanically lifted into place. The largest section was approximately 200kg and limiting the mass was a key consideration through the design process.

Due to a greater understanding from undertaking the truss on level 3, the level 1 and level 2 steel work were all predrilled and bolted together on the contractor's workshop floor to ensure it would all fit together as

designed before taking it apart and delivering it to site. This helped to de-risk the installation methodology on site, however, as with any existing structure the walls were not entirely straight meaning local adjustments were required on site (Fig. 11 and 12).



Figures 11 and 12: Steel Installation on Level 2

The final stage of works was the steel installation to the parapet. The main challenge was the installation of the vertical steel members that punched through the roof to connect to the strengthening at the parapet to level 3 (Fig. 13). There were difficulties in getting the alignment of the steel from Level 3 to the steel at the parapet, however this was within tolerance of the design.

All existing flashing and parapet capping are removed in preparation for the new construction, including the removal of existing diagonal sections of steel from previous strengthening efforts. New timber blocking was installed around the new steel sections, providing a substrate for new capping flashing to join the existing parapet with a false wall. This provides a weathertightness solution for the many roof penetrations caused by the new steel, and remediated an existing weathertightness issues between the roof and parapet. The detailing of the new parapet false wall capping flashing needed to carefully consider its connection with the heritage façade.

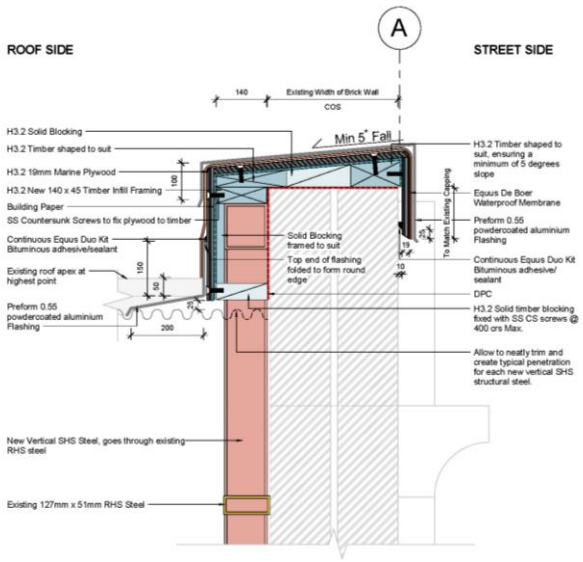


Figure 13: Parapet false wall installation

4 CONCLUSIONS

The Kennedy Building forms an important part of the built landscape of Cuba Street, and the Edwardian style façade contributes to the heritage nature of the area. It was important to preserve this heritage while improving life safety concerns.

There were several challenges that the project faced during the duration of the project, the biggest one being the tight timeframe imposed by the Hurunui/Kaikōura Earthquakes Recovery Order 2017.

The project was completed within a compressed design and construction time frame that was imposed. Use of a horizontal truss with bolted steel sections was utilised to allow for ease of construction and provided additional resilience to the façade. The work was limited to just the front areas of the building that allowed the building tenants to continue to operate. The design is elegant in the way that it respects the heritage aspects of the building, with visible strengthening on level 3 incorporated into the existing building fabric through careful use of composition, detailing and applied finish. Existing weathertightness issues between the roof and parapet are addressed with the addition of a false wall added behind the length of the parapet, encapsulating the new strengthening work.

The team utilised modern technology to obtain details of the existing building, collaborated effectively throughout the project, and was agile in its decision making which made for a very successful project.

5 ACKNOWLEDGEMENTS

The authors would like to acknowledge the client, Michael Pitt of Mibar Enterprises and the contractors, Trademark Construction and Perkinson Engineering

We also acknowledge the following WSP Opus staff who have contributed to the strengthening design: conservation architect Chessa Stevens (Wellington), and surveyor Caleb Baildon (Wellington)