[RE] CUBA

Renegotiating seismic resilience
in Cuba Street Wellington

Mark Southcombe & Andrew Charleson

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Preface

This book summarises the project work of two Fourth Year classes in the School of Architecture, Victoria University of Wellington; Cuba Street 2035 in 2012, and [Re]Cuba in 2013. Through their design studio projects, the students presented a vision that reinvigorated the architecture of Cuba Street. They respected the heritage values of the historic precinct overall, as well as those of the individual buildings they intervened in. Concurrent with their architectural designing, in a parallel Integrated Technologies course they suggested how to increase the seismic resilience of the Cuba Street buildings.

After increasing their knowledge of the history of Cuba Street, the students undertook a wide range of urban mapping, at macro and micro scales. Based upon this research they began architectural interventions to revitalise the Cuba Street precinct, envisaging how it might be redeveloped and intensified in approximately twenty years' time, 2035. We present a small selection of that work.

As part of their architectural designs the students had to incorporate and integrate seismic retrofitting schemes to meet the requirements of the Building Act. Initially they produced retrofit schemes for individual buildings in keeping with current professional practice, but then they were instructed to strengthen the clusters of buildings that were the foci of their architectural projects. Given how rare it is for clusters of buildings to be tied and retrofitted together, even though there are a number of potential benefits, this phase of the project constituted design-led-research. We hope our findings promote this retrofitting strategy where it is appropriate.

This has been an exciting and challenging project for all involved. We have enjoyed our interactions with our project partners from Wellington City Council and Heritage New Zealand, our architectural and structural engineering tutors, and finally the students. We are sure you will agree that they have produced some very exciting and insightful designs that meet the briefing requirements for a forward-looking and seismic resilient Cuba Street.

Mark Southcombe and Andrew Charleson

About the Authors

Mark Southcombe MArch, FNZIA is a Registered Architect and Senior Lecturer at the School of Architecture, Victoria University of Wellington where he is the Director of the Architecture Programme. He is also an award winning Architect, and principal of Southcombe Architects in Wellington.

Mark's academic focus is applied design-led-research. He was jointly responsible for the *Kiwi Prefab* exhibition and book in late 2012, and has *Jigsaw* and *Seasky house* solid timber construction, and '*Depth of Shadow*' ongoing research projects. He supervises a '*Housing Fieldwork*' masters research cluster that combines prefabricated and parametric research in medium density housing.

Andrew Charleson is an Associate Professor, School of Architecture, Victoria University of Wellington. He is a structural engineer by profession and enjoys the challenge of teaching Structures to architectural students without recourse to mathematics, especially as maths isn't one of his personal strengths!

Andrew has two main strands of research interest. The first, regarding how the structure of buildings can enrich their architecture, culminated in the book *Structure as Architecture: a Source Book for Architects and Structural Engineers*, published in 2005. A second updated and enlarged edition was published in 2014. The other research strand involves earthquake engineering. Andrew is the Director of the Earthquake Hazard Centre, a NGO that disseminates earthquake damage mitigation information to developing countries and also the Editor-in-Chief of the World Housing Encyclopedia, based in California. His book *Seismic Design for Architects: Outwitting the Quake* was published in 2008.

Contents

Acknowledgements

Firstly we recognise and thank the owners and occupiers of Cuba Street buildings who have accommodated us and our programmes, particularly those who have contributed to the student projects and discussions, public lectures, and presentations.

The projects arose from a partnership between the Wellington City Council, Heritage New Zealand (Formerly NZ Historic Places Trust), and Victoria University of Wellington Schools of Architecture and Design. There were two four-month duration projects running in the second Trimester of 2012 and 2013 of the MArch (prof) programme. Two parallel integrated technology papers ran over the same period of time. We would like to acknowledge the energy and inputs from our stakeholders, particularly Neville Brown and Ann Neill who led the collaboration and contributed strongly to the programme shape and development.

We would also like to acknowledge the teams who contributed to the programmes. From WCC, Neville Brown was supported by Vivian Rickard, Clare Gregory and Trevor Keppel and from Heritage New Zealand Ann was supported by David Watt, Alison Dangerfield, and Calum McLean. Wellington City Councillor Iona Pannett was also an energetic and committed supporter. We also acknowle Wellington City Council and Heritage New Zealand financial support. Both provided funding for additional Structural Engineering tutors. They provided specialist seismic retrofitting advice to the students. As well as providing building plans for all buildings from their Archives, WCC also contributed to the cost of the base for the Cuba Street model and the research assistance to collate and present much of the material in this book.

Internally at VUW we had a series of Practice Partners who worked with students on the projects and contributed so much to the student project critique and development. The practices were Kerstin Thompson of KTA Architects and Chris Kelly of Architecture Workshop, Marc Woodbury and team from Studio of Pacific Architecture, Arindam Sen of Foundation Architecture, John Mills Architects, Warren Young of Jasmax Architects, Gerald Parsonson Architect, Andrew Sexton Architecture, and Alistair Luke Architect. Victoria Willocks, Charlotte Minty, Rebecca Mclaughlan, John Storey, Guy Marriage, Karn Henning Hansen, Philippa Christie and Shenuka De Silva contributed as Tutors to the design courses.

The Structural Engineers who tutored in the ARCI421 Integrated Technologies course were Sam Kilkenny-Brown, Peter Lam, Matt Lander, Alistair Cattanach, Ryan Clark, Joe White, Win Clark, Philip Yong, Ray Patton, and Andrew Jackson, assisted by Nabil Allaf.

Additional tutors in the integrated technolgy courses were Geoff Fletcher, Angela Foster, Phil Mark, Simon Twose & Travis Gray.

Our particular thanks to the student group whose work in two courses ARCI412 Architecture Design and ARCI421 Integrated Technology is documented and reflected on here. Their projects are the largest and most extended projects within their years of study, and they took significant effort over an extended period of time to realise. Students of the two courses in 2012 and 2013 are credited where their work is utilised as a case study in this document. The project was a collective project that we recognise all students contributed to, especially with their design and modelling work that combined for the collective exhibitions, so thanks to all students of the two courses over the two years.

Thanks to the technicans and support staff who assisted with the model making and documentation in particular the workshop technicians David Carlton, Phil Nelson, Graeme Crawley, and Garry Sammons, Arthur Mahon at the Resource Centre, and Photographer Paul Hillier.

Our final thanks to our research assistants Kristen Cowley and Jayne Kersten who assisted to design, edit and produce this publication over summer.

Mark Southcombe and Andrew Charleson July 2014.

Foreword

Wellingtonians and visitors love the character of historic buildings and areas we have in the capital. They contribute to our sense of place and distinctive heritage which attracts certain businesses and tourists. The Council wants to see as many heritage listed buildings as possible retained for the benefit of future generations.

This Council has been delighted to support the work of the graduates of Victoria University, in conjunction with Heritage NZ and specialist advisors, in developing these sample solutions for the retention of Cuba Street buildings. This demonstrates what is possible with modern thinking and new technologies that are now available to building owners.

I have pleasuring in commending this work to heritage buildings owners as examples of what is now possible.

Celia Wade Brown
Mayor

Engaging closely with Wellington is a key priority for Victoria University, New Zealand's globally ranked capital city university.

Our location provides students with unparalleled opportunities to contribute to real world projects such as the one documented in this book. The vision presented within these pages, for reinvigorating the architecture of one of Wellington's iconic and best-loved precincts, is a fine example both of how our students interact with the city and the quality and relevance of design-led research at Victoria.

Victoria is an integral part of Wellington and vice versa. Our students and staff contribute to, and flourish in, the vibrant, culturally diverse and sophisticated city life. We value our collaborations with others, something exemplified by this innovative project, which brought our architecture students together with Wellington City Council and Heritage New Zealand.

We also take seriously our responsibility, as a civic-minded capital city university, to share and apply our research to lead thinking on major societal and environmental issues.

This publication presents a stimulating vision for the future of Cuba Street and Victoria University is proud to be part of shaping the area's architectural future.

Professor Grant Guilford,
VUW Vice-Chancellor.

Heritage New Zealand has been delighted to be part of the [Re]Cuba collaboration with VUW Architecture School, Wellington City Council, Cuba Street building owners and tenants. Cuba Street's regeneration needs to be built on such solid foundations as this partnership. Addressing public safety concerns by offering innovative engineering solutions and financial incentives to property owners will help retain the street's remarkable Edwardian architecture for future generations. Through working together to retrofit these buildings, owners can realise the economic potential of their investment.

History shows that Cuba Street is a survivor, remaining remarkably intact through its share of earthquakes and the redevelopment rush of the 1970s and 80s. Adaptive reuse over time can ensure these buildings continue to contribute to places where we love to live, work and play. This natural progression is what makes Cuba Street. It is what locals and visitors flock to each day to experience – spending time enjoying what is distinctly, unmistakably Wellington.

Cuba Street has been recognised as a heritage area for almost 30 years and listed for the past 13. There's one Category 1 building - the former Bank of New Zealand and now Logan Brown and 46 Category 2 listings. The number of individual registrations attests to how important individual buildings in this street are in heritage terms as well as the overall character.
Heritage New Zealand thanks all of those at VUW Architecture School for their innovative and forward thinking in this fascinating project.

Bruce Chapman, CEO, Heritage New Zealand.

Introduction

Cuba Street is awesome in an almost boring way. It's got exactly what you expect from an 'urban' street: grime, crime, and 400 op shops. But as it nears its 175th birthday, with an earthquake every other week, Cuba's future is less than certain. Understanding why requires both a look forward and a look back. [1]

Lower Cuba Street buildings June 2012.
Photograph Mark Southcombe

Architects don't just design new buildings. Buildings are expensive and have a long life. A major part of almost all architectural practices includes upgrading, altering and extending existing buildings.

Architecture never really defeats the anonymous elements; buildings gradually age, decay, deteriorate and, more dramatically, succumb to sudden economic and political forces.[2]

Buildings may also succumb to sudden natural events such as earthquakes, and it was the September 2010 and February 2011 Christchurch earthquakes that prompted this study. In 2011 we had focused our major fourth year design studio on Christchurch and a series of emerging questions that resulted from the earthquakes. When we returned from Christchurch we were unsettled when walking down Cuba Street. Despite Wellington's expectation of a large earthquake in the future, and more rigorous structural codes, the ages, construction and poor condition of many Cuba Street buildings suggested that if a similar earthquake should hit Wellington, the Cuba Street precinct would be likely to be affected in a similar manner to the High Street area of Christchurch. Buildings, canopies, and fronts of buildings would topple into the street. People would be injured and there would likely be loss of lives and infrastructure as occurred in Christchurch. A great deal of Christchurch heritage architecture has now been lost, and the same would occur here. Clearly, the architecture of Cuba Street needs an urgent structural transplant if it is to have a future, and with this will come an upgrading of amenity, scale and architectural qualities.

The VUW Schools of Architecture and Design are located in Vivian Street and are part of the Cuba Street context. So it was also a fantastic opportunity for VUW students to apply their skills to an immediate and familiar environment, complete with valued inputs, influences and support from Wellington City Council, Heritage New Zealand and Cuba Street owners. We saw the value in focusing VUW student architectural research on an urgent architectural problem that we face collectively as a community. Not only does this approach help advance solutions to the problems, it also engages the students in real world contexts where their applied architectural knowledge can be seen as relevant and of enormous value, particularly when the results are combined with those of their peers.

The problem we faced was twofold. There was widespread ignorance and apathy about the nature and extent of the problem and the need to resolve it by upgrading most of the existing buildings. Seismic retrofitting of existing building fabric is a sensitive issue. There is a level of antipathy towards local government-enforced strengthening, and architectural heritage among Cuba Street building owners. Wellington City Council (WCC) has statutory responsibilities regarding the identification of earthquake-prone buildings. Owners who have had preliminary structural assessments of their buildings done by Council perceived that they are being required to spend money they didn't have to seismically retrofit their buildings.

The precinct is also designated the Cuba Street Character Area and has a collective formal heritage status with Heritage New Zealand (formerly NZ Historic Places Trust). Many owners had little understanding of the implications of this heritage status and the role of Heritage NZ. They perceived that they had limited opportunity to change or adapt their existing buildings because of their heritage status. A key project objective was to draw building owners, and wider public attention, to the need to seismically retrofit, the range of ways this might occur, and to the amazing potential of adaptive reuse of heritage building fabric.

The [Re]Cuba project was a rare opportunity to focus attention on the poor performance of existing inner city building stock, and particularly, the silent collective danger of earthquake-prone buildings. It also offered a timely chance to critique the too often half-hearted, half informed approach taken to a great many New Zealand seismic retrofitting projects. It further offered a chance to highlight the breadth of the problem, and its architectural consequences and potentials. Detailed predesign information gathering and analysis, and significant consequential architectural work is required for seismic retrofitting projects. There are also a huge range of design tactics that can be deployed to address the integration of architecture and seismic retrofitting as will be evident in the many selected case studies illustrated on the following pages.

Mid Cuba Street buildings June 2012.
Photograph Mark Southcombe

References
1. *http://salient.org.nz/features/cuba-street-past-present-and-future.*
2. Michael J Ostwald, in Mark Taylor, Julianna Prteston, and Andrew Charleson *Moments of Resistance*, Archadia

On Cuba Street history

Alison Dangerfield

The following Cuba Street history incorporates extracts from author Pat Lawlor's two annotated versions of his childhood diary, "Old Wellington Days" and "More Wellington Days" (Whitcombe and Tombs, Wellington, 1959)

Cuba Mall entrance, Wellington. Winder, Duncan, 1919-1970 :Architectural photographs. Ref: DW-4160-F. Alexander Turnbull Library, Wellington, New Zealand. http://natlib.govt.nz/records/23118555

One August day in 1901, a small boy wrote in his diary: *'Caught a cold. Stayed home from school and looked out the window.'*

That particular window was at 141 Cuba Street, where he lived. Fifty years later he described the view from the window as a panorama of '*people on the pavements, and on the street cabs, gigs, horses, and one or two of those new fangled things called bicycles*. …Stronger notes of colour were to be found in the occasional street musicians including an organ grinder with a monkey, butcher boys on horses, "*rabbit oh's", "milk oh's", honey-men with cans on their shoulders and chinamen with vegetables slung from a wooden yoke.*" The organ grinder came along once a week and played tunes from Italian opera. The monkey was '*dressed in crimson trousers, with a little cap on his head*', and was attached to the organ with a chain, '*for he was a warlike little fellow*' and a danger to the knot of children who gathered round to watch.

The small boy grew up to become a noted journalist and author, as well as something of an expert on Wellington. He is no more but the house at 141, later renumbered as 214, remains: a modest two-storeyed building on the west side of the street. Across the road were the stables of Hepburn the cabby. '*Hepburn was always coming and going and had a grand wave of his whip for his two carefully groomed horses.*' Nearby was the pork butcher, *'a tall, lean, sad looking man with a penetrating nasal voice*'. Next door was Brian the chemist, '*with two or three mammoth coloured bottles in his window*', and further down the street, behind high walls, was the Salvation Army Home. '*Now and then, but mostly on Sundays, they sang sacred hymns set to popular melodies*. They had one very devotional tune based on "*I'll be Your Sweetheart*".'

Cuba Street has always been about commerce and entertainment, all mixed up together with daily life and spilling onto the street. From the turn of the twentieth century, most of the commercial buildings had shops on the ground floor and residential accommodation above. People still live in the late Victorian and Edwardian tenements, giving the street its lively urban character. The Salvation Army, too, has stayed in the same part of Cuba Street for over a century, though the Salvation Army Home was torn down and a large, impressive three-storeyed edifice built to replace it in 1908. Designed in the Edwardian Free Classical style, complete with pilasters, a honeycomb pattern frieze, arched windows, and a balustraded parapet, the People's Palace was a private hotel, operated by the Salvation Army. Eight years later, the Army commissioned the architect W. Grey Young to design an addition, and also took over the elegant doctor's building next door at 203-205, built in a similar style.

Commercial building in Cuba Street continued apace. Many of the buildings in the street date from 1900-1940, after which the street lost its cachet, and development largely passed it by. The result is a coherent streetscape of three storeyed buildings, recalling the confident years of the twentieth century when drapers and milliners commissioned substantial buildings. The nature of the businesses has changed over the years: these days there are more cafes than grocers, the drapers have been replaced by shops selling clothes, a tattooist lurks amongst the shoe shops, and there are no butchers in sight. But Cuba Street still serves the locals as well as the visitors. In the century since seven-year-old Pat looked out his window and reported on what he saw, the last Chinese fruiterer has left the street and the lugubrious pork butcher is no more, but the Italian organ grinder and his monkey would not look out of place today, and Hepburn the cabbie would do a roaring trade.

Although narrow, there has always been plenty of traffic on Cuba Street. For the first few decades the wheeled traffic was horse-drawn. There was room for the 'electric trams' to run on double tracks down the middle of the street on their way to the northern suburbs. For 60 years they carried passengers into the city and back. Cars didn't make their appearance until after 1900: 'May 21. Saw a motor-car on Cuba Street. Lots of jerks and noise and smell…' wrote young Pat Lawlor in 1903. The car was one of the first in Wellington, and attracted a good deal of attention. 'When it "slowed down" from 10 to 5 m.p.h as it turned from Vivian Street into Cuba Street all the boys of the neighbourhood were able to keep pace with it.'

It is in the pedestrian section that Cuba Street turns theatrical. A casual afternoon stroll in Cuba Mall on a summer afternoon these days is enlivened by street performers. You might see a pretty girl dancing with gauzy scarves in the sunshine to the accompaniment of a piano accordion, with a chamber group further up the mall, and jazz spilling out of the Hotel Bristol. Hipsters hang out here; children play; shoppers dawdle, teenagers gossip, and friends meet. Cuba Mall was the first pedestrian mall in the country. It was built in 1966, not long after the last tram trundled down to Manners Street, amidst considerable controversy. Today the controversy is long forgotten, and the paving, flowerbeds, and famous bucket fountain remain.

The busy intersection with Manners Street was also revamped in the 1960s. The traffic lights featured a novel pedestrian phase known as the 'Barn Dance' that allowed pedestrians to cross in all directions, including diagonally. Before, the intersection had been controlled at busy times by a helmeted policeman on points duty, standing in the middle and directing traffic with a twirl of white gloves.

For decades, shoppers were drawn to the corner of Cuba and Manners streets by James Smith's department store. The business was founded in Victorian times by one of the prominent citizens of the city, and the present brick and concrete building dates from 1907. It is one of the notable buildings of Cuba Street. The original façade was designed by architects Penty and Blake in the Edwardian Palazzo style. In 1932 the exterior was brought up to date in Art Deco style, and it has been given Category 2 status as befits one of the grand old ladies of the area.

Across the road, on the north-west corner of Manners and Cuba, is the grandest old lady of them all: the Bank of New Zealand building. It is a Category 1 heritage building, designed by William Turnbull and built in Edwardian Baroque style in 1912-13. The impressive three-storey concrete façade features Corinthian columns, with the entrance flanked by Doric columns

Lower Cuba Mall. Photograph by Alison Dangerfield.

Lower Cuba Mall and the bucket fountain. Photograph by Alison Dangerfield

The Working Mens Club building, Architect Thomas Turnbull for Robert Hannah. Photograph by Alison Dangerfield

Cuba Mall towards Barber's building, designed by Willian Clayton. Photograph by Alison Dangerfield

Upper Cuba Street near Tonks Grove. Photograph by Alison Dangerfield

and ornate projecting cornices. Lions' heads, festoons, a meander frieze, and other ornaments combine to create maximum grandeur. The building itself is an early example of a steel-framed concrete and brick structure, and has been placed on the tricky corner site so as to create maximum impact, with the entrance at the apex of the corner. Although the architectural style signals 'money', 'stability', and 'probity', the building itself has been subjected to undignified usage in recent years.
The other Category 1 building in Cuba Street, now known as the Logan Brown Restaurant, could have gone the same way, if it had not been for a pair of visionary restauranteurs who saw the potential in the old National Bank on the corner of Cuba and Vivian Street. The area was looking very tired in the late 1990s, and converting the Category 1 bank building into a fine dining restaurant seemed bullish. But the building's bones were sound, and the banking chamber was beautifully detailed, its formality appropriate to its new use. Fifteen years later, the restaurant is a Wellington institution and the building still looks great. Designed by Claude Plimmer Jones in Greek Temple style and built in 1917, it is made of concrete faced with rusticated Malmesbury stone. The marbled front entrance features Sandy Bay marble, with sandstone for the upper floors. The first floor windows have keystones and small triangular pediments flanked by Ionic columns. The eye is drawn upwards by the coupled Corinthian columns that extend the full height of the building, complete with entablature and a balustraded parapet.

Across the road, at 199 Cuba Street, is the Category 2 Morgan's Building, a typical Edwardian Stripped Classical building dating from 1922. Built for F. J. Morgan's china and fancy goods store, with reinforced concrete columns and beams and exposed and rendered brick, it is currently serving as a restaurant. Inside, the present owners have stripped the ceiling back to reveal the original pressed metal. There was originally a billiard hall upstairs. Other Category 2 commercial buildings nearby had varied original uses. Across Vivian Street, at 191-5, is an art deco building originally built for a draper, Douglas Smith Patrick, in 1931. Number 181 was built as a cinema in 1915, and was given an art deco facelift twenty years later. Number 147 was the photographic studio of William Berry, who commissioned architect W. Crichton in 1900. Like its neighbour at 141-143, it is in Commercial Italianate style. The Edwardian Classical Hotel Bristol at first had offices above and shops on the ground floor.

The Edwardian character of Cuba Street is especially strong at the Webb Street end, where many of the buildings retain their original use: a shop below, with living space above. A number of them have glazed tiles on the shop front. Around Tonks Avenue there is a strong connection with the Tonks family, an important settler family.

Mid Cuba Street and Fidels Cafe. Photograph by Alison Dangerfield

William Tonks was responsible for the first major harbour reclamation, seawards of Lambton Quay between Panama and Waring Taylor Streets.

At the beginning of the twentieth century, not all the original town acres were built on. Pat Lawlor recalls taking the leftover shin of beef from Saturday's soup to feed a neighbour's chickens.

'*Mrs Edwards had a fowl run just a few doors behind where we lived in Cuba Street and also grew apple trees.* Nearby also was a huge Chinese market garden which, with Mrs Edwards' section, ran from Abel Smith Street to Ingestre [now Vivian] Street.' The orchard and market garden have gone, but the impulse to grow food lingers on in the nearby community gardens. And that is the essence of Cuba Street: continuity and change, adapting itself to the lives of its citizens.

The best way to appreciate Cuba Street is to take a walk on a sunny afternoon, book in hand, and watch the parade of styles on the buildings opposite, the play of decoration and structure, and enjoy the passing show of walkers and talkers, buyers and sellers. Welcome to Wellington's most interesting street.

Swan Building at the upper end of Cuba Street, corner Cuba Street and Aurthur Street


Highlighting the original canopy decoration on the upper end of the Cuba Street area.

Entrance to the iconic Tonks Grove, upper Cuba Street area

Renegotiating the Architecture of Seismic Retrofitting

Contexts for the Cuba Street 2035 and [Re]Cuba student projects 2012 and 2013

Contrary to popular perception, architecture is constantly being remade. Processes of upgrading are reflected in the range of common terms that are used to describe building change over time. Maintenance, restoration, refurbishment, refitting, remodelling, alteration, extension, strengthening and conservation are all commonly understood building upgrading processes in New Zealand. Each has a particular approach to building revision over time. Traces of the regular remaking of buildings come to light in the close study of an existing building. Generations of work characteristic of particular eras are layered as palimpsests over each other. Facades and interiors are often reconfigured several times in a building's life to reinvigorate the building and respond to its changing cultural and economic contexts, and changed uses. Incremental additions also occur to a building over time. The original design and material qualities of the best buildings are retained as they are maintained and upgraded. Lesser buildings and buildings with a poor fit to their use are more often adapted over time, and literally 'remade' to greater or lesser extents.

Seismic retrofitting is very much an architectural issue, despite a general public perception it is solely a structural matter. To strengthen a building is a major event in the life of a building. While minor superficial remodelling may occur at regular intervals over time, upgrading structure has significant consequences for an existing building fabric. New foundations for new structural elements will require floors to be removed, excavations to occur and new works to be built within the existing building. The same process occurs as walls are strengthened. Wall linings are removed back to the core structural elements of the building. Ceilings and upper floors will also be disrupted by new structure which will need to be integrated with the existing in some manner. Connections between roofs and walls all will require attention. *The extent of disruption and scale of the work requires care to minimise impact and maximise the value of the new work.* Much of this is making good and remodelling to accommodate the seismic retrofitting, and concurrent upgrading of the building to contemporary codes triggered by a structural upgrade. Fire ratings and escape provisions, and accessibility performance need to be addressed as a minimum requirement. There are significant opportunities that arise from the extent of the new work occurring. It is the ideal time to upgrade interiors and function, and often to extend a building to improve its financial performance in terms of the income it generates. There are a number of different ways that seismic upgrading can occur in relation to the underlying architecture. These are set out below as a framework for the presentation of student work that follows and the discussion at the conclusion to this book.

Renegotiating the architecture of seismic retrofitting

How should architects, engineers and clients approach seismic retrofitting of heritage building fabric? How are existing and new building structure and fabric related? Close study reveals that there are different degrees of integration between new structure and existing building work possible; several different types of relationship that can be developed between new and old. Michael J. Ostwald, in the essay *Binding issues and critical strengthening,*[3] theorises three historical approaches to thinking about seismic retrofitting of architecture. These approaches along with a fourth one, 'indifference' form a basis for a taxonomy presented here as a basis for future reference.

Indifference

The first category of retrofitting is Indifference. Seismic retrofitting is perceived as primarily an engineering problem, and many see it as a solely engineering problem. This approach is particularly evident with solutions that set out to minimise cost with minimal additional engineering to minimal acceptable standards. The retrofitting is indifferent to the aesthetic qualities of the underlying building and the impact of the finished result. This indiscriminate strengthening approach has little dialogue with the host building beyond addressing structural deficiencies. New structure most often dominates the old, with clashes between existing and new elements occurring as structurally necessary and accepted as a consequence of the need to retrofit structure. An example of this would be braced frames passing over window openings. These clashes draw attention to the new structure and its priority over the host building. This will be a typical engineering-driven solution, often argued to be more pragmatic and cost-efficient than a more holistic solution.

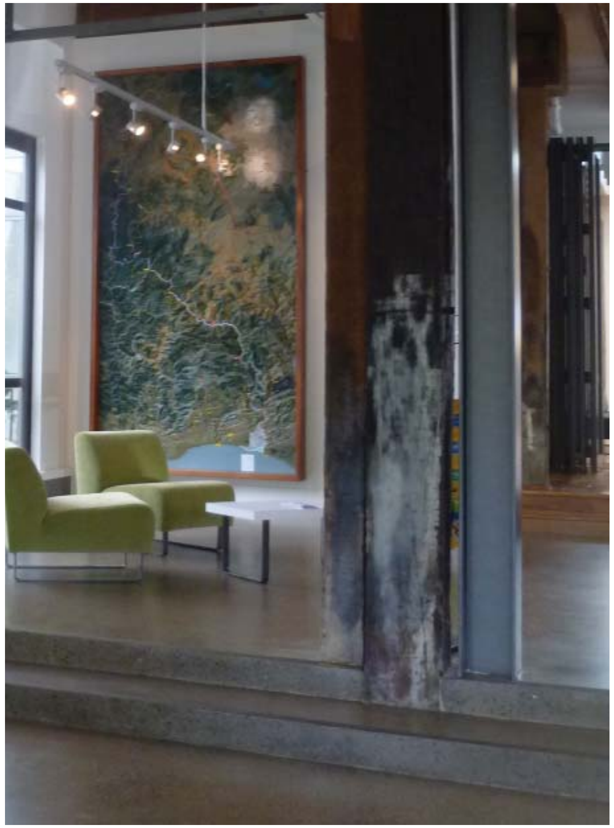
The irony with an indifferent approach is that the structural component is only *part* of the project. Seismic retrofitting has significant consequences for existing architecture. Ignoring these creates significant problems and extra expense during implementation of a seismic retrofit. New structural needs range from minor augmentation of existing building structural systems through to the more common need for the addition of complete new structures. This process requires weaving a new structure into and around an existing building, and most often requires loads transferred to new foundations – and consequently existing floors need to be partially removed, excavations made and new foundations formed. Floors, ceilings, and their substructures must be cut away to accommodate new structural members, which must also be interconnected with existing structural elements before being reinstated afterwards. Structural clashes with service intensive parts of buildings result in expensive remedial measures. Consequences of these clashes are primarily architectural, often extending to the complete internal and external refinishing and refitting of a building. Early, designed renegotiation of the relationships between new structure and existing architectural fabric can minimise the extent of consequential work required.

Invisibility

The second seismic upgrading approach is Invisibility. It is typically applied to architecture recognised as having high heritage value. With an invisible approach to seismic retrofitting new structure is carefully threaded through an existing building in a manner that allows it to be concealed. Parts of the building are removed and new structure is placed within. A concern with the original qualities of the building dominates. The integrity of the original building structure, materials and finish are renegotiated based on the origins of the building and current structural deficiencies. Key concerns are visual continuity and minimising change and alteration to the existing architecture. The underlying idea is that new structure will detract from the authenticity of the original. Secondary structures are hidden, channels and holes are created for them, or new coverings are created to hide the new work. Subtle shifts and changes to the building fabric occur to accommodate the new. There is an operation of camouflage and concealment occurring, suppressing expression of new work. This masks the reality of the deficient structural performance of the original and suggests that the structure of the original has always been appropriate and continues to be. Strengthening can however, never be completely invisible. Past heritage reconstruction and replication practices fall into this category of work, and range in the extent of compromise they make to a work. Whatever the extent of change that has occurred, evidence of the changes may be detected by the informed and the vigilant. Paradoxically, the desire to retain the appearance of authenticity undermines the apprehension of the architecture's genuine and continuing history.

Separation

Separation approaches to seismic retrofitting demonstrate an awareness of how strengthening processes irrevocably change a building. Direct controlled relationships occur between new seismic retrofitting and the existing building. New materials and structural systems are expressed as a specifically designed new layer of work. Visual distinction is created between existing and new layers of work differentiating a complementary, new structural layer of work within and around an existing building. Original structural and architectural elements are left as untouched as possible or undergo minor restoration. New structure is expressed and contrasted with the old as a carefully orchestrated juxtaposition



Separation of new and existing structure at Whanganui isite Centre.[5]

of new against old, as a legible new layer of work. There is an assumption with this approach that retrofitted structure can be read separately, and is a secondary, coexisting, 'nuetral' and interdependent layer. Examples of this approach may also draw out the aesthetic potential of the new structure within a building, or externally as an exoskeleton. Concern for the visual integrity of both the existing and new structure results in a palimpsest; a new structural layer applied over the original.

Dialogue

The final approach to seismic retrofitting advanced by Oswald is Dialogue. Oswald argues that while separation may infer support for the original cultural values of the original structure and leave an original structure with a degree of authenticity, it reduces the ability of the secondary structure to interact with and critically illuminate or dialogue with the existing. Qualities of existing architecture in both design and construction range from exemplary to substandard, and it is necessary to critically consider the value of existing architecture, both in whole and in part. Even great architects have their bad days or 'bottom drawer' projects where circumstances conspire to result in lesser quality work that an architect would not choose to highlight as part of their oeuvre. Part of Quay School of Fine Arts existing buildings in Whanganui was made of such poor materials and so badly constructed that part of them literally fell down during the seismic retrofit. No amount of care was able to save such poor building. All that is left in these circumstances is reconstruction. Heritage buildings require careful architectural judgement about what has value and why and how. Which parts of a building have significance and why? Which do not have significance and why? A professional cultural heritage assessment or conservation plan will be required to assist making these judgements. The judgements can then be the basis for a discussion; a dialogue to occur between existing and new work.

Ostwald quotes Alberti noting that strengthening should not *neglect the elegance of the existing work. If a wall happens to be unsightly because it is too high, insert a cornice.*[4]

This implies that a secondary structure has capacity to critique the first - to improve on its evident flaws. Ostwald argues that secondary structure has the ability to tease out and bring to light a buildings' inconsistencies and potentials, to create a form of critical resistance and an active dialogue with history.

This less pure and differentiated approach to seismic retrofitting treats the existing building fabric as the site of the redesign of architecture to create a hybrid old+new architecture. Techniques will adapt, add to and alter an existing building to create a renewed hybrid building result.

New Atrium cut through centre of Whanganui isite Centre and Gallery space linking lower and upper floors, and creating a hybrid new old architecture.

Less pure in its architectural approach, this tactic works critically from and with the qualities of the existing, augmenting these with new work using a variety of techniques. The recent Whanganui isite centre project[5] regenerating a victorian warehouse scheduled for demolition is a good example of this approach with a major new atrium cut through the middle, a new contrasting glass box window addition to the street, and a large new north facing terrace cut into one side amoung the major interventions. With a dialogue approach new work may be in juxtaposition, parasitic, prosthetic or interwoven with the existing. Structure may be partially expressed and exposed and partially hidden as required by the new architectural intentions and the relationships crafted with the existing. Radical surgery may be required to address building deficiencies that were original or have become evident over time because of disjunctions between the characteristics of a building and the needs of its contemporary uses. Poor seismic performance is most often the most serious of a building's deficiencies, but other needs, particularly cultural expression, maintenance, building code compliance, function, investment return and services may be addressed at the same time.

The Cuba Street student projects

The Cuba Street projects documented in this publication was a fantastic real world learning environment, a test bed for innovative ideas, and a laboratory of different seismic retrofitting and heritage adaptive reuse tactics. It was a creative hothouse where a future vision for the entire Cuba Street precinct was grown and simulated over a three month period of intensive research, experimentation, design testing, projections, representations and modelling. Seventy students worked for 12 weeks in two consecutive year groups. Their efforts are the equivalent of 7 person years of full time research. The value of this research is significant, hence, the reason for documenting it and making it available for Cuba Street stakeholders and the wider public with an interest in or affected by seismic retrofitting. A strength of the student project outcomes is that they show a varying range of approaches to existing buildings. This, combined with the reflections on the problem and findings of the research included in this document will provide a resource and context to add to the contemporary discussion around seismic retrofitting of heritage building stock.

We planned for students to work with owner stakeholders in partnership. Building owners' needs were intended to be addressed through the production of a series of measured drawings of each building. Some Cuba Street owners were keen to work directly with the student group, offering direct access to their buildings, however that was not able to happen because of the increased risk to the public associated with spending time in earthquake prone buildings. The risk was highlighted by the 6.5 Seddon earthquake on the 21st July 2013 and the series of earthquakes that followed it. It was an insistent reminder of the important reality of the issue we were dealing with for New Zealanders and visitors. It was also a local issue affecting the student group with Cuba Street nearby to the VUW Te Aro campus where the Schools of Architecture and Design are located. The Seddon earthquakes were of sufficient seriousness to cause the University to be evacuated and to close its Te Aro campus for a period of days on two occasions while the safety of its buildings was checked.

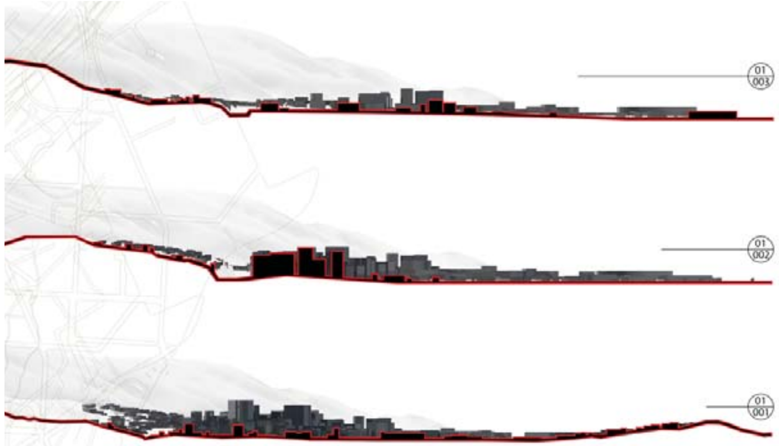
The seismic performance of historic building stock is an immediate issue. There are a mix of affected people in earthquake-prone buildings, owners, investors, tenants, building users, and Council with statutory responsibility to address the issue within a set time frame. Heritage New Zealand also has an interest in advocating for and saving heritage buildings. In the Cuba Street case, this includes individual buildings but also the whole of the Cuba Street precinct where the collective value of the buildings is recognised alongside particular individual building's with heritage value.

The following student projects consider the redevelopment of every site along the full length of Cuba Street. The projects begin with a consideration of the wider Wellington urban context and its relations to the Cuba precinct, before some detailed urban context mapping and analysis. This was followed by documentation of the existing buildings and assessment of their condition before a cultural heritage assessment was undertaken of each building to determine its heritage values. This was followed by two projects. A seismic retrofit and remodel of a single heritage building, followed by a seismic retrofit and redevelopment of a cluster of buildings. The cluster buildings project was a means to explore potential issues and synergies that are possible with larger sites and multiple buildings, and with redevelopment and intensification of the use. Intensification of uses are likely to arise from the financial demands of redevelopment associated with seismic retrofitting.

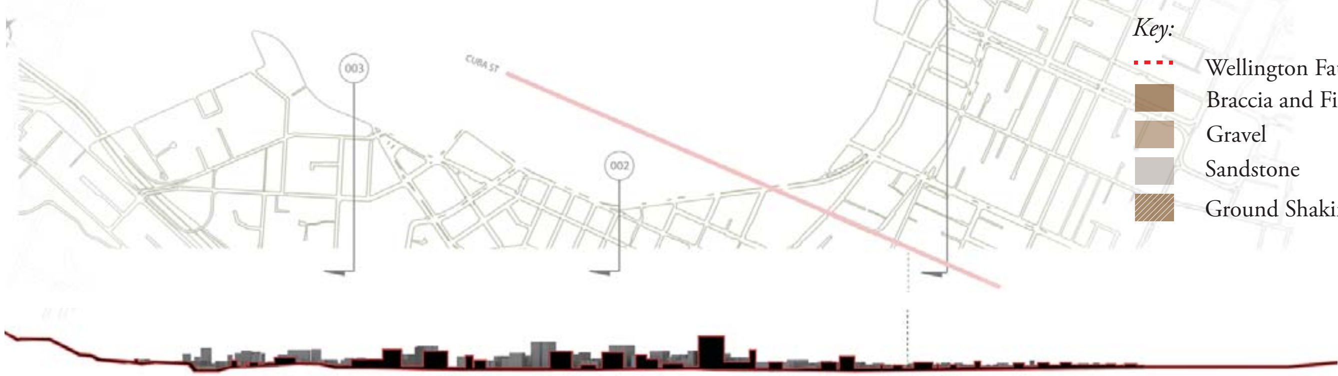
References
3. Michael J Ostwald, in Mark Taylor, Julianna Preston, and Andrew Charleson *Moments of Resistance*, Archadia Press, Sydney 2002, p23 - 40.
4. Ibid, p33.
5. Mark Southcombe Architect, *Whangani isite Centre and Quay Gallery*, Taupo Quay, Whanganui.

Macro-mapping & Urban Context Analysis

Wider urban context analysis was the starting point for the project. Students researched and compiled detailed information and translated it to a series of maps. A wide spread of analysis occurred on the city's wider context to gain understanding into important factors that may affect design and further development of the city centre and the Cuba Precinct context.



This macro-map takes a topographical look at Wellington City. Section cuts show the height and density variation, giving a comprehensive account of the cityscape and its relations to the surrounding hills.



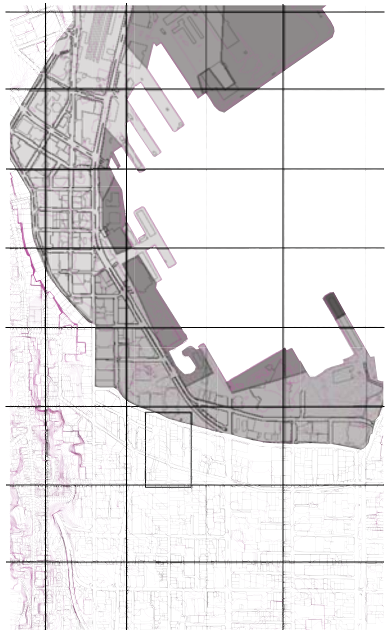
Topography of Urban Context.
Henry D'Ath

Wellington Ground and Soil Types
Declan Burn

Key:

- Wellington Fault Line
- Braccia and Fill
- Gravel
- Sandstone
- Ground Shaking Hazard

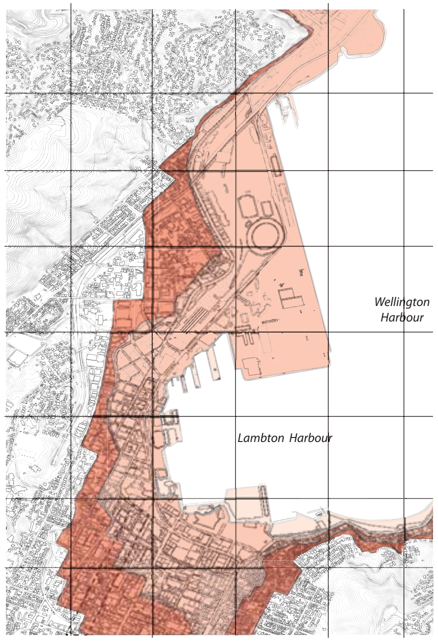
Wellington Reclaimed Land
Declan Burn



Key:

- Original Coastline - 1847
- 1852-1879
- 1880-1900
- 1901-1930
- 1931-1955
- 1956 Onwards

Hazardous Flooding Zones
Declan Burn



Key:

- Tsunami Evacuation Zone 1
- Tsunami Evacuation Zone 2
- Tsunami Evacuation Zone 3

Building Category and Earthquake Hazards
Declan Burn

The Majority of the Category 1 Heritage buildings in central Wellington are along Cuba Street and Lambton Quay. Category 2 Heritage buildings are more spread out around Wellington City and are found mostly in the suburbs surrounding the city centre. Cuba Street has two Category-1 heritage buildings and 40 Category-2 heritage buildings.

There is a spread of earthquake-prone buildings in the city but most can be seen clustered around the city centre. The majority of the heritage buildings have been maintained in their original construction style and material, and they have also been classified as being earthquake-prone. Heritage buildings that are also earthquake-prone are required to be retained because of their cultural heritage significance, and they must also be seismically strengthened to meet requirements of the building act.

Key:

- Building Outlines
- Curb Lines
- Category 1 (1850-1900)
- Category 1 (1900-1950)
- Category 2 (1850-1900)
- Category 2 (1900-1950)
- Earthquake Prone Buildings

Micro-Mapping & Urban Context Analysis

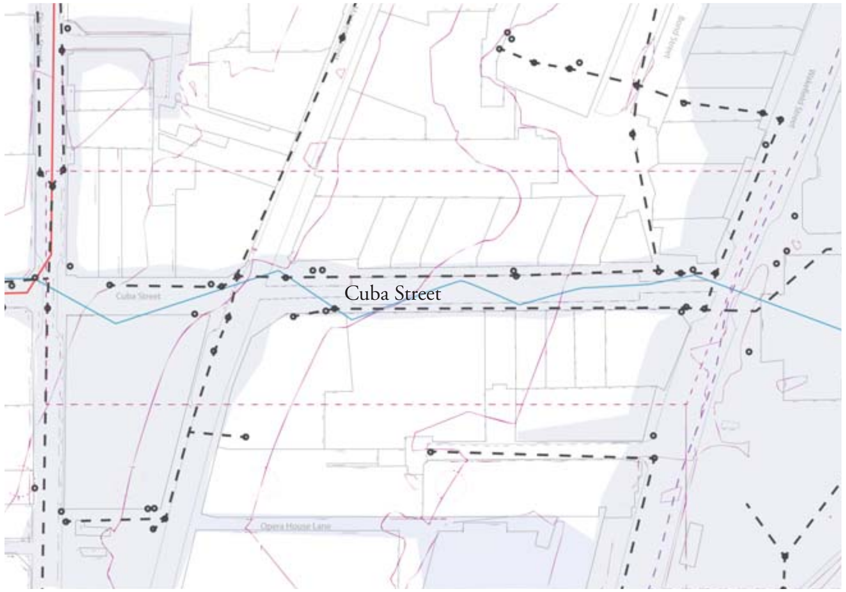
Lower Cuba Street: Wakefield - Dixon Street

Local urban context analysis occurred in five groups. Each group considered a block of Cuba Street and studied a series of different characteristics of their part of the wider Cuba Street site. Groups produced a series of maps documenting the information found. A selection of this investigation is presented below for each of five study areas.

Reverse Figure Ground Mapping

This map simplifies and highlights the reverse figure ground of the lower Cuba Street area highlighting building mass and open space

Key: Negative Space
Building Footprint



Hydrology Mapping

This mapping illustrates the topography and related water management and hydrology.

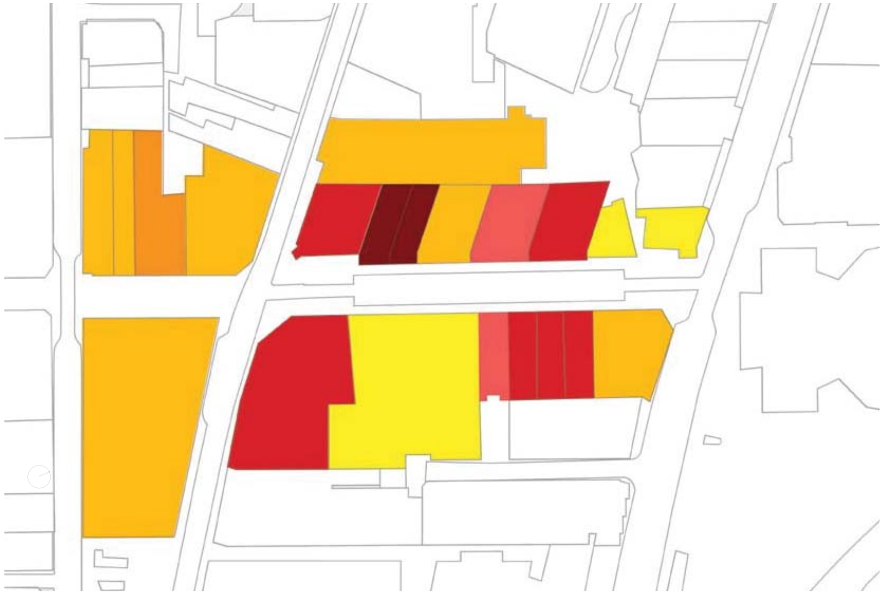
Key: Hazardous Flooding Zones
Tsunami Evacuation Zone
Tsunami Evacuation Zone Border
Current Te Aro Stream Culvert
Storm Water System

East Elevation of Cuba Street

Wakefield Street to Dixon Street

Building Age Mapping

This map illustrates the date of construction of the buildingss along the Cuba Street frontage

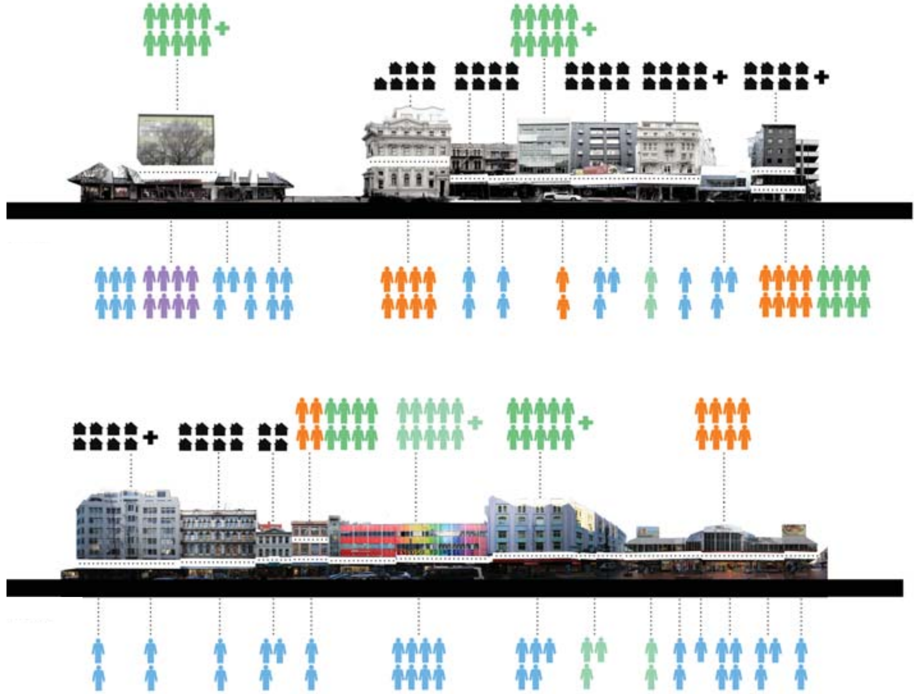


Key: Date of Construction

- -1879
- 1880 - 1899
- 1900 - 1919
- 1920 - 1939
- 1940 - 1959
- 1960 - 1979
- 1980 - 1999
- 2000 - 2009

Social Occupation Mapping

This map illustrates the range of occupational disciplines and the number of employees and residences associated with each building, or part of building



Key:

- Health / Beauty
- Art / Gallery
- Retail
- Offices
- Education
- Bar / Restaurant
- Dairy
- Services
- Residential
- Residences
- Employees

West Elevation of Cuba Street

Dixon Street to Wakefield Street

Micro-Mapping and Urban Context Analysis

Dixon Street- Ghuznee Street

Reverse Figure Ground Mapping

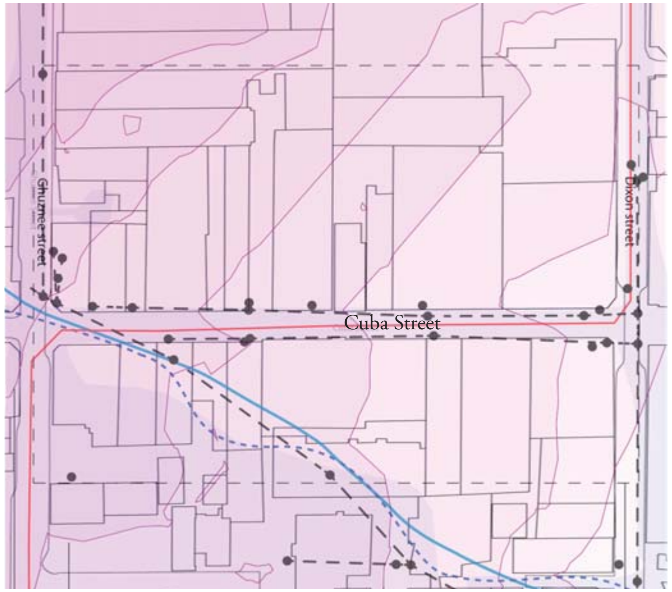
This map simplifies and highlights the reverse figure ground of the Cuba Street block highlighting building mass and open space

Key: Negative Space (eg streets)

Building Footprint

Hydrology Mapping

This mapping illustrates the topography and related water management and hydrology.



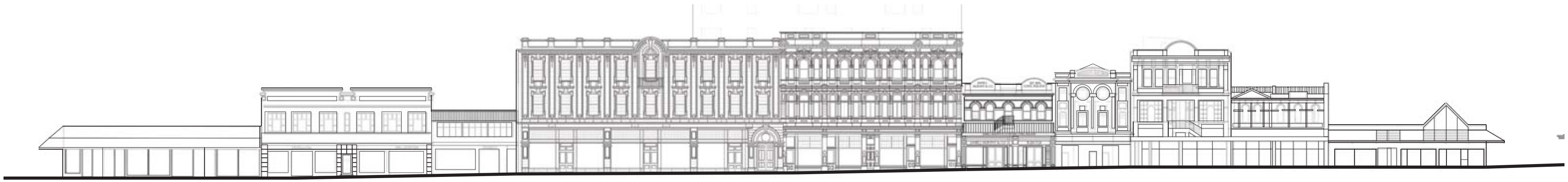
Key: Hazardous Flooding Zones

Tsunami Evacuation Zone

Tsunami Evacuation Zone Border

Current Te Aro Stream Culvert

Storm Water System



East Elevation of Cuba Street

Dixon Street to Ghuznee Street

Building Age Mapping

This map illustrates the date of construction of the buildings along the Cuba Street frontage

Key: Date of Construction

- -1879
- 1880 - 1899
- 1900 - 1919
- 1920 - 1939
- 1940 - 1959
- 1960 - 1979
- 1980 - 1999
- 2000 - 2009

Social Occupation Mapping

This map illustrates the range of occupational disciplines and the number of employeees and residences associated with each building, or part of building

Key:

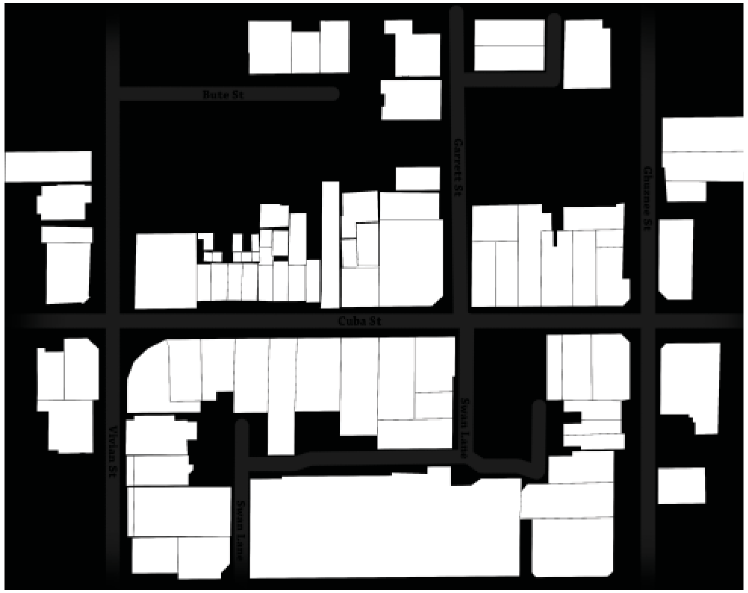
- Health / Beauty
- Art / Gallery
- Retail
- Offices
- Education
- Bar / Restaurant
- Dairy
- Services
- Residential
- Residences
- Employees

West Elevation of Cuba Street

Ghuznee Street to Dixon Street

Micro-Mapping and Urban Context Analysis

Ghuznee Street- Vivian Street



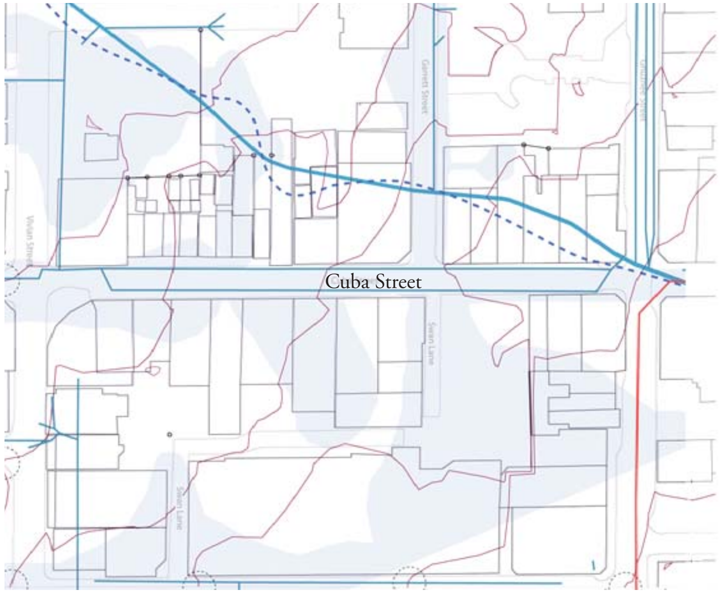
Reverse Figure Ground Mapping

This map simplifies and highlights the reverse figure ground of the Cuba Street block highlighting building mass and open space

Key:
- Negative Space
- Building Footprint

Hydrology Mapping

This mapping illustrates the topography and related water management and hydrology.



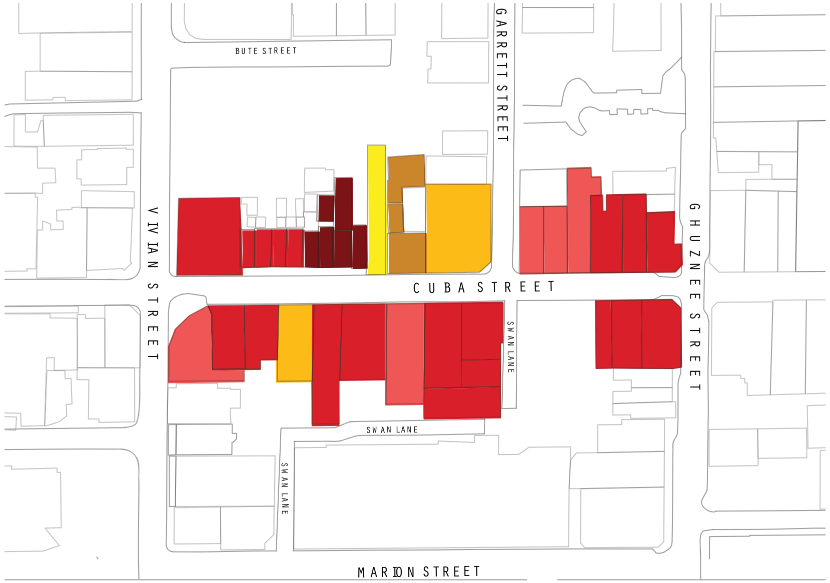
Key:
- Hazardous Flooding Zones
- Tsunami Evacuation Zone
- Tsunami Evacuation Zone Border
- Current Te Aro Stream Culvert
- Storm Water System

East Elevation of Cuba Street

Ghuznee Street to Vivian Street

Building Age Mapping

This map illustrates the date of construction of the buildings along the Cuba Street frontage



Key: **Date of Construction**

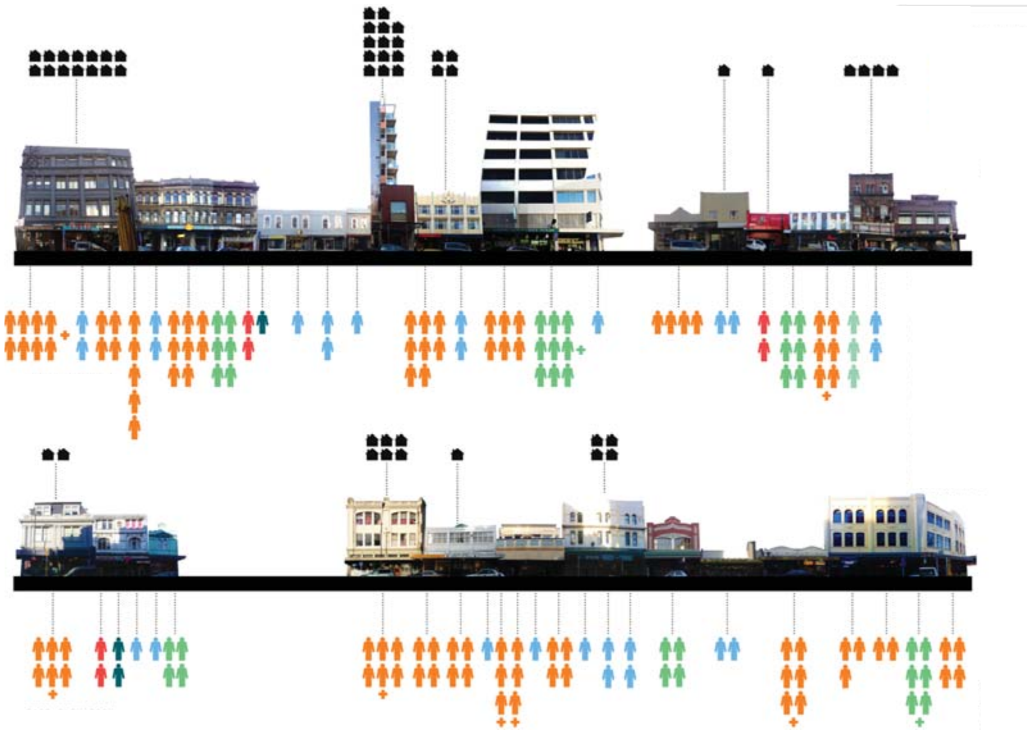
- -1879
- 1880 - 1899
- 1900 - 1919
- 1920 - 1939
- 1940 - 1959
- 1960 - 1979
- 1980 - 1999
- 2000 - 2009

Key:

- Health / Beauty
- Art / Gallery
- Retail
- Offices
- Education
- Bar / Restaurant
- Dairy
- Services
- Residential
- Residences
- Employees

Social Occupation Mapping

This map illustrates the range of occupational disciplines and the number of employeees and residences associated with each building, or part of building



West Elevation of Cuba Street

Vivian Street to Ghuznee Street

Micro-Mapping and Urban Context Analysis

Vivian Street - Abel Smith Street

Reverse Figure Ground Mapping

This map simplifies and highlights the reverse figure ground of the Cuba Street block highlighting building mass and open space

Key: Negative Space
Building Footprint

Hydrology Mapping

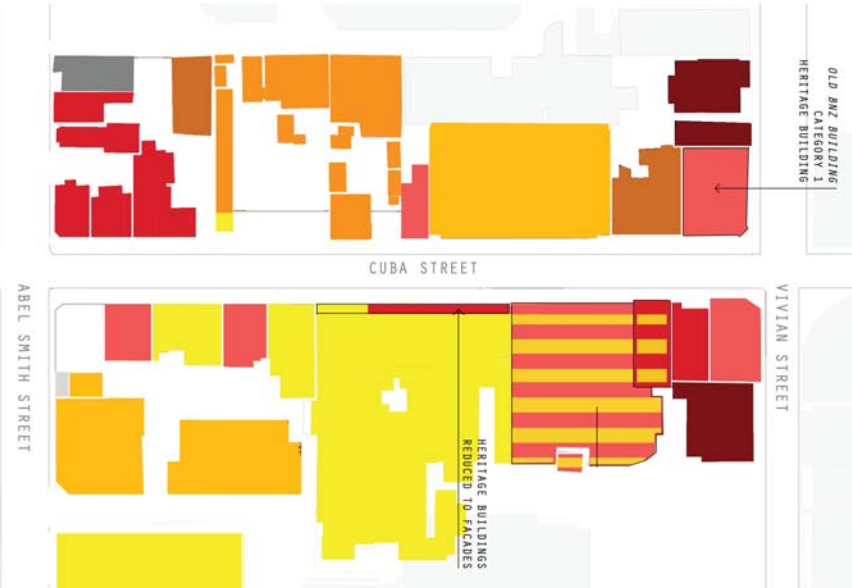
This mapping illustrates the topography and related water management and hydrology.

Key:
Hazardous Flooding Zones
Tsunami Evacuation Zone
Tsunami Evacuation Zone Border
Current Te Aro Stream Culvert
Storm Water System

East Elevation of Cuba Street
Vivian Street to Abel Smith Street

Building Age Mapping

This map illustrates the date of construction of the buildings along the Cuba Street frontage

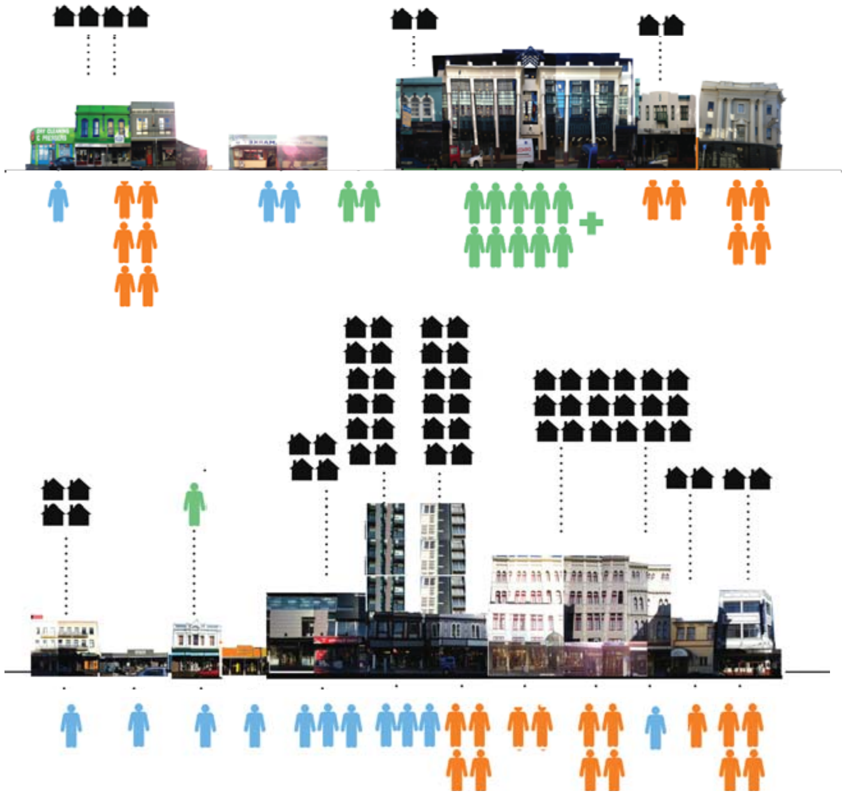


Key: Date of Construction

- -1879
- 1880 - 1899
- 1900 - 1919
- 1920 - 1939
- 1940 - 1959
- 1960 - 1979
- 1980 - 1999
- 2000 - 2009

Social Occupation Mapping

This map illustrates the range of occupational disciplines and the number of employees and residences associated with each building, or part of building



Key:

- Health / Beauty
- Art / Gallery
- Retail
- Offices
- Education
- Bar / Restaurant
- Dairy
- Services
- Residential
- Residences
- Employees

West Elevation of Cuba Street

Abel Smith Street to Vivian Street

Micro-Mapping and Urban Context Analysis
Abel Smith Street - Webb Street

Reverse Figure Ground Mapping

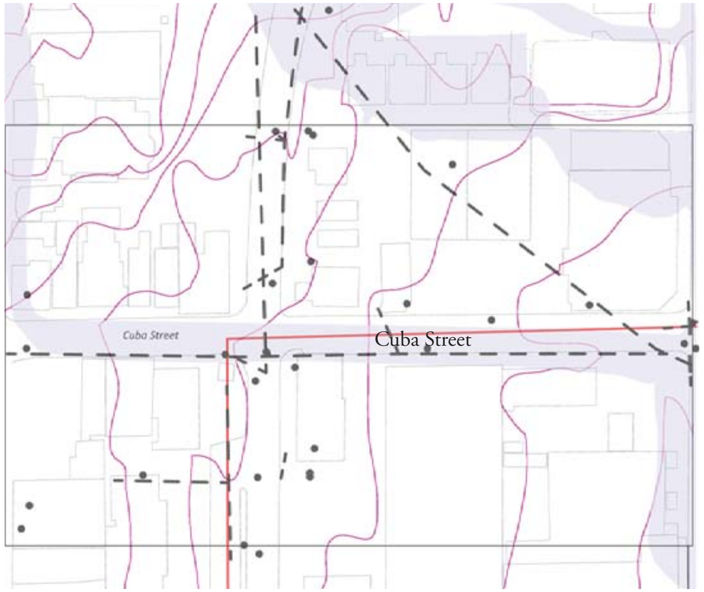
This map simplifies and highlights the reverse figure ground of the Cuba Street block highlighting building mass and open space

Key: Negative Space

Building Footprint

Hydrology Mapping

This mapping illustrates the topography and related water management and hydrology.



Key: Hazardous Flooding Zones

Tsunami Evacuation Zone

Tsunami Evacuation Zone Border

Current Te Aro Stream Culvert

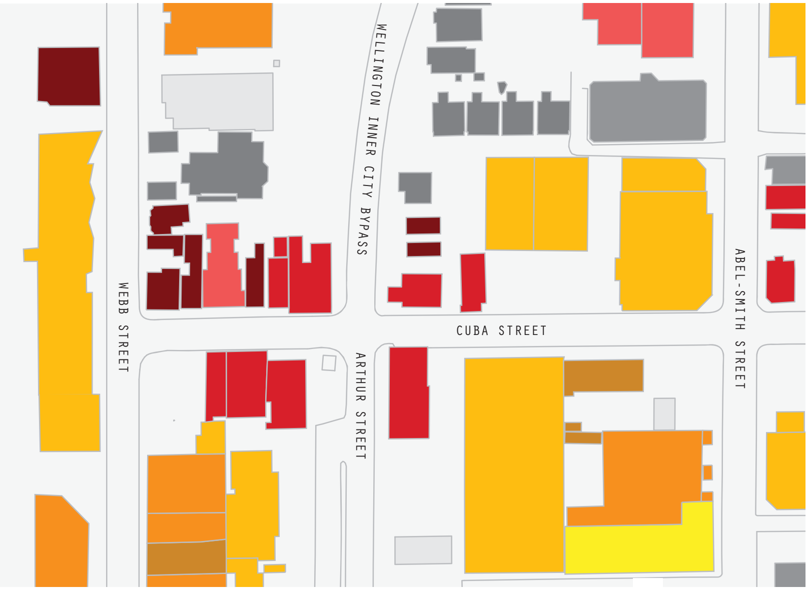
Storm Water System

East Elevation of Cuba Street

Abel Smith Street to Webb Street

Building Age Mapping

This map illustrates the date of construction of the buildings along the Cuba Street frontage

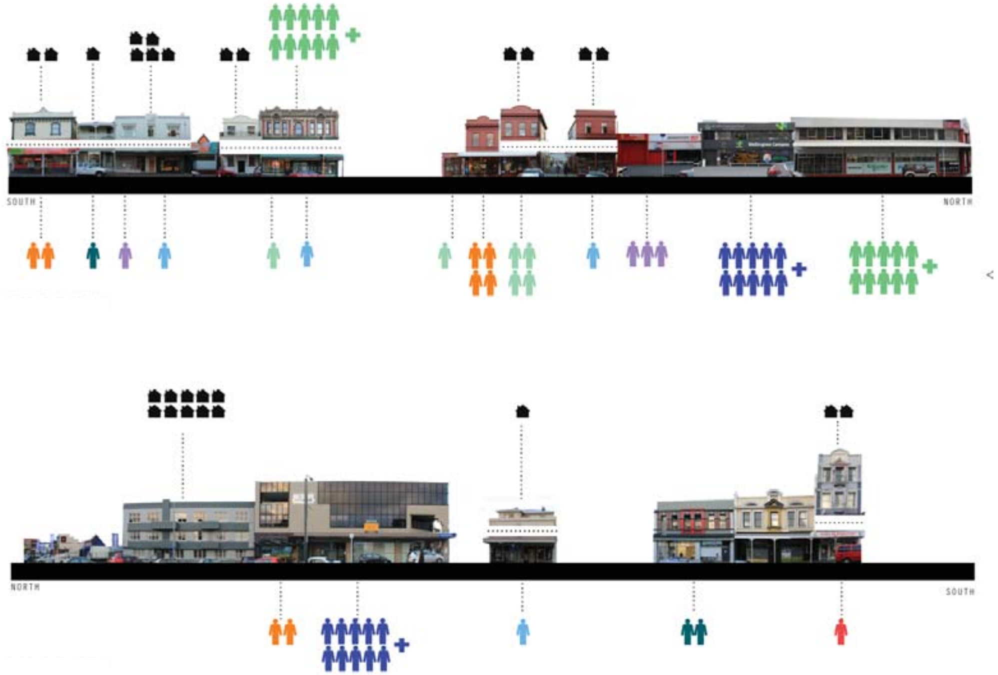


Key: ***Date of Construction***

- -1879
- 1880 - 1899
- 1900 - 1919
- 1920 - 1939
- 1940 - 1959
- 1960 - 1979
- 2000 - 2009
- 1980 - 1999

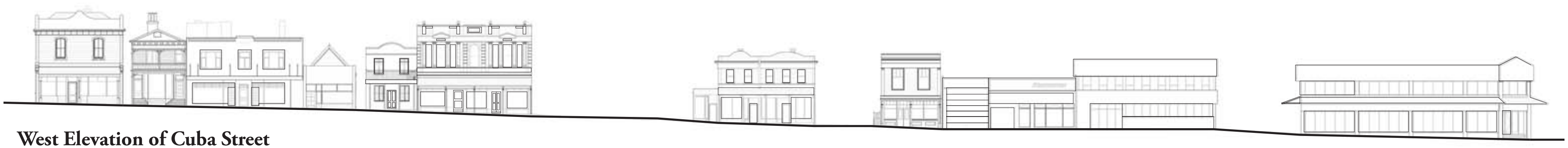
Social Occupation Mapping

This map illustrates the range of occupational disciplines and the number of employees and residences associated with each building, or part of building



Key:

- Health / Beauty
- Art / Gallery
- Retail
- Offices
- Education
- Bar / Restaurant
- Dairy
- Services
- Residential
- Residences
- Employees



West Elevation of Cuba Street

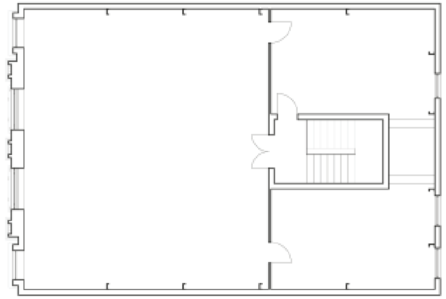
Webb Street to Abel Smith Street

Existing Building Documentation

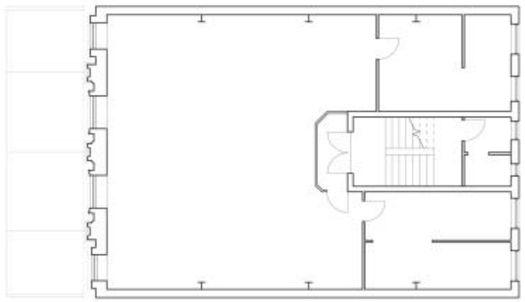
The following plans are a representative example of student work undertaken as part of the existing building documentation phase of the project. Wellington City Council archives provided available records of the existing plans for student reference. The quality and quantity of the existing plans varied, and so primary research and measurements were also required to provide the information on which the plans were based. An existing condition survey and preparation of accurate and clear drawings that define and document the existing building current characteristics and state are the key first steps for any seismic retrofit design. Following this will be investigation of the existing building elements and their connections prior to the assessment of the existing structural performance that will occur prior to any new design. The better the documentation and assessment and testing of the existing building qualities, the more targeted and efficient the seismic retrofit can be. The importance of this process cannot be over stated if an efficient utilisation and reuse of the existing building structural and architectural qualities is to occur. For the student exercise we concentrated on provision of good quality, simple existing condition drawings that were subsequently the basis for the integrated structural component of the [Re]Cuba project. Material and building condition were documented as part of the Heritage Assessment component of the project and Structural Report.

Existing Building Documentation
123-125 Cuba Street, Barber's Building

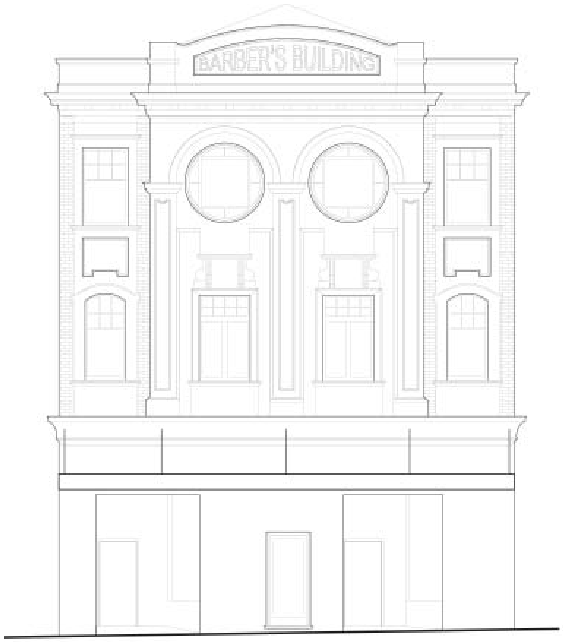
Sophie Edwards



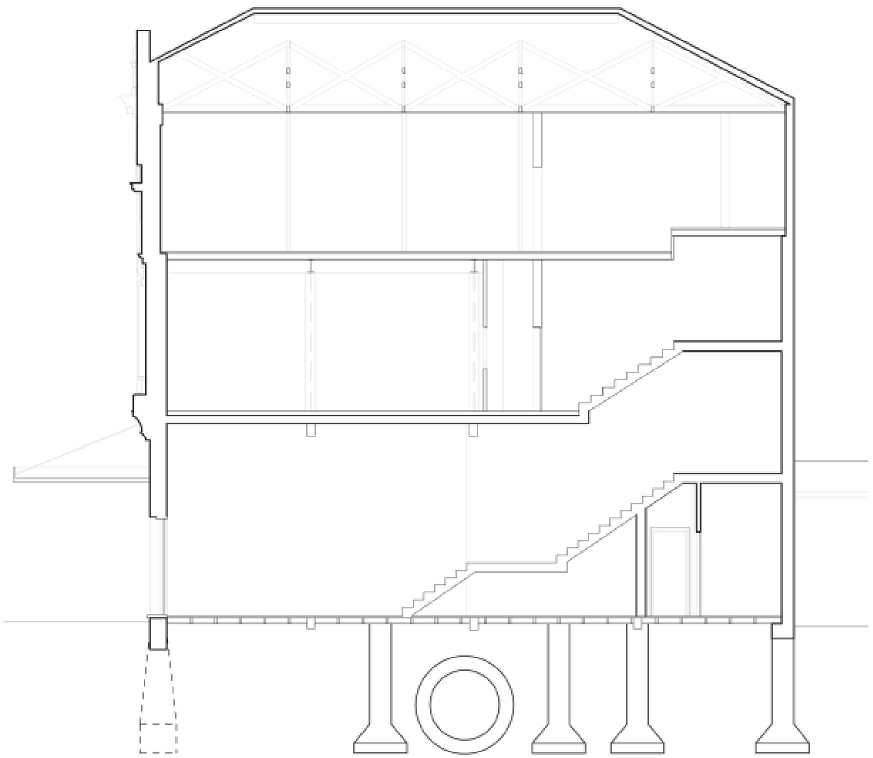
Second Floor Plan



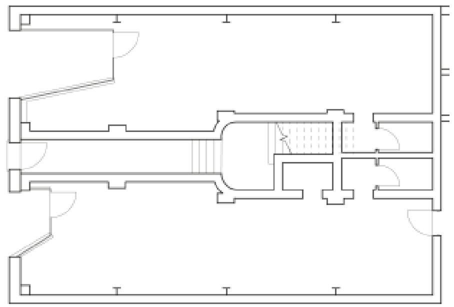
First Floor Plan



Cuba Street Elevation



Key Longitudinal Section

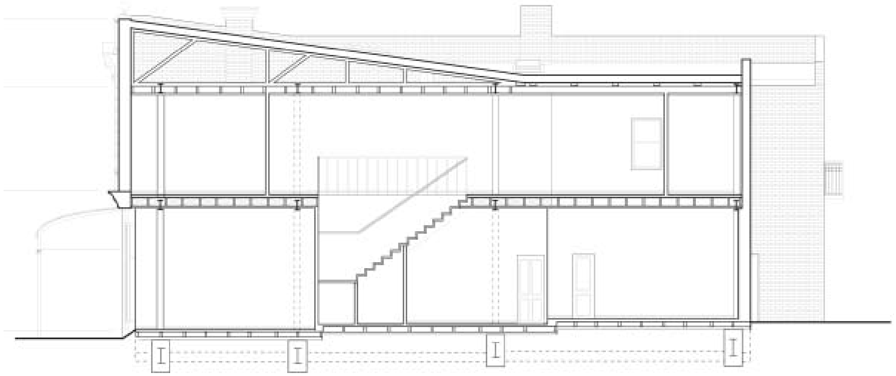


Ground Floor Plan

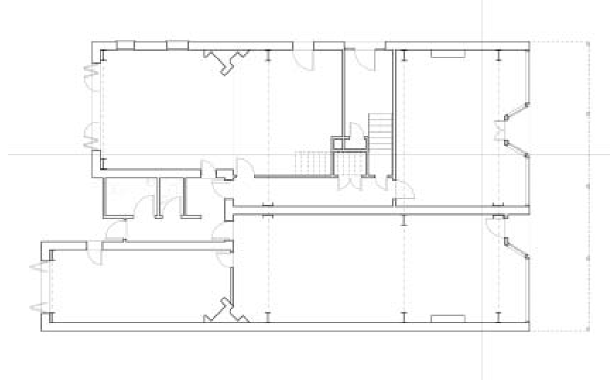
Existing Building Documentation

276-278 Cuba Street, Martha's Pantry

Jayne Kersten



Key Longitudinal Section



First Floor Plan

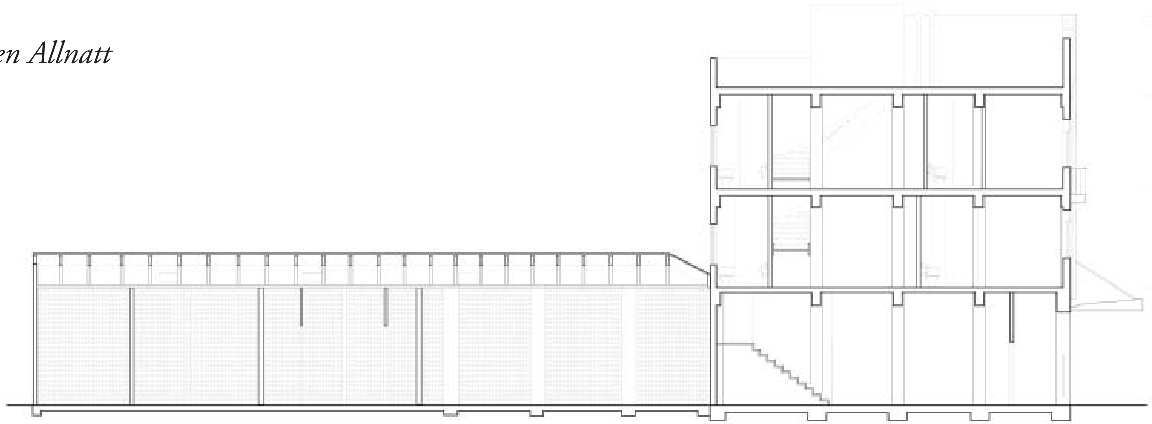
Cuba Street Elevation

Ground Floor Plan

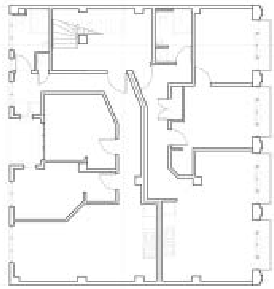
Existing Building Documentation

154-156 Cuba Street, The Vic

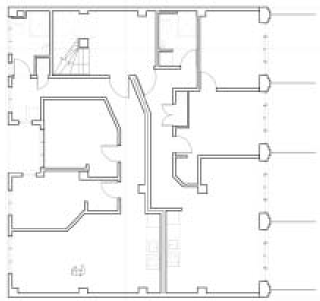
Ben Allnatt



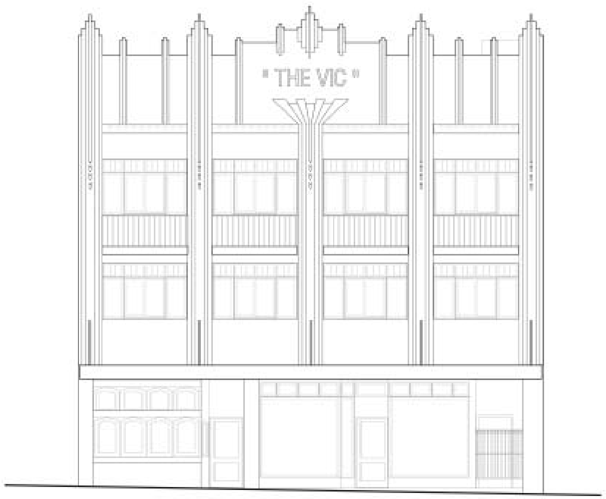
Key Longitudinal Section



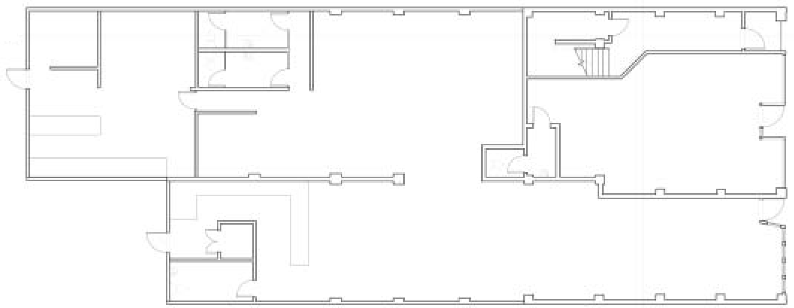
Second Floor Plan



First Floor Plan



Cuba Street Elevation



Ground Floor Plan

Heritage Assessment

Alteration, adaption and seismic retrofit work associated with heritage buildings have become a specialist branch of architectural knowledge. Conservation architects and architects working in the heritage field have understanding and experience of the procedures of assessment, analysis and documentation of heritage significance and the statutory approvals required for work associated with historic sites and architecture. There are several areas of legislation that relate to heritage at a local and national level. The key one is the Heritage New Zealand Pouhere Taonga Act 2014. This Act provides for an advocacy role in several processes including resource consents, development of rules and heritage provisions within District Plans and heritage management processes. This Act also prohibits the modification or destruction of an archaeological site (defined as any place, building or structure associated with human activity that occurred before 1900) unless an authority has been obtained from Heritage New Zealand before the work commences. Other important legislation includes the Resource Management Act and the Local Government Act.

Not all work to historic buildings requires input from specialist heritage architects. Heritage New Zealand has published guidelines that set out the principles for the identification and assessment of historic heritage. Most architects, with assistance from a trained historian, would be able to prepare a basic heritage assessment. Heritage New Zealand supported students to prepare short form heritage assessments for the Cuba Street buildings to identify the building's heritage values as part of the [Re] Cuba project.

The heritage values may be of physical, historic or cultural value. These include archaeological, architectural, technological, social, aesthetic and rarity values as well as those associated with important people or events. These may be both tangible and intangible values. It was common for buildings on the project to have a range of heritage values.

There is widespread misconception that the heritage status of a building will prevent any change or adaptation when required to suit changing needs. The idea that heritage status somehow freezes a building in time is far from reality in many cases. Being clear about why a building has heritage value, what the heritage values are and the relative heritage value of different parts of a building is key knowledge. It is common for historic buildings to have parts that are more significant than others or that have no heritage significance at all. These may have been added at a later date or may cover over existing heritage fabric that is of value. This knowledge can then be used to develop subsequent seismic retrofitting and potential adaptive reuse proposals with the new structure and changes in dialogue with the existing building.

There is wide scope for adaptive reuse of many heritage buildings and this approach is highlighted by the [Re]Cuba project student projects that follow. These projects demonstrate the potential design flexibility of retrofit projects in an exemplary manner.

30 Arthur Street, Wellington

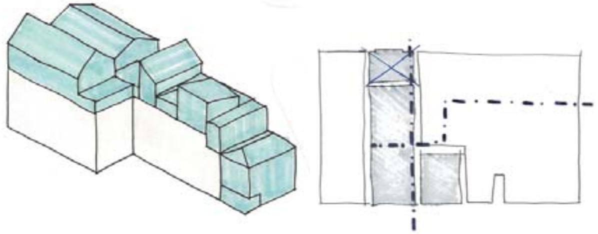
Heritage Assessment

Source: Authors own photograph

Louise Seyb. **Heritage Assessment for 30 Arthur Street**

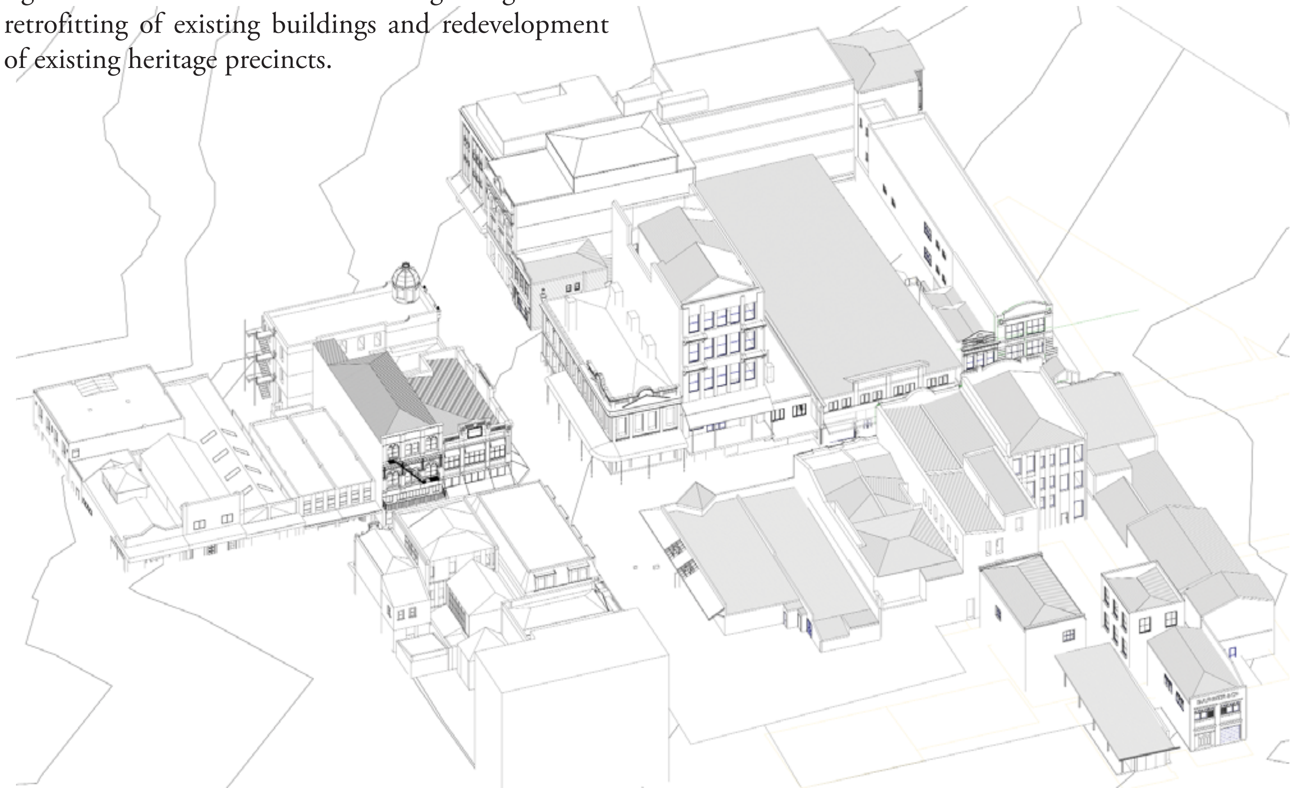
Architectural Project Case Studies

The student projects presented in this and the next sections of work are firstly individual architectural projects and secondly composite projects that incorporate work to clusters of buildings and sites. They are also presented according to the design tactics or approaches that drive the design and have potential significance for wider discussions regarding seismic retrofitting of existing buildings and redevelopment of existing heritage precincts.



Alexandra Sawica-Richie. **Cluster Case Study sketches**

Alexandra Sawica-Richie. **Cluster Case Study design**



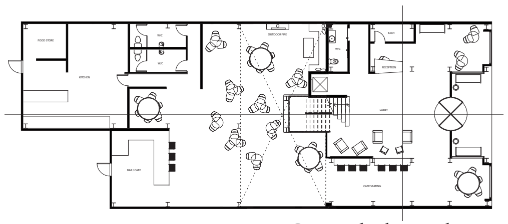
Thomas Strange. **Clusters of existing buildings around the intersection of Cuba and Ghuznee Streets.**

Liam McGarry. **Single building Case Study Design**

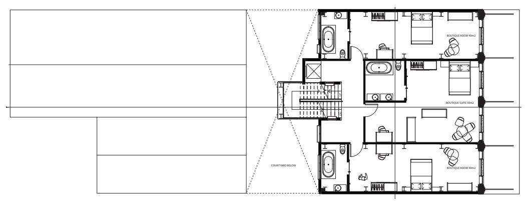
Architectural Project
Single Building Case Studies

Complimentary Facade Design
Ben Allnatt

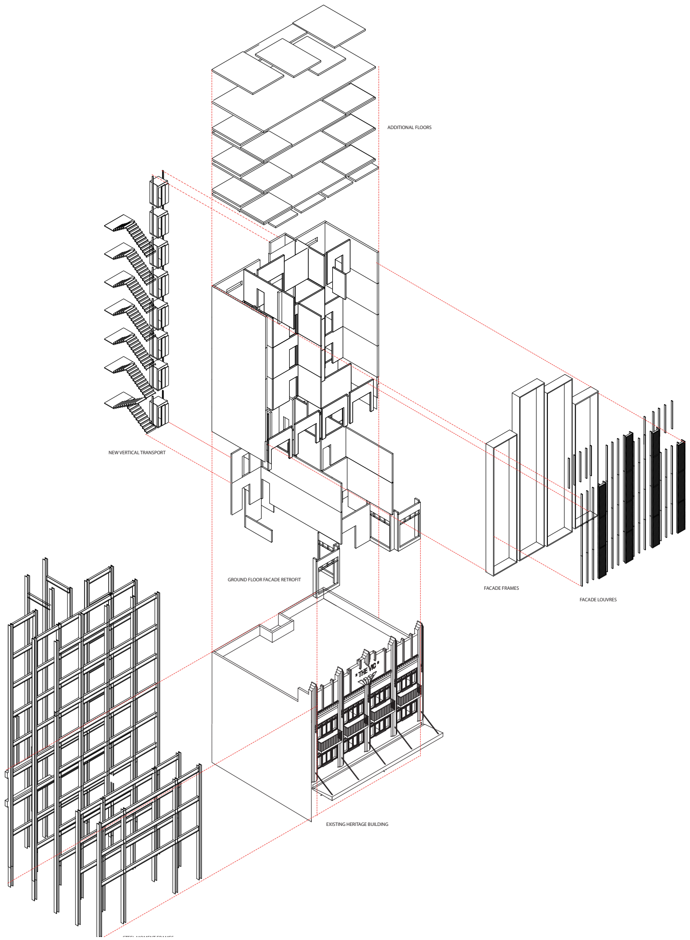
For buildings that address a street, the facade design is often the most highly visible part of existing and new work integration. The way in which the new work is approached can strengthen or undermine a buildings' existing architectural integrity. The exterior of a building has a key relationship to the existing host building and the wider urban context.



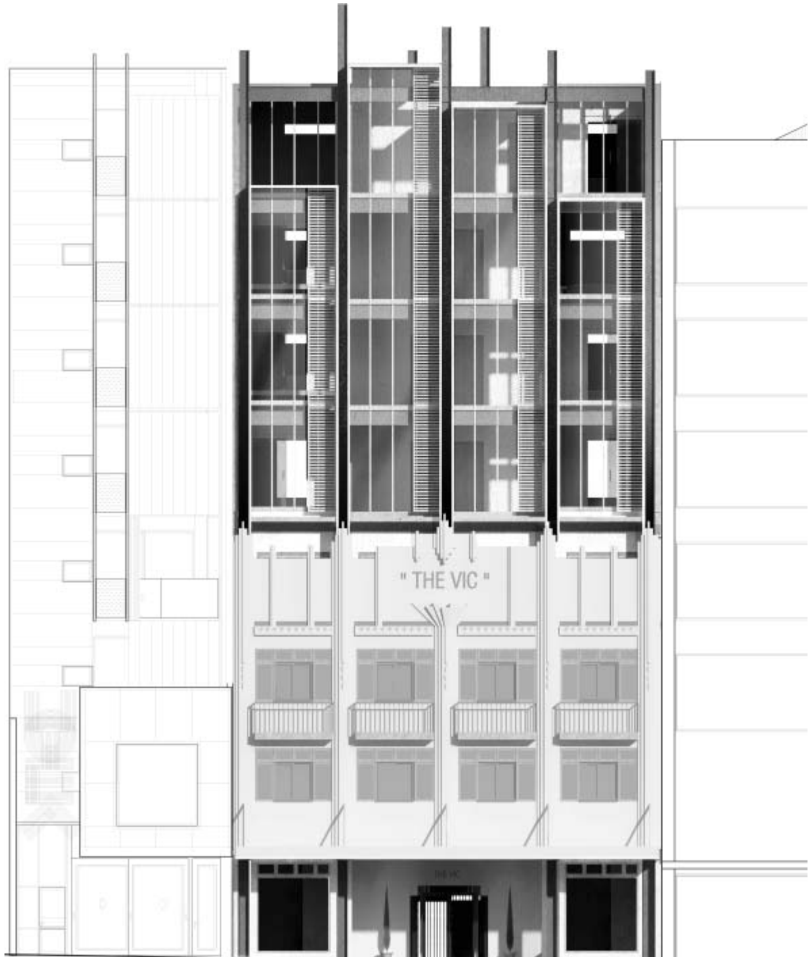
Ground Floor Plan



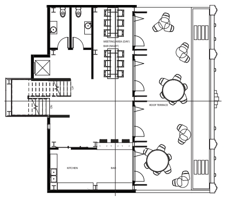
First and Second Floor Plan



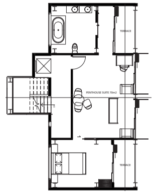
Exploded Isometric



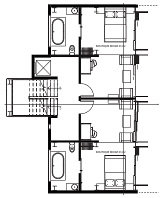
Cuba Street Elevation



Third Floor Plan

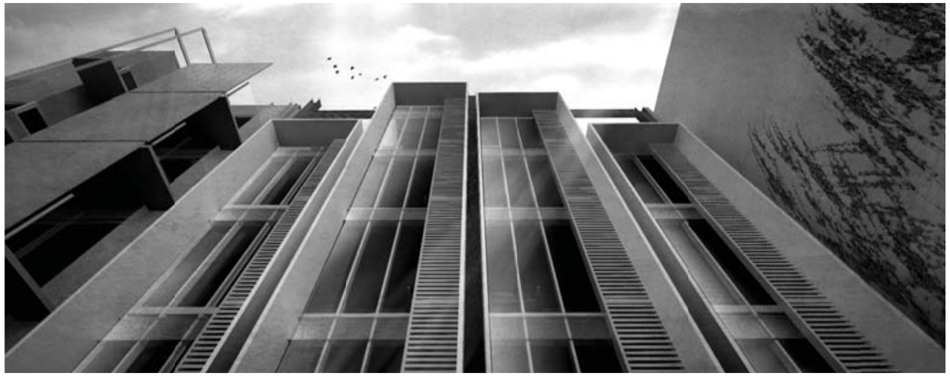


Fourth to Sixth Floor Plan



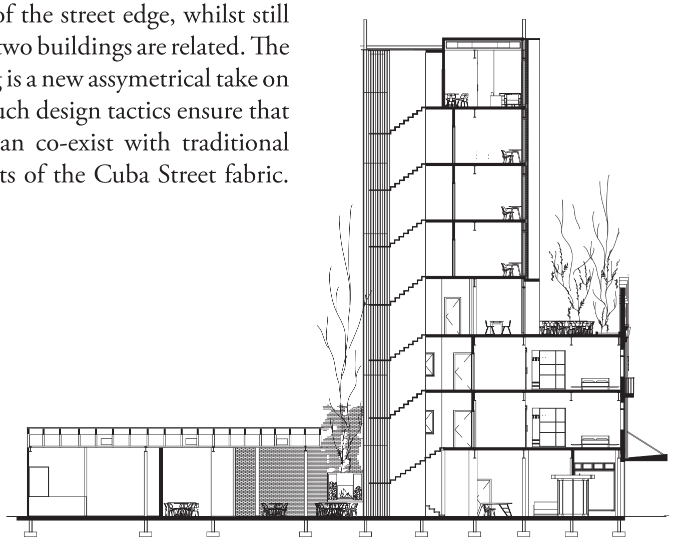
Seventh Floor Plan

The additional new building has been designed with an understanding of and sensitivity to the existing. Based on a conversation between existing and new forms, the addition is a complimentary addition that respects and works from the underlying geometry of the 'Victoria' building, particularly the existing rhythms and verticality.

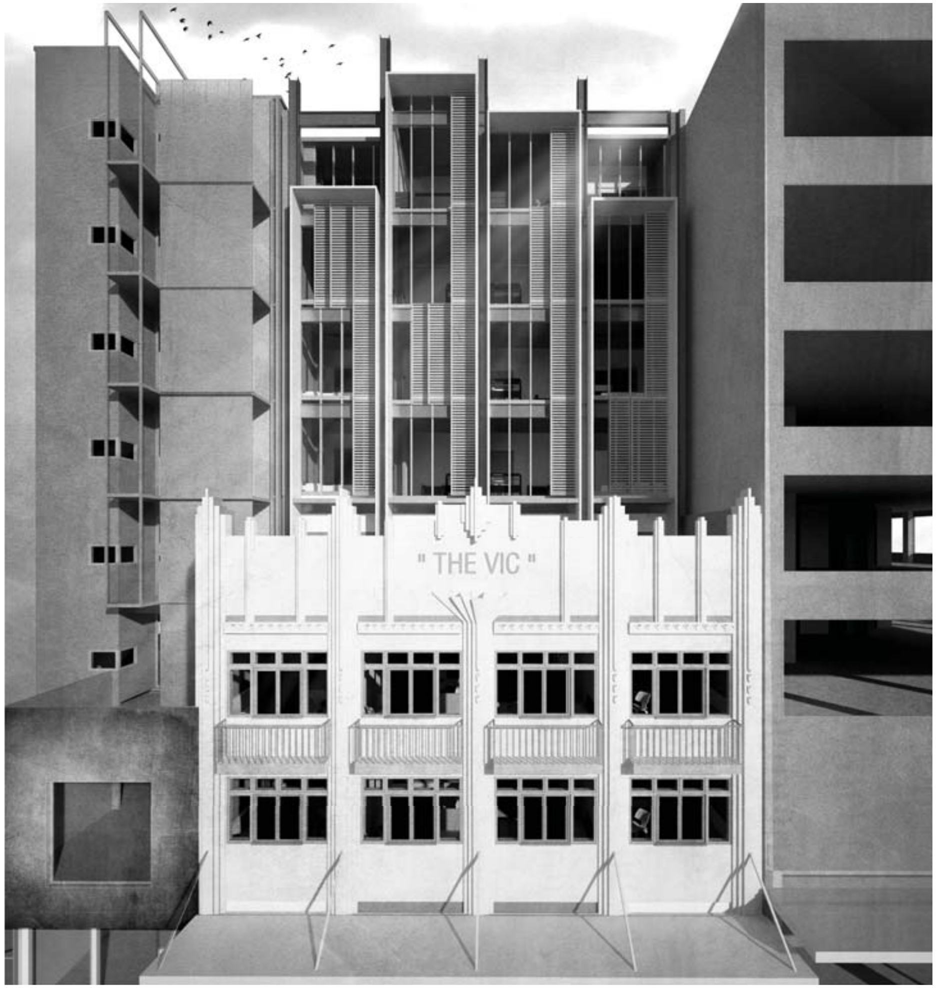


Perspective looking up

A set-back from the original building has been used as a way of retaining the original scale of the street edge, whilst still densifying. It is clear that these two buildings are related. The stepped top of the new building is a new assymetrical take on the original stepped parapet. Such design tactics ensure that the contemporary additions can co-exist with traditional and historically significant parts of the Cuba Street fabric.



Key Section



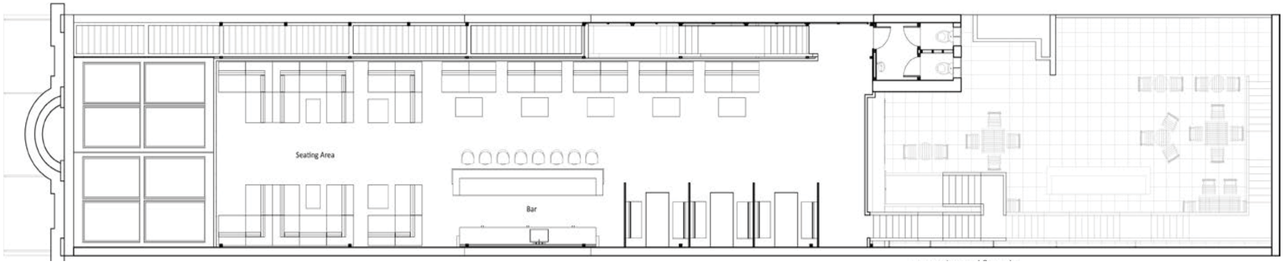
Perspective view above canopy

Architectural Project: Single Building Case Studies

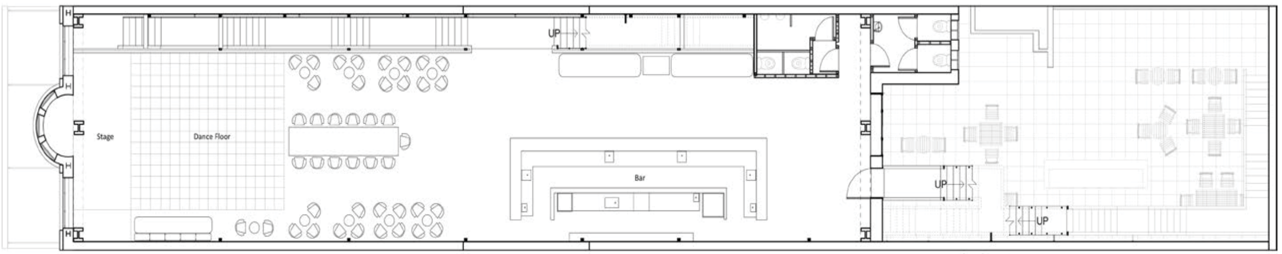
Internal Augmentation: Working from Existing interior. Structural Grids and Elements.

Katie Dixon

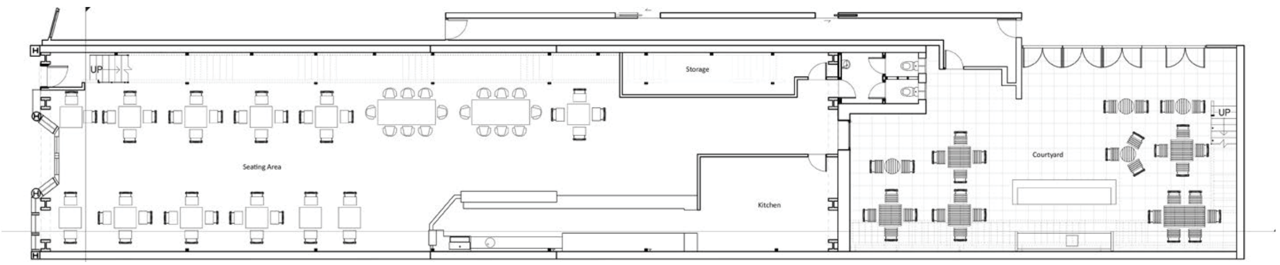
Facade strengthening tactics are an important part of integrating existing and new. Typically, shopfront facades lack lateral strength and are often weakened by alterations to open up the shopfront to full public vision. The way in which this strengthening is approached can reinforce existing architectural integrity. Ways that the exterior of a building is viewed are important to the wider streetscape and play an important role in establishing the building into the wider urban fabric.



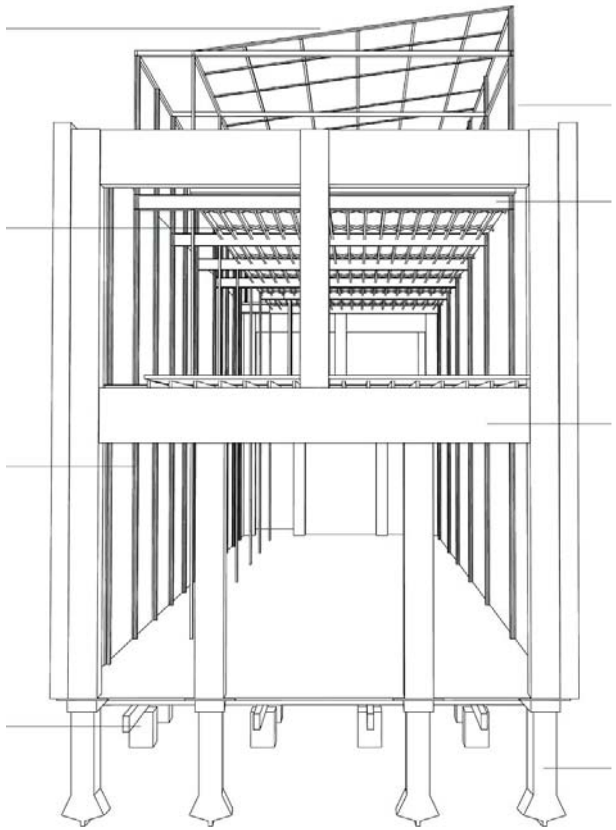
Second Floor Plan



First Floor Plan

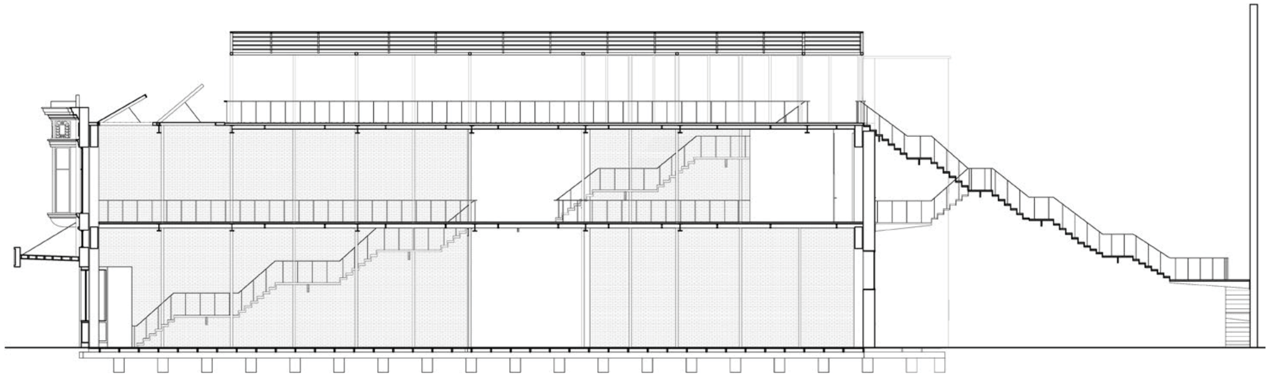


Ground Floor Plan

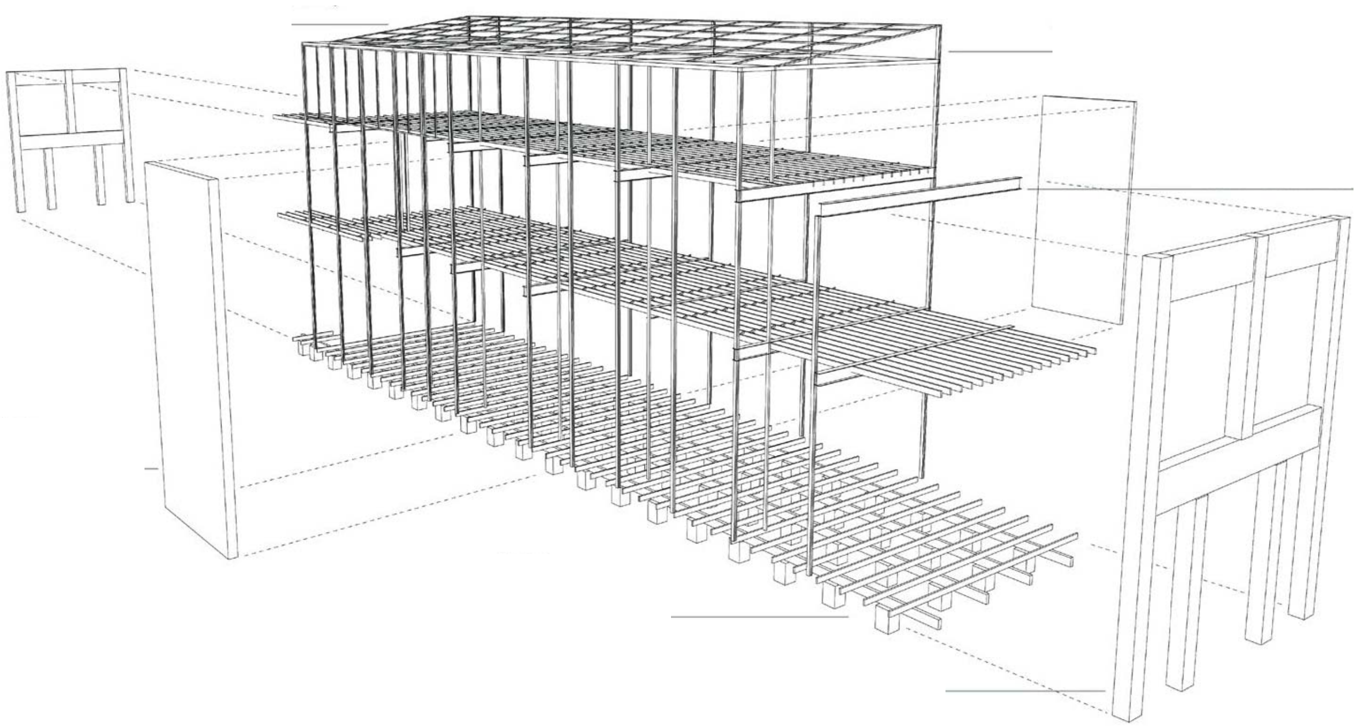


Sectional Elevation
New structural frames within existing building shell.

This case study shows a productive and common tactic for interior structural strengthening. New structural frames are contrasted with the existing structure and building fabric. These are set out within the existing building to align with and augment existing structural elements and to connect to the existing building fabric. The new elements are treated as a new generation of structural work to be expressed and read separately from the existing structure.



Key Sectional Comparison
Showing contrast between the new and existing structure

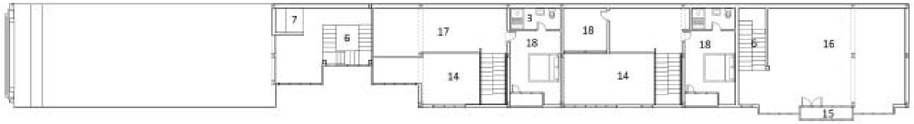


Exploded Axonometric
Clearly separates all elements of the building into separate components

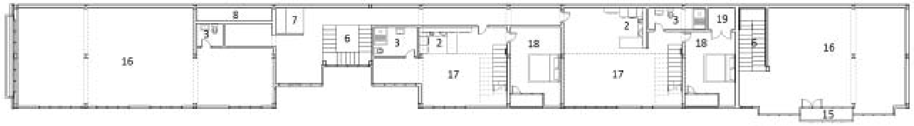
Architectural Project:
Single Building Case Studies
Replication:
Design after the Manner of the Existing.

Georgia Sanson

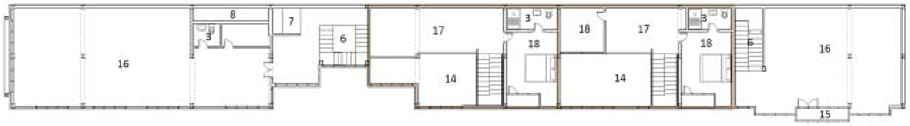
Perspective from Cuba Street



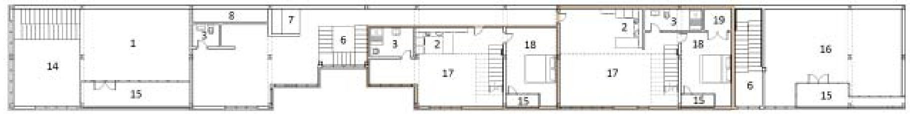
Third Floor



Second Floor



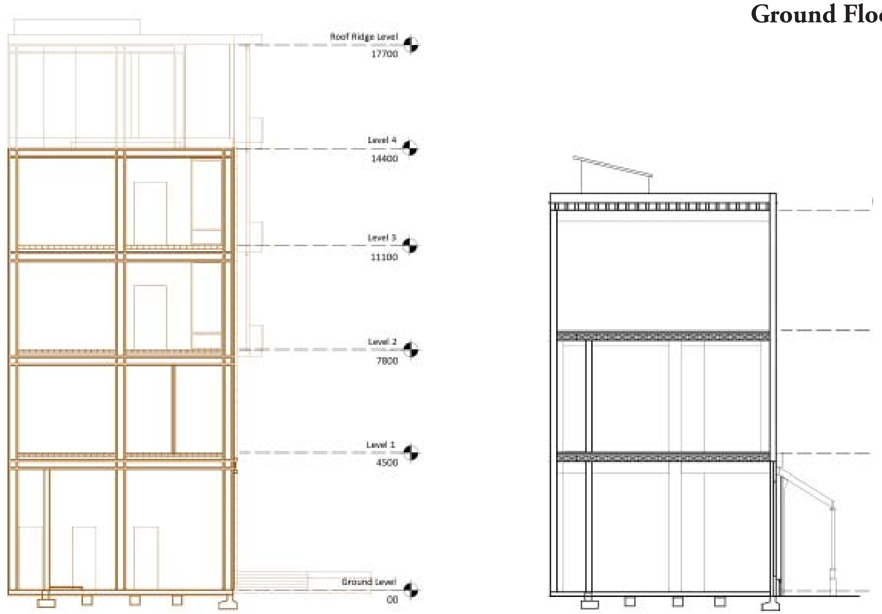
First Floor



Ground Floor

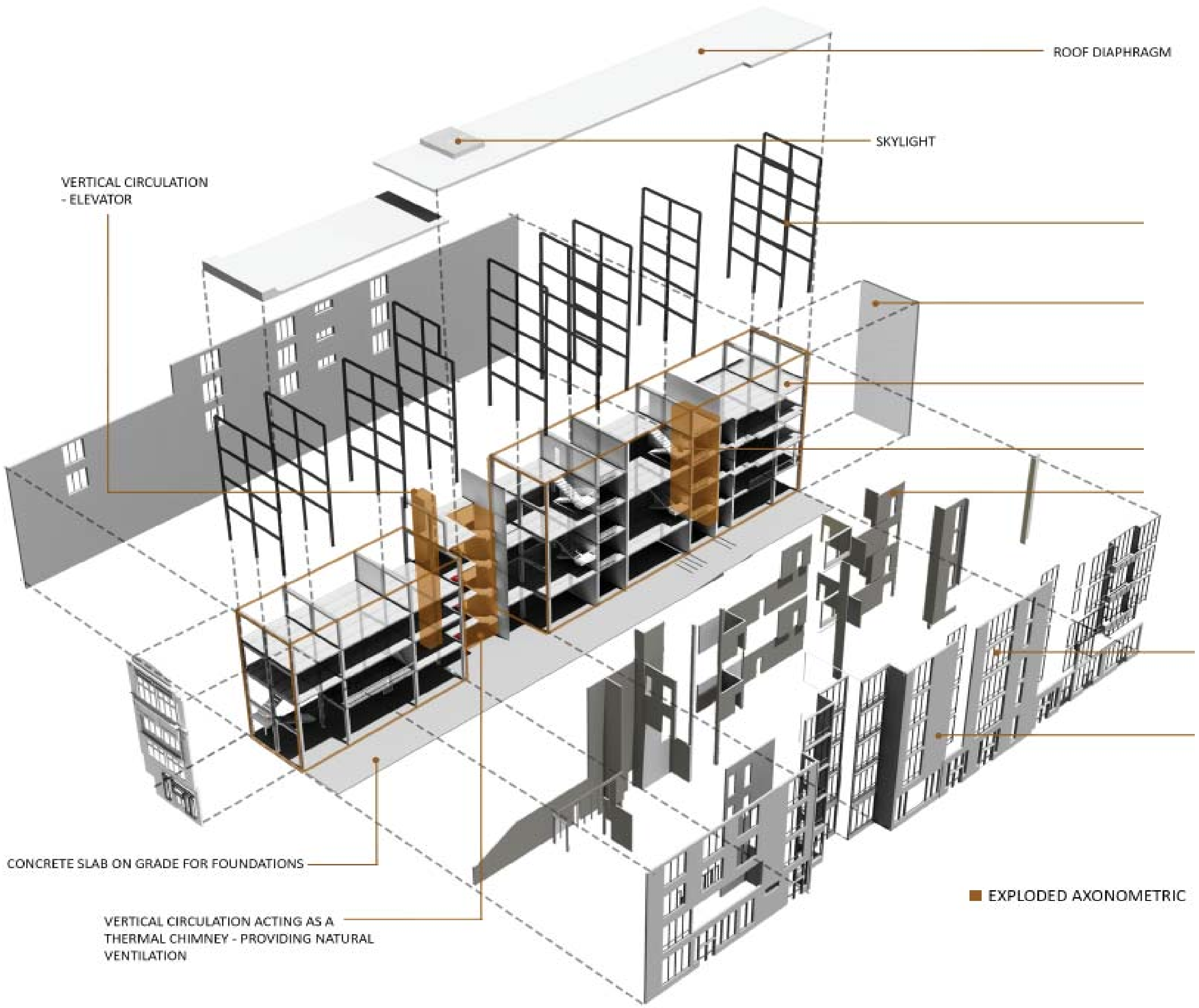
Cuba Elevation

Showing facade alterations and comparison between the old and new facade



Key Sectional Comparison

Showing difference between the new and existing structure



Exploded Axonometric
Separation of elements of the building into separate layers of components

Replication is a common tactic employed when approaching designing with existing heritage buildings. An existing design is extended, taking its cues from the existing, and designing in the manner of the original architect. This approach superficially seems to be very sympathetic, yet ironically, when applied with skill, this tactic blurs the legibility of what really is original and what is new. It results in a new revision of an old building.

Georgia Sanson has used the principle of replication of the existing design by extending the building height by a whole level within the street front facade. The extension inserts an extra level in the middle part of the building. This adapts the existing building scale to its new context and uses what has historically been a common tactic to extend the height of existing buildings over time. Often buildings that appear to have been designed and built in one historical period can be found after closer examination to consist of two or more well-matched generations of work. This type of historically-based context-generated design insertion undermines ease of recognition of truely historic fabric and new work.

By retaining, extruding and carefully enhancing this existing facade, and working directly from its underlying design integrity Georgia has appropriated a heritage design as a medium for a contemporary reinterpretation. The extended historic part of the design has also acted as a transition into the larger scaled and contrasting character of the associated new construction.

This tactic may be seen as a safe approach to designing with the existing because it embraces the qualities of the familiar and is popular for its lack of apparent new work. Many people see this way of working as designing with respect to heritage, however its success can be debated and its prevalence as a tactic should be questioned. As often as not, this tactic results in distortions of an original building's design integrity and sometimes results in a caricature of an original, taking away more from the existing building than it contributes.

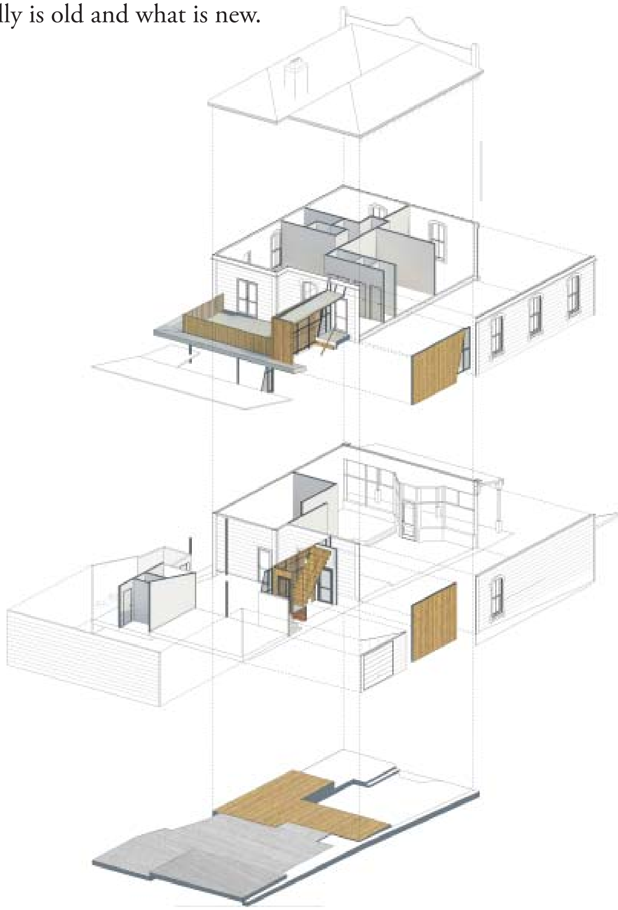
Architectural Project: Single Building Case Studies

Contrasting Existing and New: negative junction in between old and new.

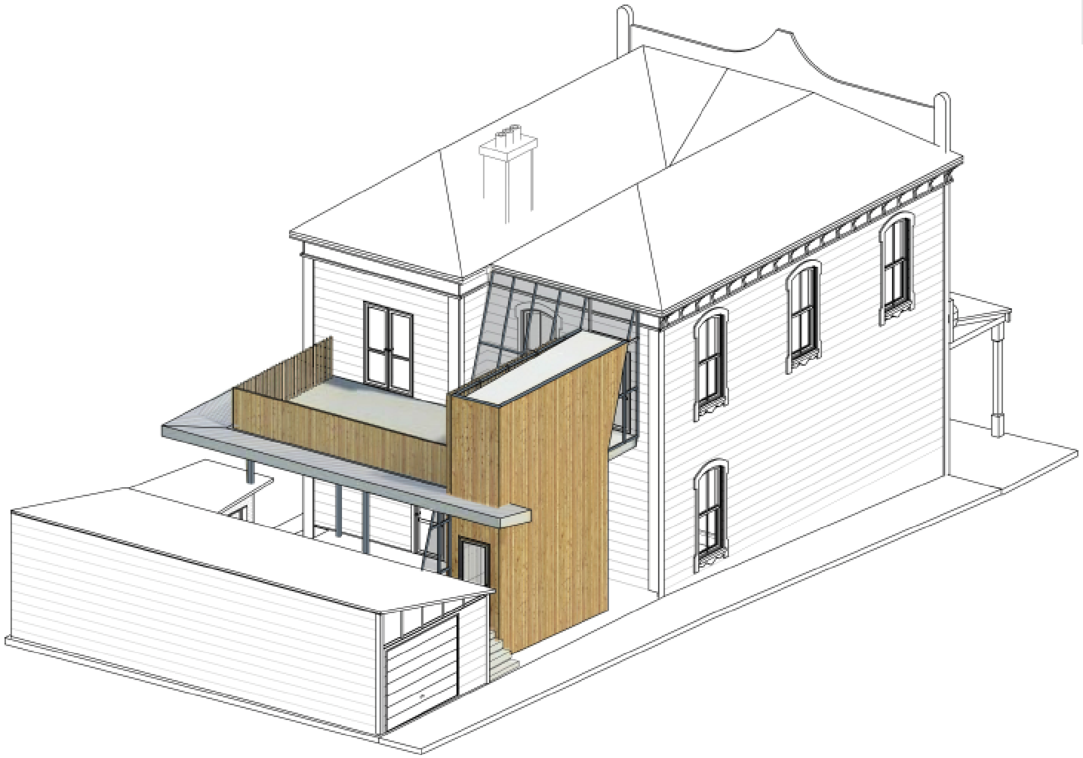
Belinda Stewart

Facade relationships are an important part of integrating existing heritage architecture and new architectural interventions and additions. The way in which this relationship is approached, can strengthen an existing building's architectural integrity by being clear about what really is old and what is new.

Cuba Street Elevation

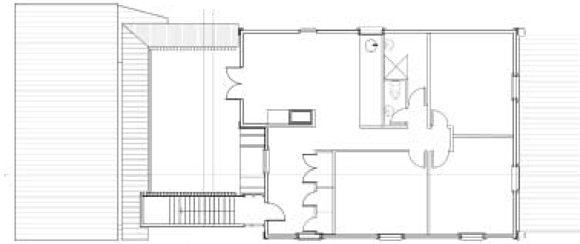


Exploded Axonometric

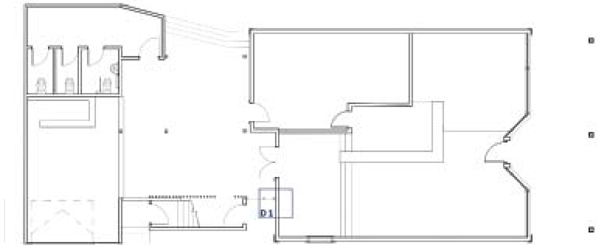


Rendered Axonometric
Highlighting contrast between the existing architecture and the new addition

Key Section



First Floor Plan



Ground Floor Plan

The case-study design by Belinda Stewart explores the well understood architectural principle of contrasting existing and new work. It exploits the idea of negative space between old and new, creating an intermediate space that acts as a 'turning point' between new work and parts of the existing building. A new entrance to the building also occurs at this part of the building on the street edge. The negative junction continues as a slice of space between the old and new parts of the building throughout the site at all levels.

This building is both heritage listed and earthquake prone. The character of the existing property has been retained through restoration of the heritage aspects of the building whilst introducing contemporary form, structure and services. The new parts contrast with the historic and therefore provide a readable interaction between the buildings on site and from the street.

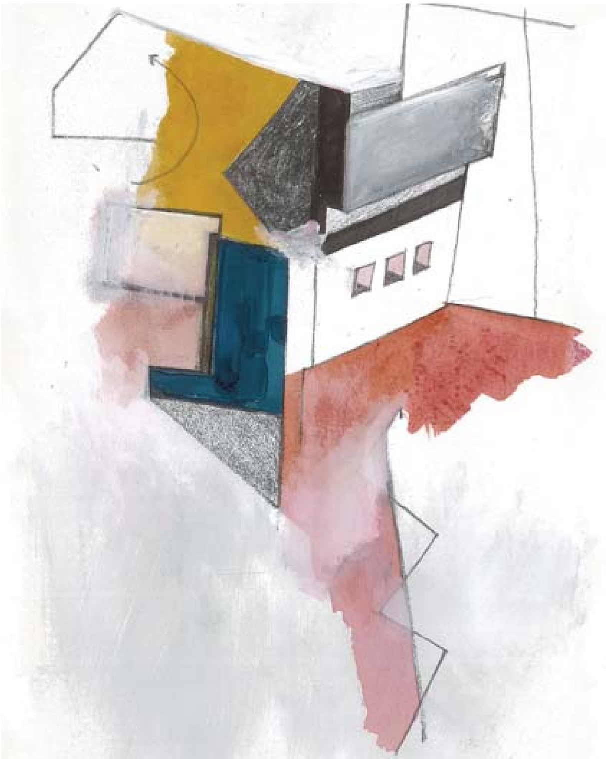
Interior views
Showing the new addition architecture and how it uses negative space to act as a mediator between new and old.

Architectural Project: Single Building Case Studies

Contrasting the Existing: Rooftop Architecture

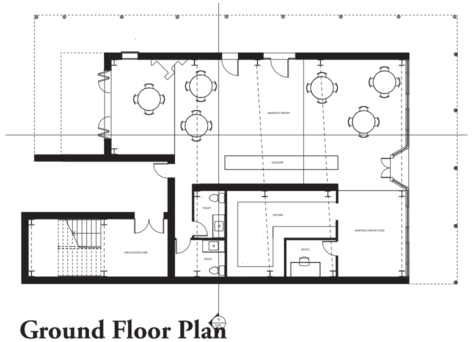
Jayne Kersten

Contrasting old and new when applied to new additions on top of an existing building creates rooftop architecture. This design tactic can highlight existing architecture in a positive way through difference. The new design addition creates two entities with their own design integrity so it can be less critical from a design perspective than for complementary strategies. An underlying parasitic co-dependence exists where the host design qualities are the site for a new contrasting design composition.

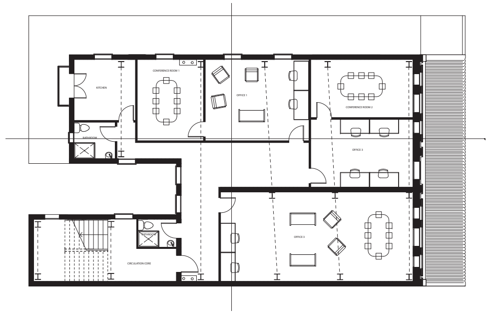


Absracted Render

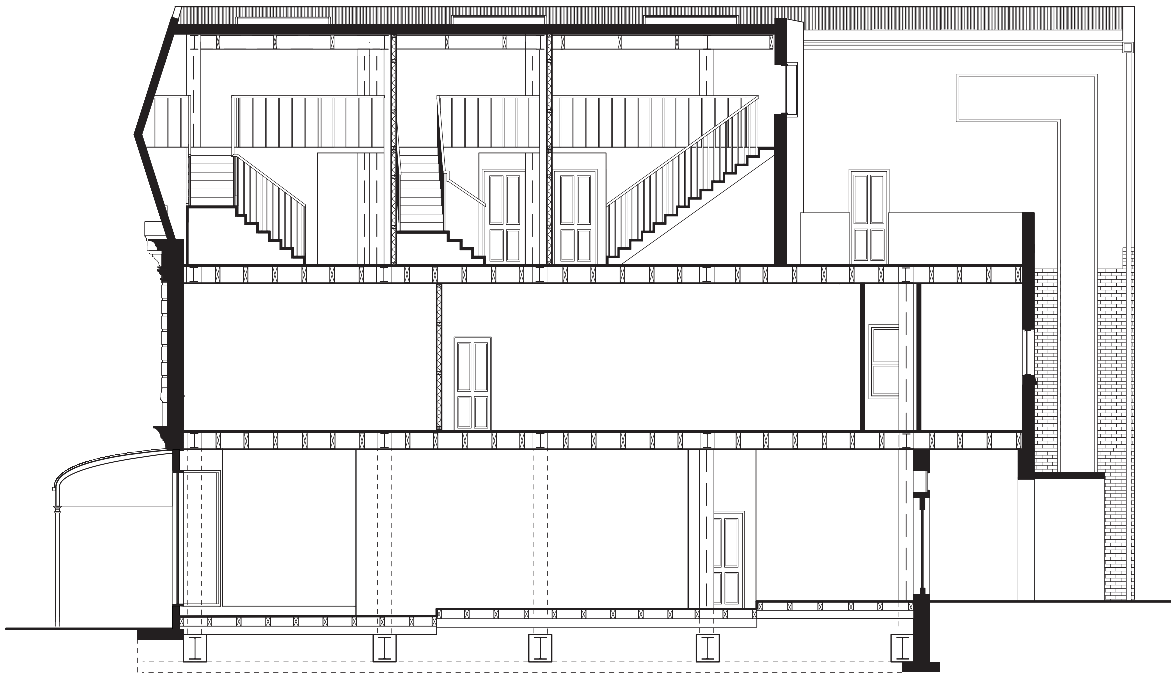
Design sketch of abstracted design method reducing the existing building to block-colour and geometry



Ground Floor Plan

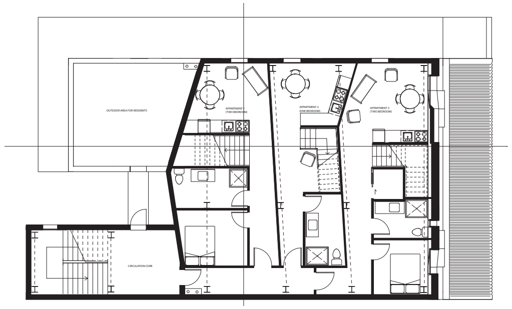


First Floor Plan

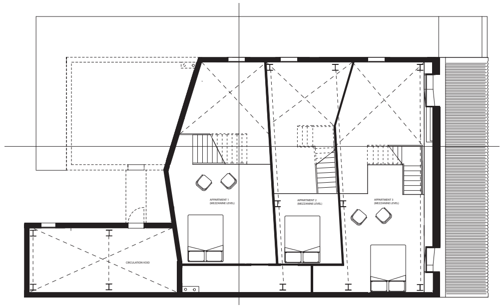


Key Longitudinal Section

Highlighting contrast between the existing architecture and the new rooftop addition

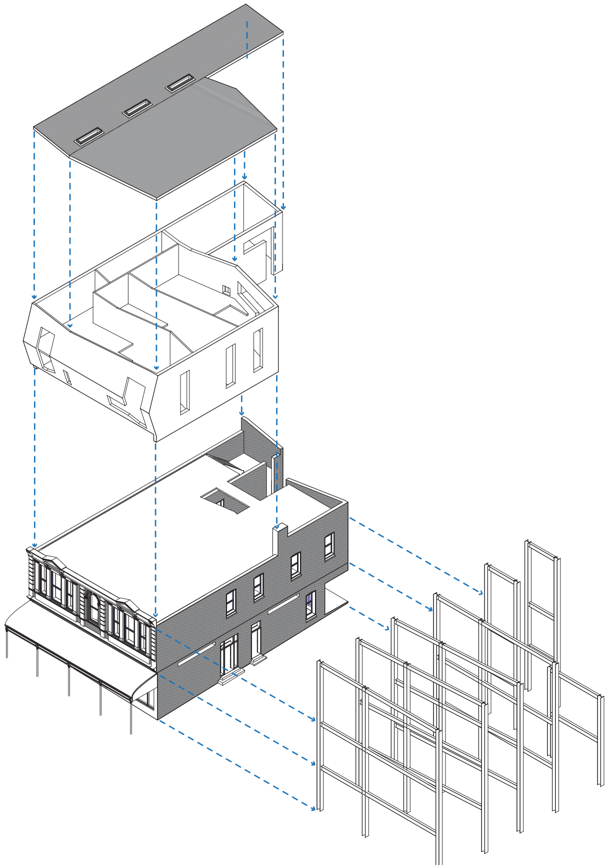


Second Floor Plan



Third Floor Plan

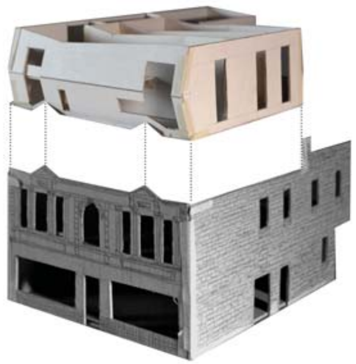
The tactic employed here is similar to the previously discussed tactic of two contrasting buildings on a horizontal plane. Instead of a horizontal spread this project explores the placement of new construction on top of the existing in a vertical contrast where the eye is drawn upwards. In this functional design integration each of the components has an independent design integrity based on a subtle underlying abstract relationship. Another tactic Jayne employed was an adaption of the original roof silhouette as a profile for the new design. The windows in the new addition to the building followed the lines of the existing pediment shapes above windows creating a dialogue between new and old.



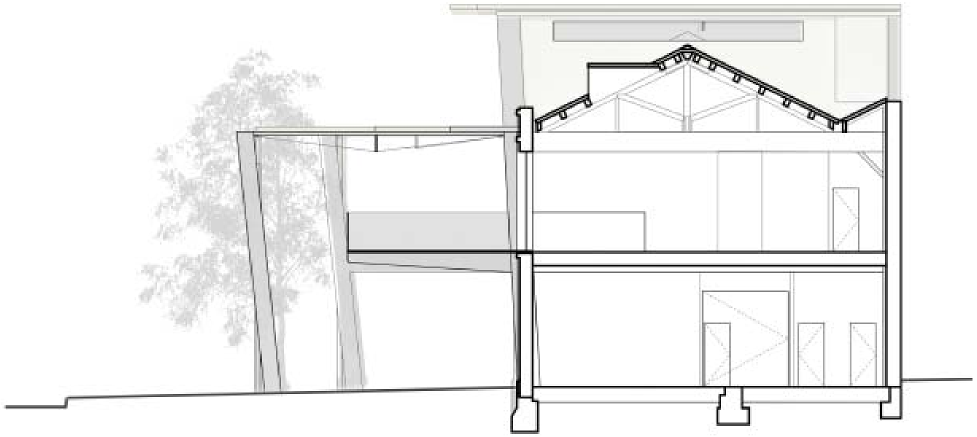
Exploded Axonometric

Rendered Elevation

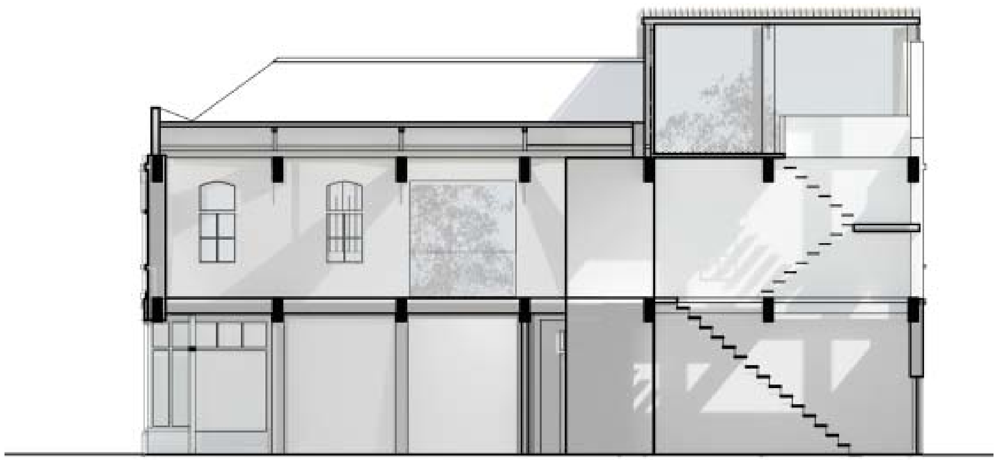
Highlighting contrast between the existing architecture and the new addition



Architectural Project:
Single Building Case Studies
Strengthening from the Outside:
Partial Exoskeleton
Henry Dengate-Thrush



Key Section
Showing the transition between interior and exterior environment



Key Section
Longitudinal Section

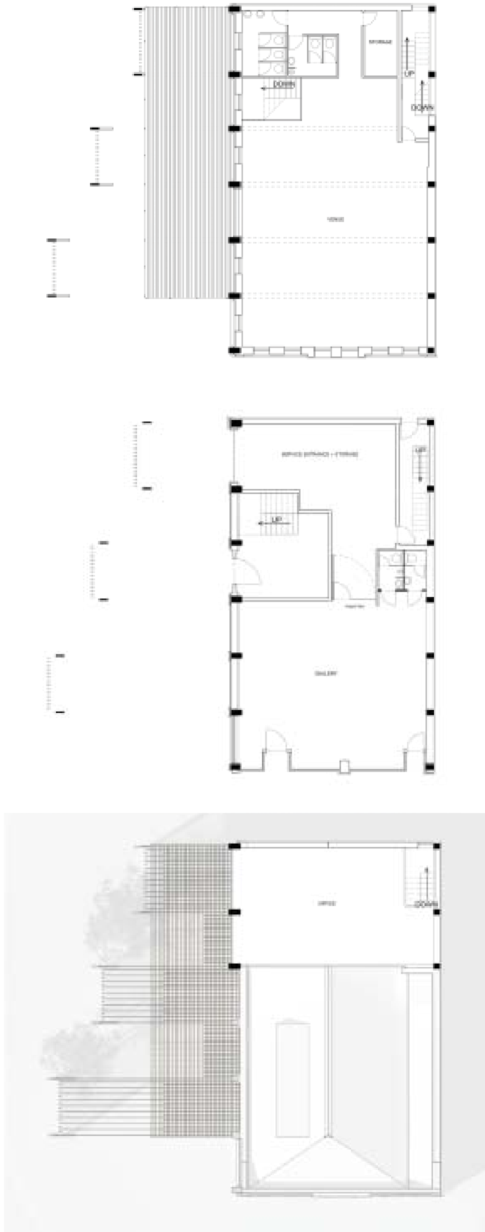
Images of new structure from the exterior
Showing contrast between the new and existing structure

External strengthening is an increasingly attractive tactic to strengthen existing heritage buildings. It has the huge advantage of minimising internal disruption and consequential interior remodelling required. It requires additional land availablity around an existing building to accommodate the external structural elements. The design of structure and its integration with architecture are critical as the structure is visible externally around the existing building.

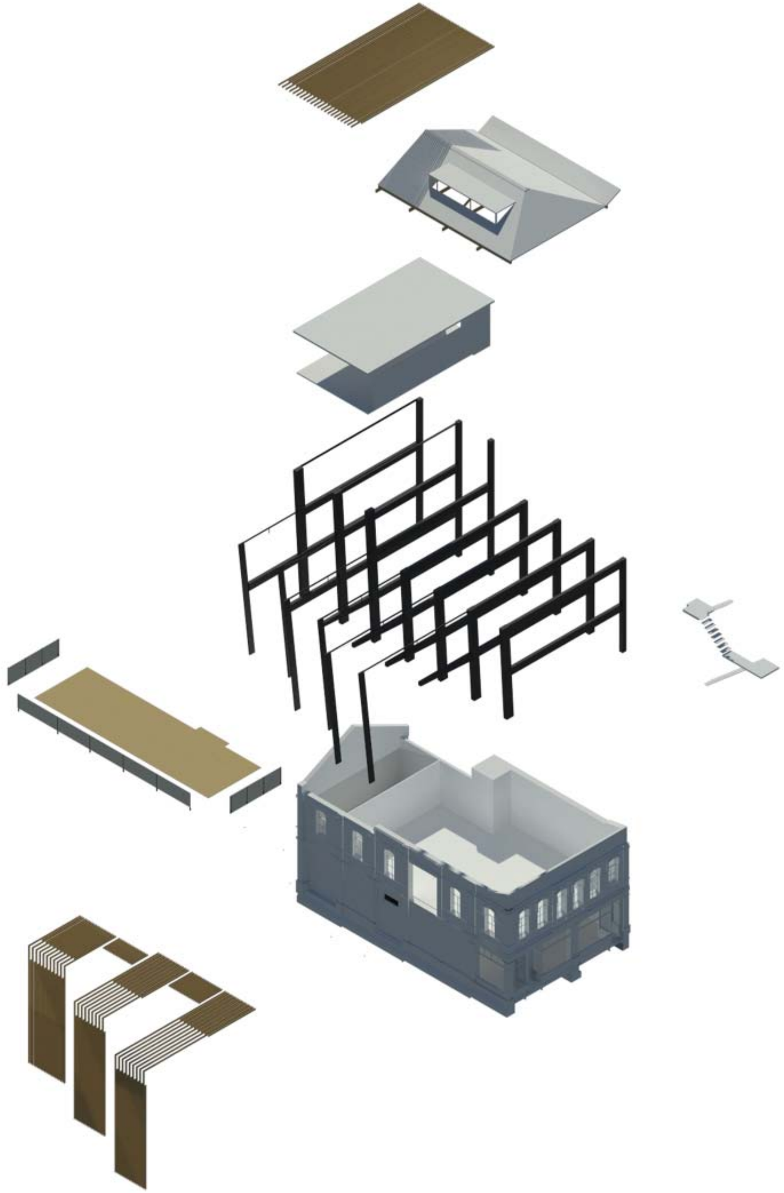
The retrofit of Thistle Hall and its developed design was driven predominantly by the building's structural need for seismic reinforcing, and the desire to maintain a culturally important building. Growing and shifting community needs are accommodated by improving the space functionally.

When approaching the re-design of Thistle Hall, Henry Dengate-Thrush has used the principles of a strong structural external expression and integration in his work from the exterior, minimising internal retrofitting needs. Existing structural lines and foundations are extended on the building exterior, in this case providing full integration by also providing for an exterior balcony and canopy. The addition of the balcony increases the building's potential uses, utilises its connection to the street frontage and creates an active connection between the interior and the north-facing side street frontage.

More extensive external structural retrofitting solutions may form an exoskeleton structure around the exterior of a building to be strengthened.



Plans
Note: little work is required to the interior



Axonometric
Showing new structure and major building elements

Architectural Project: Single Building Case Studies

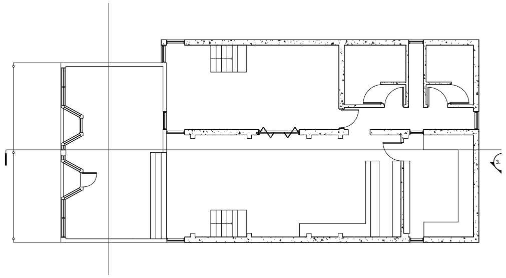
Critical Editing

Adam Atmore[1] & Jonny Fletcher[2]

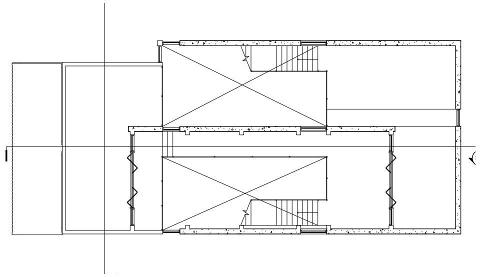
Critical editing design tactics leave most existing building fabric un-altered while performing selective surgery on part of it. This tactic assesses existing fabric and adapts it for new contemporary occupation that keeps important parts of a building and edits out others. By editing critically, a designer can chose to draw attention to parts of the building through the absence of others.

Render of Facade Alteration[1]
Adam Atmore

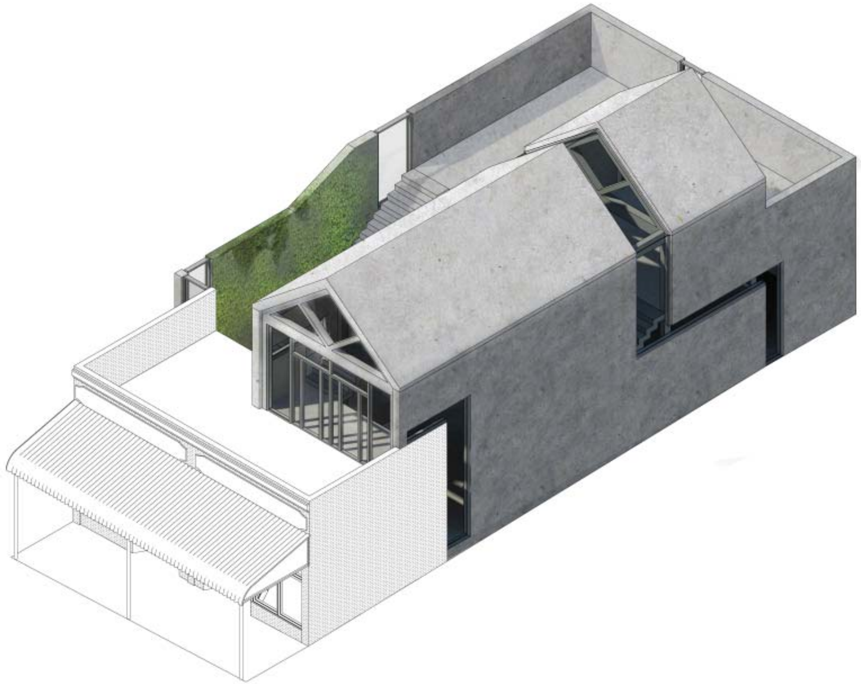
Adam Atmore dramatically expresses the design changes to this building. He takes an obvious slice out of the existing façade to highlight its adaption in a contemporary context, and the location of a new laneway and entrance. Major surgery to the existing façade creates a dramatic sense of editing the existing, highlighting it and creating a sense of dynamism in the new hybrid design.



Ground Floor Plan[2]

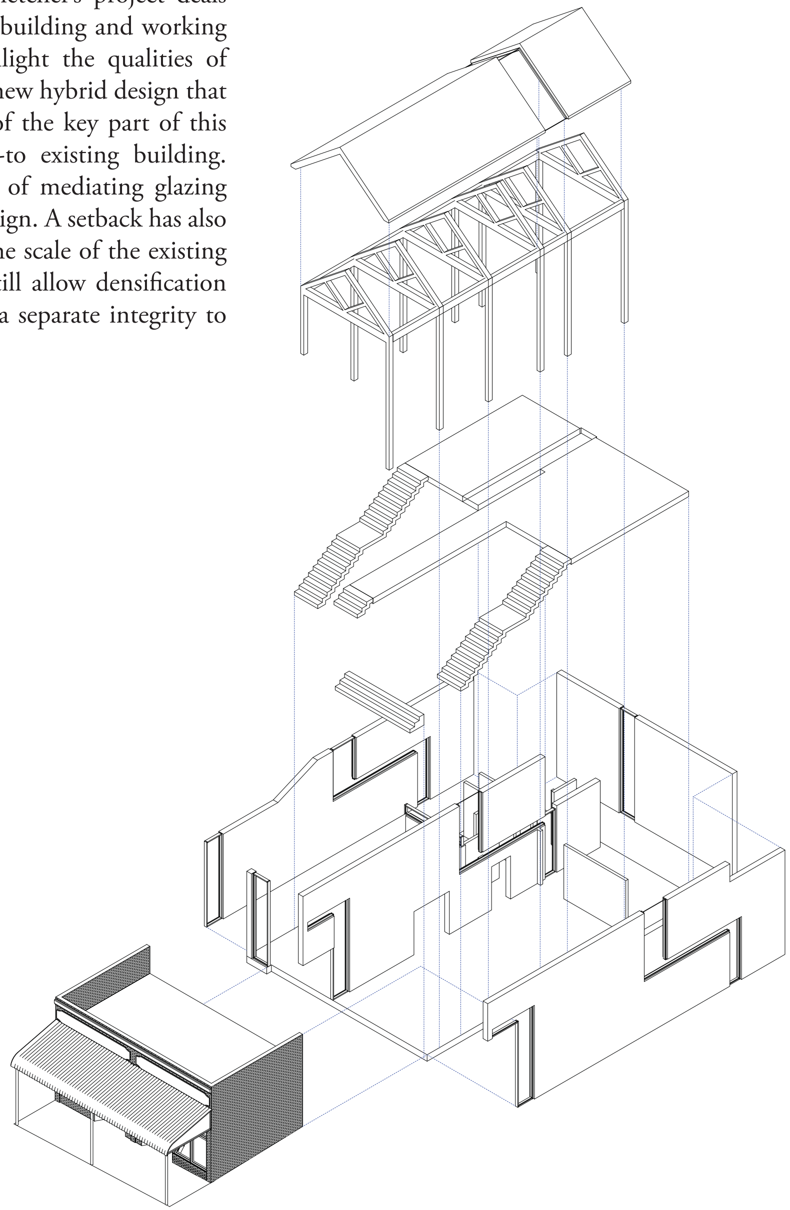


First Floor Plan[2]



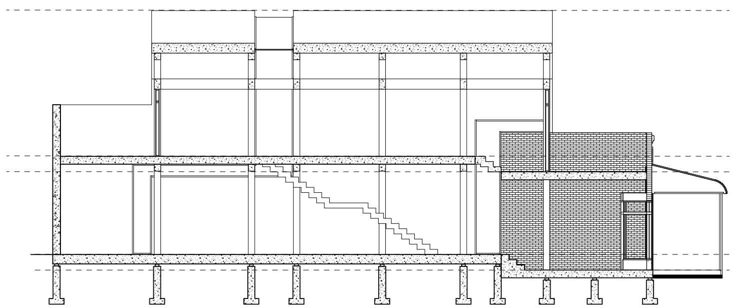
Rendered Axonometric of Additional Construction[2]
Jonny Fletcher

Negative junctions may be used effectively to express and clarify what is new and what is existing at the critical points where old and new join. Jonny Fletcher's project deals with the idea of slicing parts of the building and working with negative space to gently highlight the qualities of existing historic fabric. He creates a new hybrid design that has accentuated the heritage value of the key part of this otherwise badly-altered and added-to existing building. Negative-space is used in the form of mediating glazing between old and new parts of the design. A setback has also been used so as not to overwhelm the scale of the existing architecture at street level, but to still allow densification and a new design component with a separate integrity to the existing façade.



Exploded Axonometric view[2]

Elevation from Cuba Street[2]



Key Section[2]

Architectural Project Cluster Case Studies

Existing Buildings as Seed.

Louise Seyb

Corner Perspective at Karo Drive
Showing existing building co-existing with the new development over

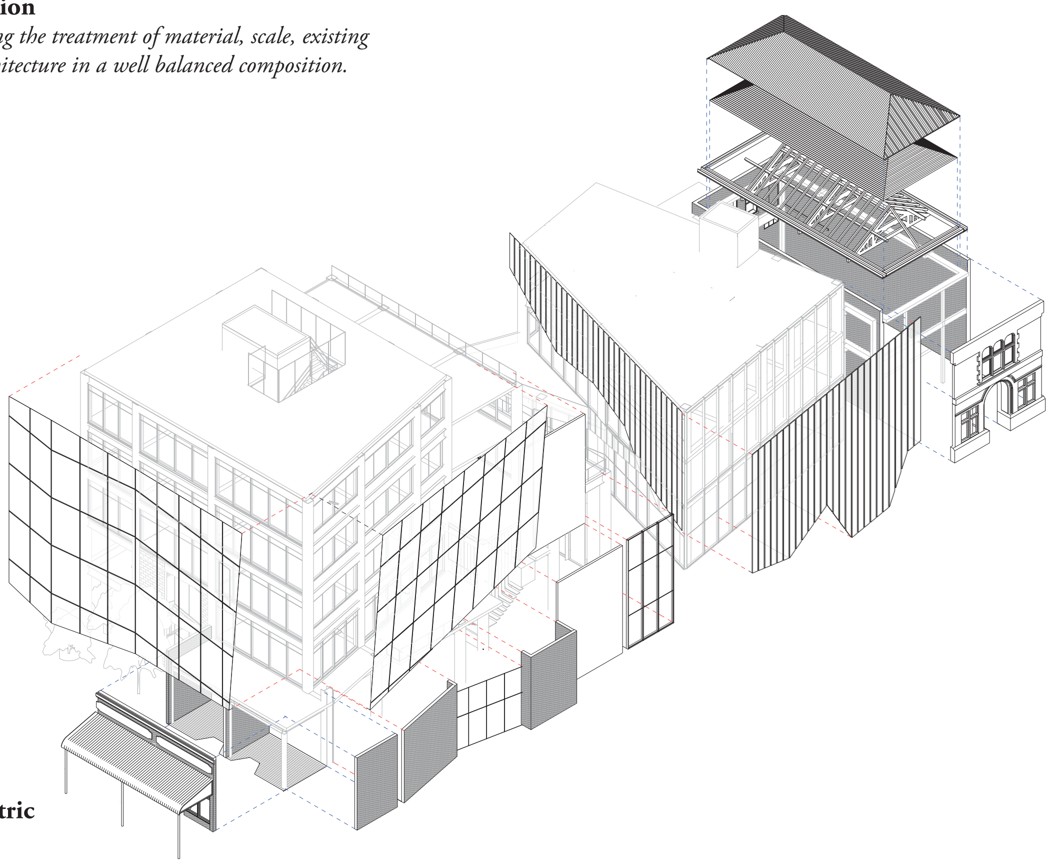
Context was a major challenge even where there were several heritage buildings existing on a site, and particularly when buildings had a long and varied history of alteration, addition and adaption. Which buildings and which parts of buildings should be retained, restored, or edited? How can the changing economic and development context be manipulated to ensure that the qualities and scale of the existing architecture are not overwhelmed?

Interior Perspective
Interior of Arthur Street heritage building

Laneway Perspective
Pedestrian laneway through site.

Floor Plans
Existing buildings shown on the lowest plan, upper levels above.

Arthur Street Elevation
Key elevation highlighting the treatment of material, scale, existing and intensified new architecture in a well balanced composition.



Exploded Axonometric

This project investigates the value of small-scale historical buildings and their integration into a larger urban ensemble and building footprint. Two small-scale historical buildings have been regenerated and celebrate their historic value as bookend and cornerstone of a new much larger urban renewal project. The project defers to and emphasises particular qualities of the existing buildings and also extracts key existing qualities from the historic buildings as seeds to propagate a new complementary architecture, whilst celebrating the old.

Located in Upper Cuba Street, the site for the project is a unique one, with historical buildings at each end, and a large space in-between. The selection of this site was based on the 30 Arthur Street building. Particular characteristics about this building that are to be worked upon are the scale of the building, its material qualities and the exposed 'honest' use of materials. These ideas,and responding to the physical and planning contexts of the site, served as inspiration for the design. Respect for the existing heritage 'anchors', and the building ideas they represent, were critical to the new design. Laneways were also introduced to break up the otherwise potentially dominating scale of the new composite design. The form of the new development was therefore key to the design, playing with scale and relationships between main buildings and the wider urban context.

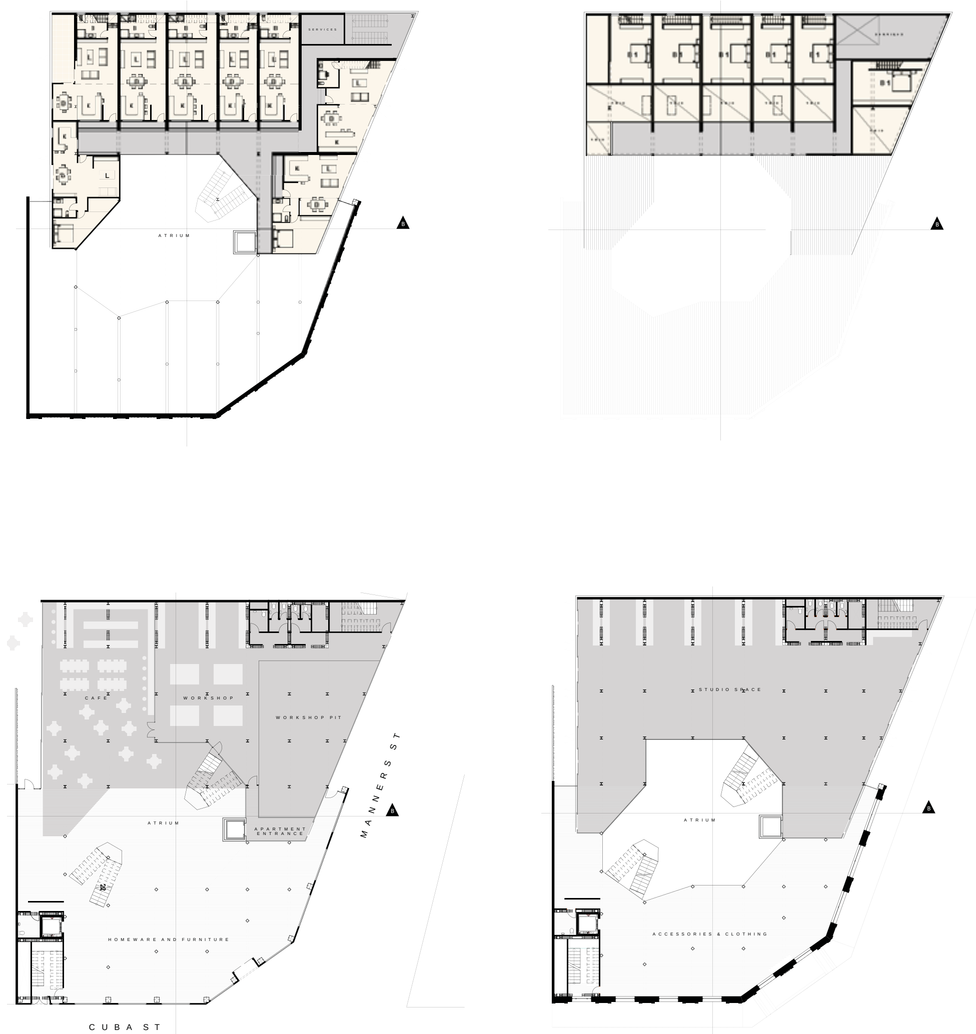
The seismic retofit of 30 Arthur Street is also significant. It adopts an attached new adjacent building as the means to seismically upgrade the existing building and retain its beautiful existing interior qualities without the disruption of a new structural interior frame.

Architectural Project: Cluster Buildings Case Studies

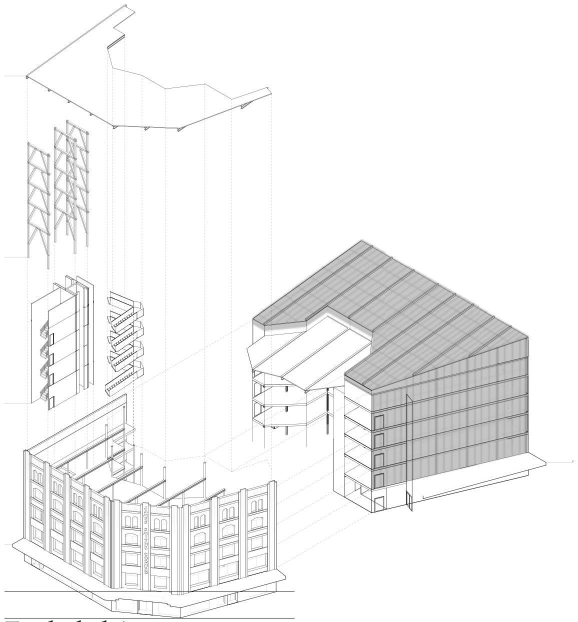
Contrast and Co-Dependence: Old and New

Kelly Lambert

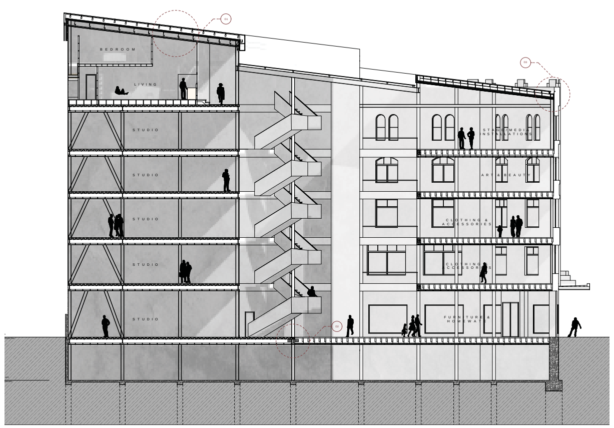
View of void.
The junction between the old and new building parts and the expressed contrast showing co-dependence of both.



Floor Plans



Exploded Axonometric
Showing key structural elements of the building



Key Section
Highlighting the old and the new parts of the building

Perspective
Drawing of the building from Manners Street

This project seeks to respect the integrity of the original building, and highlight a co-dependence between the old and the new seismic retrofit, which takes the form of a partial new building alongside and supporting the existing original building. It is an example of a new addition, which through contrast of its separately conceived and expressed new structure, reinvigorates the existing architecture and facilitates new spatial qualities.

The new building references the old through the continuation of its proportions and levels. An obvious and important design tactic is the creation of a large void between new and old parts of the building. The void deals with the transition and interface between the old and the new elements.

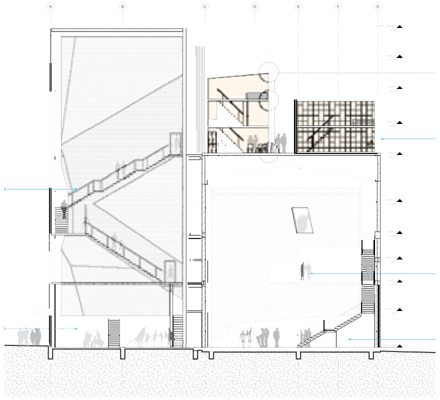
New structure has been created through a continuation and augmentation of the pre-existing structural grid lines. The simultaneous interdependence of new and old parts of the building is articulated throughout the design of the building and is clearly expressed through the void as a dialogue between old and new.

Architectural Project:
Cluster Buildings Case Studies

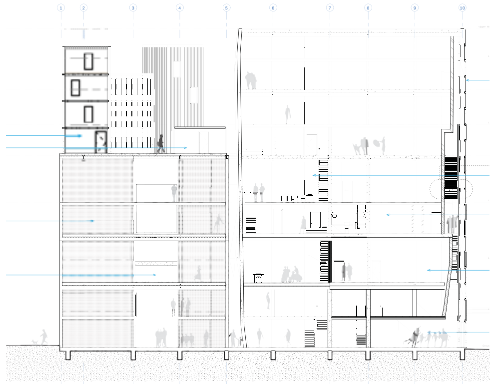
Building within a Building
& Rooftop Apartments

Grant Douglas

Seismic retrofitting is inherently invasive to an existing building typically affecting foundations, walls, floors and ceilings. There are opportunities for parts of buildings to be strengthened as new volumes vertically within an existing building. This case study differentiates what is existing and what is new through contrast and spatial isolation through structure and material specification. Spaces seamlessly merge through the circulation space, the left-behind spaces in-between the old and the new.



Lateral Section

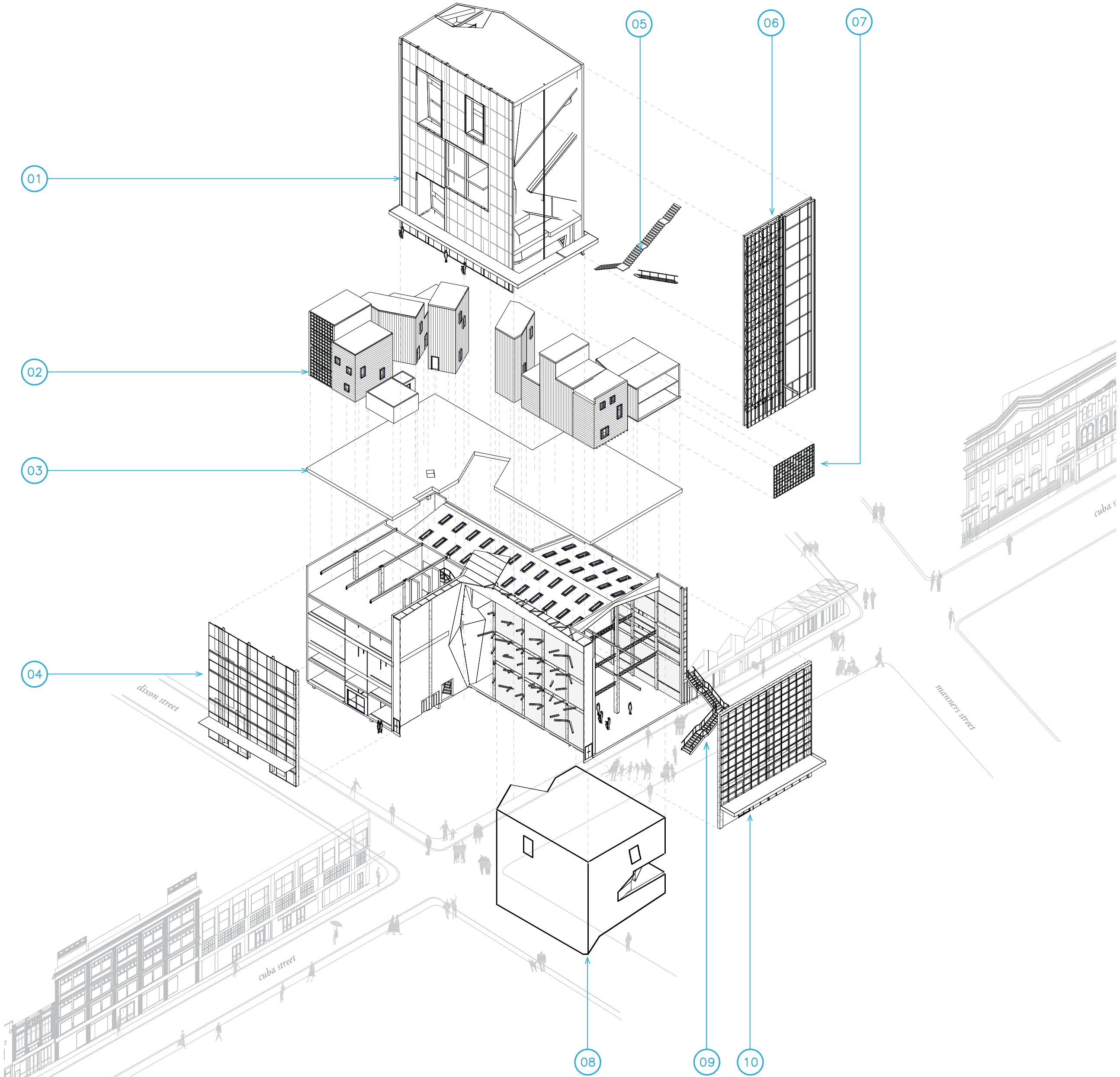


Longitudinal Section

Interior view
The main public spaces

Interior view
The junction between the exxisting and new interior spaces

Exterior view



Exploded Axonometric
Showing new and existing structure

This project has a focus on human scale and character, and the implications of densification for the potential loss of the smaller scale grain of Cuba Street. It reponds to and introduces an intimate smaller scale for interior retrofitting and building intensification.The interior retrofitting is proposed as new structural volume within the existing building. Volumetric strengthening where shear cores are linked to gravity resisting systems have great potential for seismic retrofitting in a similar manner to their application within new buildings.

The other significant component of this proposal is the rooftop apartment typology. In this case individual apartments and spaces are expressed as a new residential scaled layer of design work on top of the existing building that acts as a datum, a podium on which the rest of the design rests. Existing exterior treatments to the existing buildings are maintained.

Key:

1) Dixon Street facade
2) Upper residential housing
3) Supporting floor slabs
4) Dixon street facade
5) Circulation visible from street
6) Split curtain wall facade
7) Tight residential timber formed curtain wall
8) Internal volume- visual atrs & production
9) Circulation visible from street
10) Existing modernist curtain wall facade

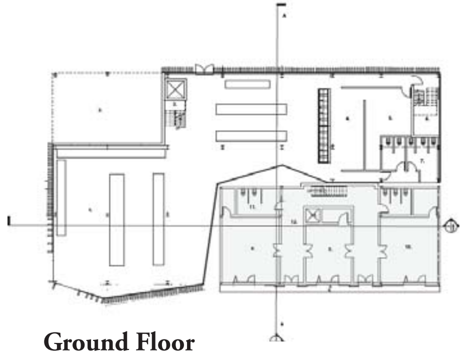
Architectural Project: Cluster Buildings Case Studies

Formal Separation & Visual Contrast

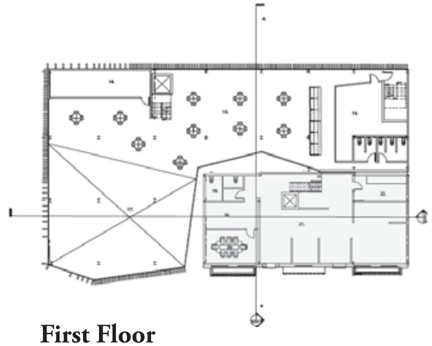
Kristen Cowley

The intensification problem, considered in the previous two case studies, is addressed in a different manner in this example. Two contrasting formal responses are juxtaposed with a clearly expressed mediating space between them.

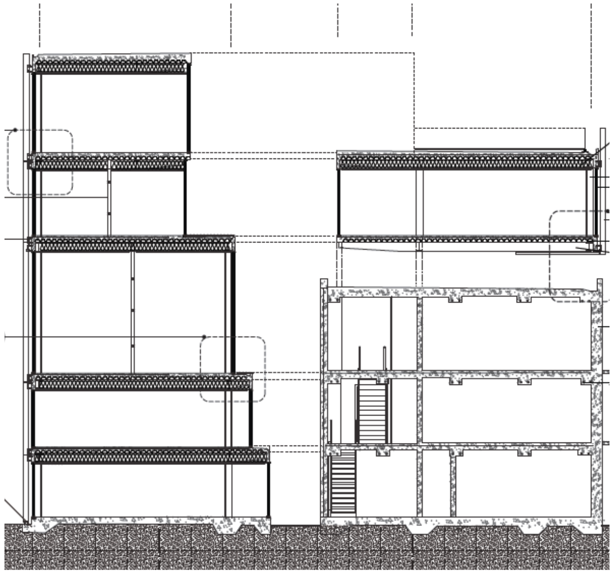
Kristen's design response to redevelopment of an art deco era apartment building clearly and unambiguously contrasts the new work from the old. She designs the space between the buildings as not only a gap - it becomes an important fissure, a laneway with its own character and formal expression that is an important key design element within the overall design of the building cluster.



Ground Floor



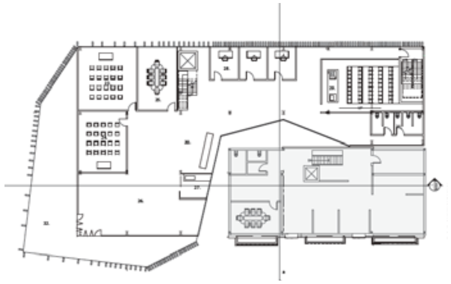
First Floor



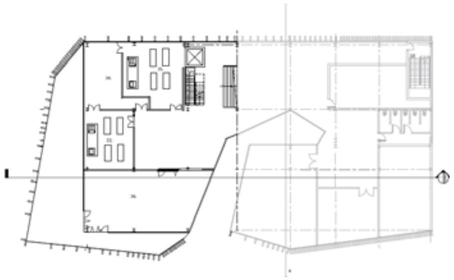
Cross Sectional view

Exterior view showing spaces between buildings
Physical separation both vertically and horizontally

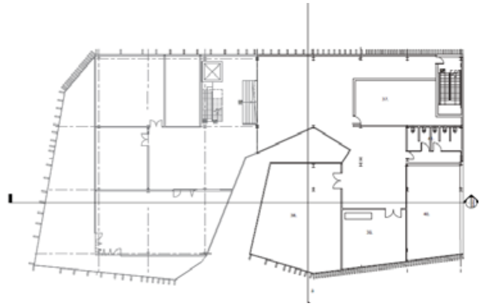
Interior void
Physical separation shown vertically.



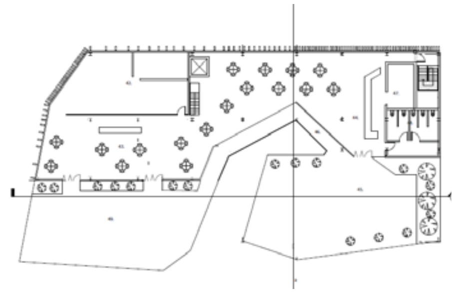
Second Floor



Third Floor
Split Level 1

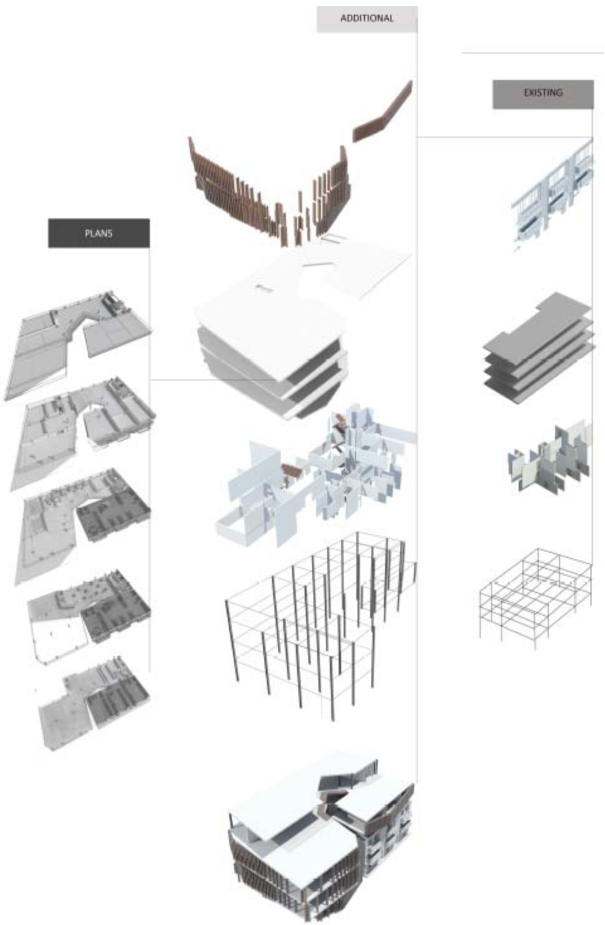


Third Floor
Split Level 2



Fourth Floor

Strengthening work occurs both within the existing building and the new work which is linked to the existing along part of the rear of the building. New construction over the top of the building is also expressed as separate to the existing building and appears to float above it. There is absolute clarity of what is new and what is older, and a dialogue is created between them across the void space that separates them.



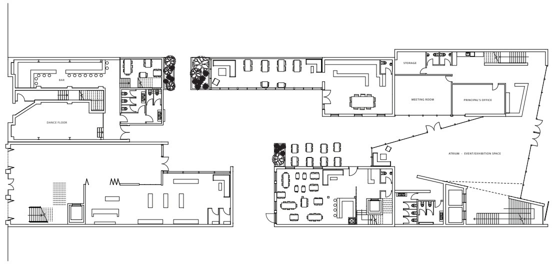
Exploded Axonometric

Scale Model

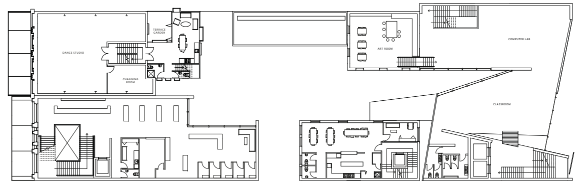
Architectural Project: Cluster Buildings Case Studies

Scale contrast: Big building behind smaller scale existing buildings on street

Sophie Edwards



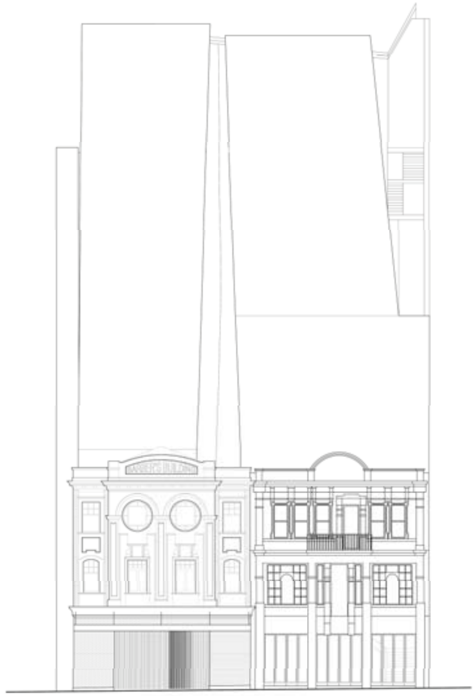
Ground Floor Plan



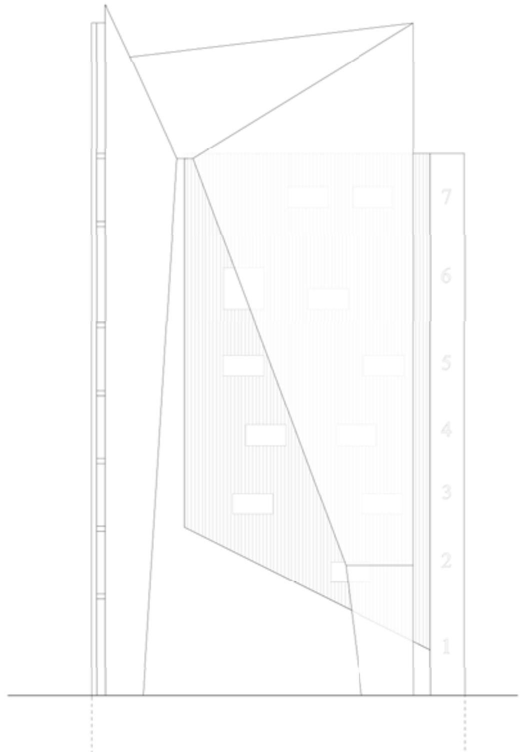
First Floor Plan

Intensification of sites containing heritage buildings can result in 'facadism' - the demolition of heritage buildings and keeping a trace of the building, its facing, its outline, its facade. Keeping a building facade is like wallpapering with architecture. It results in a thin semblance of an original, adhered to a new usually much larger building behind. While there will be times this is the only way that any architectural heritage can be salvaged, it is a last resort, and results in a pale shadow of the original architecture with no spatial depth or integrity.

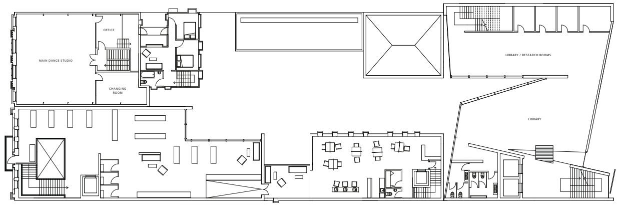
Sophie Edward's design responds to the above issue with an elegant and simple response. Sophie utilises a deep set -back to substantially retain the buildings and their building forms and spatial depth immediately behind them. A substantially larger contemporary contrasting new building is then designed behind it on the rear of the site. Significant spatial and scale integrity results with the old building scale and its related facade remaining as a separate part of the new architectural ensemble. Access to the new building is behind the existing buildings, between the new building and the existing.



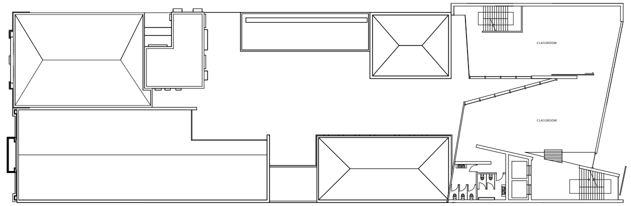
Cuba Street Elevation



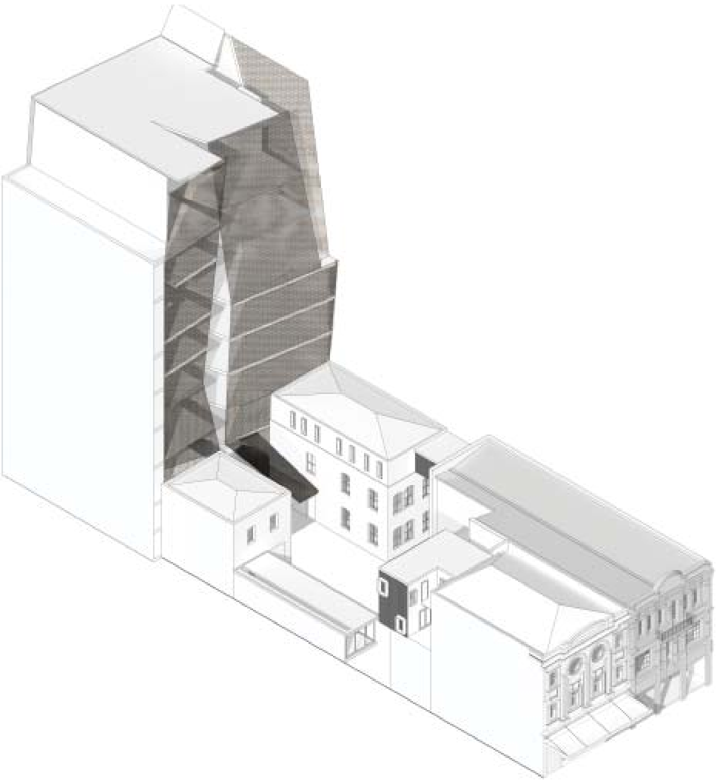
Leeds Street Elevation



Second Floor Plan



Third Floor Plan



Axonometric
Interplay between the existing and new buildings as urban ensemble.

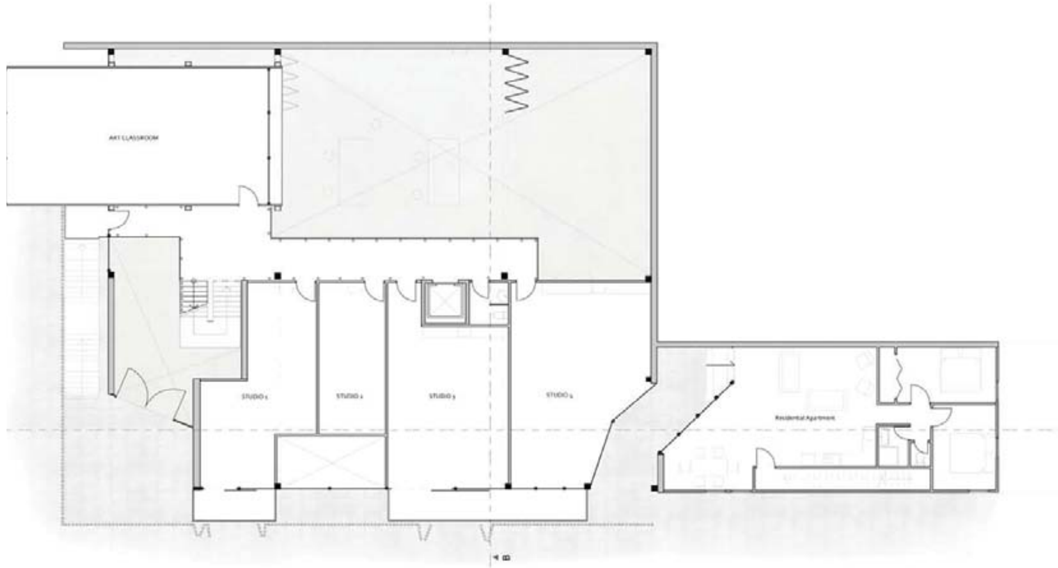
Longitudinal Section

Architectural Project: Cluster Buildings Case Studies

Scale Transition

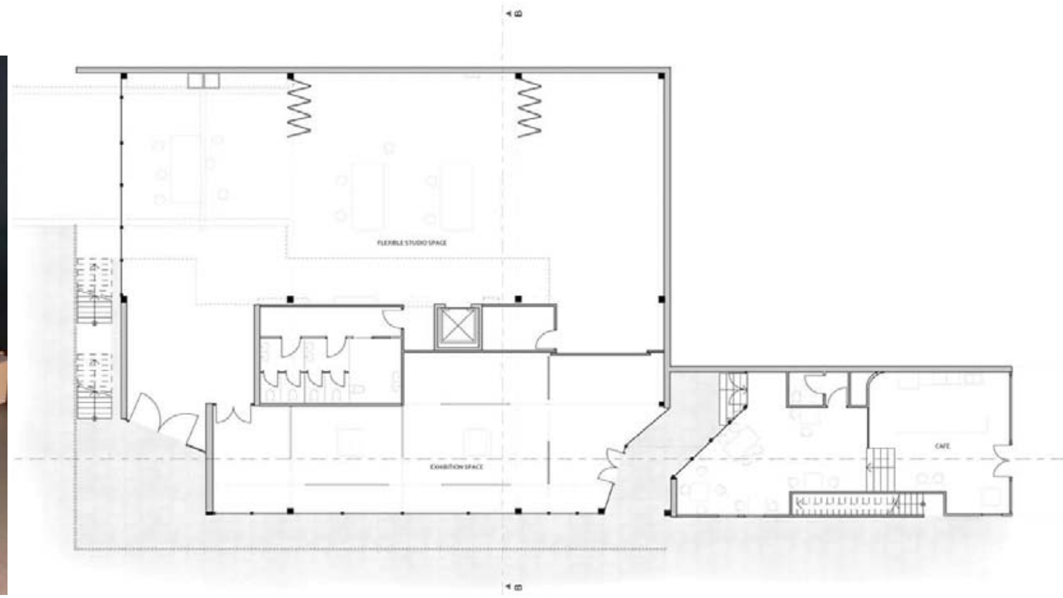
Stephanie Roughan

Tonk's Grove is an important and now almost secret part of the historical make-up of Cuba Street. When grouped with the meticulously restored buildings of upper Cuba Street, together there exists an important heritage-protected architectural snapshot. The group of buildings are all stand-alone and smaller scale houses and shophouses. The contrast with the intensifying scale of the rest of Cuba Street, particularly on the sites adjacent to Tonks Grove creates a significant urban issue for the future in terms of relationship. There is a danger that the rest of Cuba street will turn its back on, and loom over Tonks Grove.

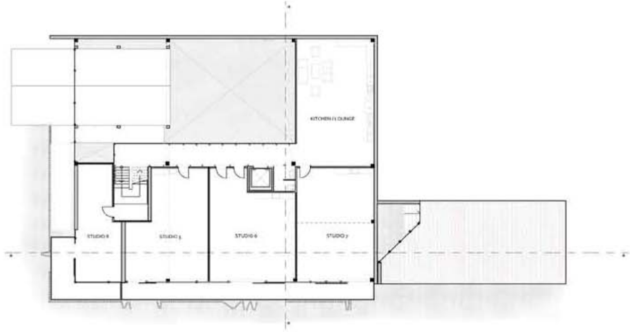


First Floor Plan

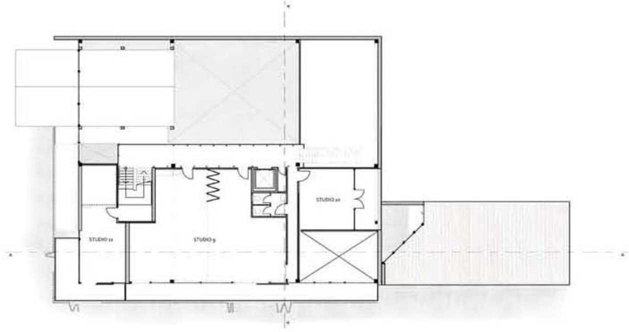
Scale Model



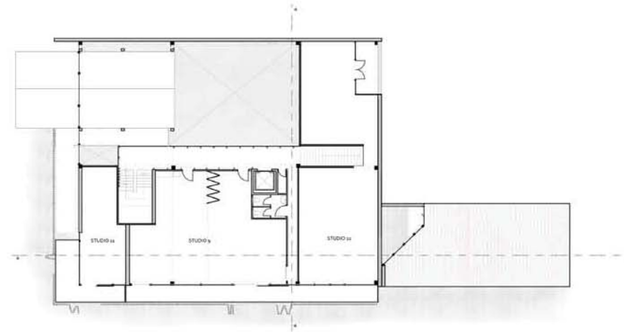
Ground Floor Plan



Floor Plans
Second Floor Plan



Third Floor Plan



Fourth Floor Plan

View from Tonks Grove
Showing the elevation of the facade of the new building and the mediation of scale and context.

Tonk's Grove is a precinct within the upper Cuba Street Karo Drive bypass area where a cluster of historic buildings have been conserved and restored to their historic glory as if frozen in a moment in time. The buildings have a series of contemporary uses and collectively represent the historical character of upper Cuba Street. They also represent well the predominant perception of the results of architectural heritage processes.

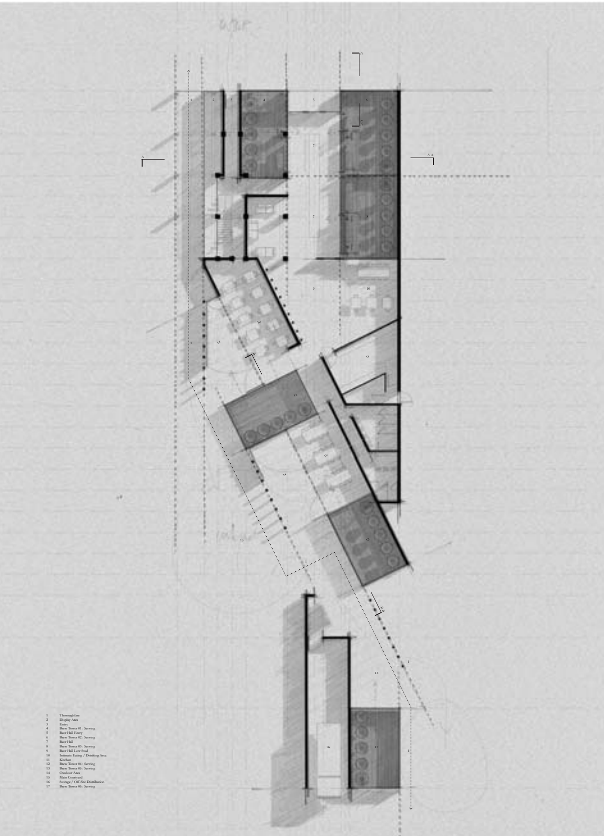
This difficult site context can accommodate large buildings that turn their back on the heritage precinct. Stephanie's design addresses the disjunction of scales ingeniously with an active edge and 'skirt' to the facade shaped to reflect the roof profile of the buildings accross the street. The roof line is also shaped to reflect the scale of the adjacent buildings, breaking down the grain of the new design despite its height. Careful placement of the multi-scaled windows in a somewhat random composition also helps to further break down the building scale by masking the actual scale of the four to five floor building. The introduction of a complementary community arts use also contributes to recharging what is currently an isolated enclave.

Architectural Project: Cluster Buildings Case Studies

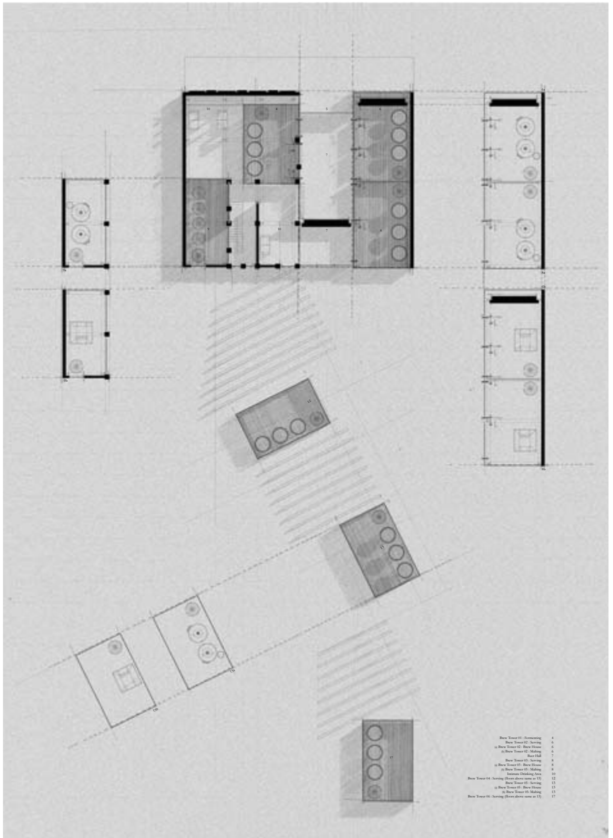
Architecture as Changing, Living Cultural Heritage.

Thomas Seear-Budd

What is original and what has been added or altered to Heritage Architecture in the past? Which history is more important? The original building, its most important layer of work? Its current state?



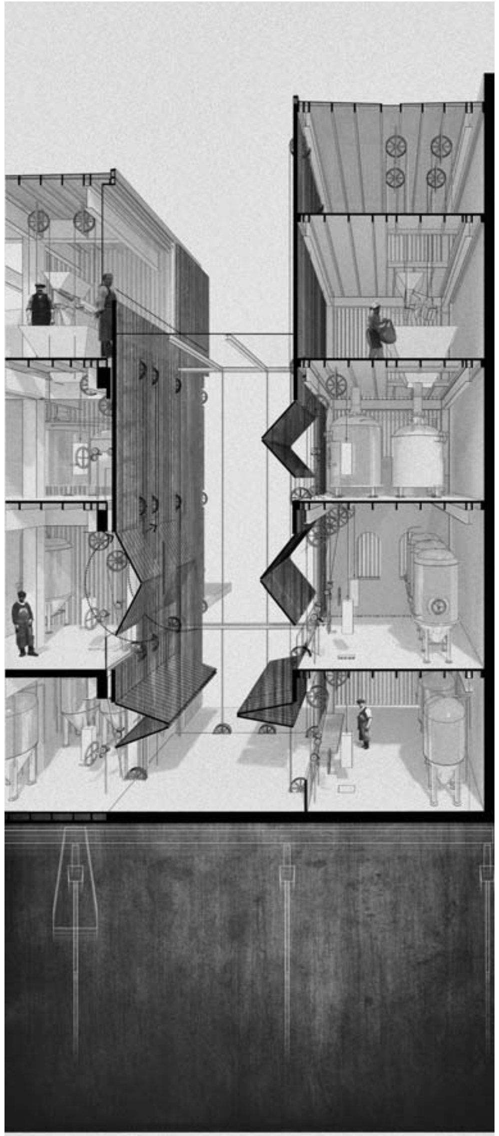
Ground Floor Plan



Third Floor Plan

Cuba Street Perspective
Showing the view at street level.

Atrium interior view.
The relocated facade within the atrium Beer Hall public space.



Section
Showing internal facade treatment and internal courtyard

This project proposes the changing, living character of heritage architecture be embraced rather than erased, as tends to occur with a purer conservation approach to heritage. The JJ Murphys or 'Barbers' building in Cuba Street is an important Heritage building at 123 -125 Cuba Street by architects Crichton and McKay. Close examination of the building reveals there is little of the original remaining, excepting the upper parts of the front building and facade. In particular the lower level interiors and shopfronts confuse what is original and what has occurred in subsequent generations of work.

Thomas Seear-Budd's project takes the blurring of distinction between what is original and what is new as a basis for his new project design. He highlights and critically questions what is original and what is changed, and how they interact. This occurs in two ways. A new timber slatted facade is overlayed over the existing heritage facade. The original facade will be partially masked and partially visible through the slats. The slats also form folding doors that can be opened up to expose and highlight the beautiful heritage facade below and create a canopy over the street edge.

A second part of the facade is completely moved to within the building and suspended as a focus within a major Atrium public space. It's design and its strengthening can be appreciated from both sides, once again highlighting the saving of heritage, its value, and drawing attention to potential critical heritage practices.

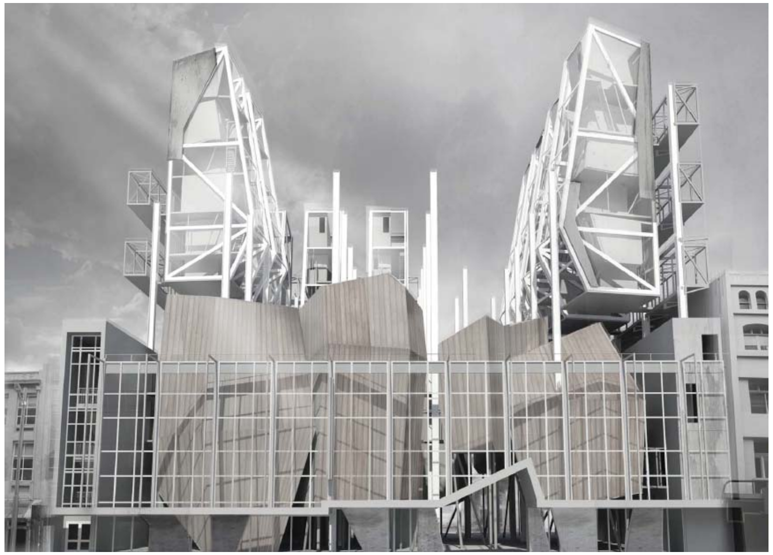
Architectural Project: Cluster Buildings Case Studies

Major Surgery

Declan Burn[1], Henry D'Ath[2]

There are good buildings and poor buildings designed and built in every generation. Some well-designed buildings are poorly built and some poorly-designed buildings are well built of high value materials. A heritage precinct such as Cuba Street contains some buildings of little particular value on their own accord but significant for their contribution to the overall character and scale of the wider precinct.

Declan Burn's and Henry D'Ath's approach to heritage is qualitative. They questioned the intrinsic architectural qualities and value of the existing buildings. They saw existing buildings as potential sites for major surgery and adaptation. While both of these examples are on the more radical end of building adapative reuse, they are good examples of the value of working from heritage, reforming and regenerating existing building structure and fabric to create new architecture. Their design embodies the philosophy that heritage architecture starts with the design of good architecture today. Declan's building strips back the existing building to a frame and creates a new series of cellular building pods within it. The existing facade and stair components are also retained. The pods each have independant structures. A second series of independent pod apartments is supported by new perimeter exposed structural frames.



Cuba Street Elevation[1]

Exterior Perspectives[1]

In Henry's case the existing building and its structure contrasts with the rest of Cuba Street. It is a relatively recent developer-quality building of large scale but with little relationship to the underlying characteristics of the Cuba Character area. It also represents an opportunity for urban intensification. Henry cuts some well formed vertical laneway spaces within the existing building, breaking down its scale. This assists access to its deep rear portions, and a residential component above its uppermost floors. New retrofitted structure is added and expressed for its architectonic qualities. The building is also reclad changing its material qualities. The result is a contemporary restoration and regeneration that has a better match with the underlying scale of its Cuba Street context.

Rendered Contrast Perspective[2]
Rendered perspective of both the old (bottom) and the contrasting new (top) development

Cuba Street view[2]
Entrance from Cuba Street.

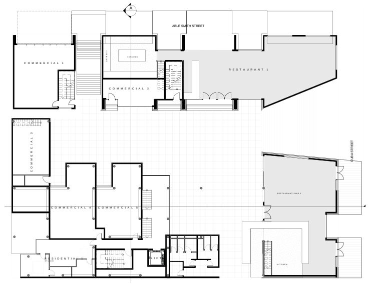
Architectural Project:
Cluster Buildings Case Studies

Working With Historic Grain

Henry Read

The next two projects in a heritage precinct are on sites that did not already contain heritage architecture. These new project designs respond positively to their contexts, exploring how a contemporary architecture might work with, draw from and respond to the underlying historic site sizes or 'historic grain' and reinforce the qualities of a heritage precinct.

Ground Floor Plan



First Floor Plan

Second Floor Plan

Cuba Street Elevation

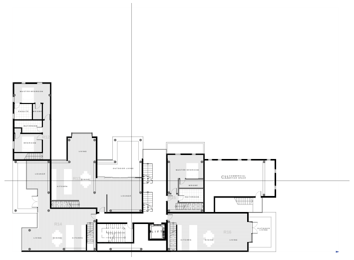
Note foreground scale and setback of major building massing.

Key Longitudinal Section

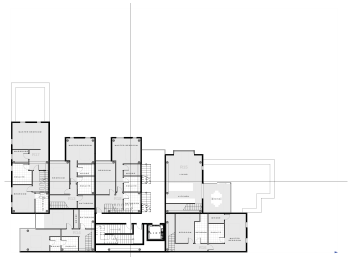
Major building massing is setback from the street.

Third Floor Plan

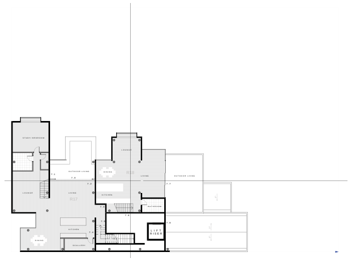
Fourth Floor Plan



Fifth Floor Plan



Sixth Floor Plan



Seventh Floor Plan

Rendered Perspective
Context at street level. Note use of raised courtyard over carparking to rear of site.

Henry Read's case study uses historic grain as a starting point. Many larger sites today have been amalgamated from two or more original sites changing the scale of an area. This design has addressed this problem by designing in relation to the underlying plot sizes, based off historic maps. Consideration of both vertical and horizontal scale is prominent.

Henry has worked with block shapes that have strong positive and recessed silhouettes to re-establish and reinterpret the urban grain in the upper end of Cuba Street. Within this block the underlying scale has been lost due to amalgamation of a number of sites. The design works from upper Cuba Street site typologys, reinstating underlying geometry and patterns. The design creates an environment that reconnects and reinstates a street scale and grain appropriate to the context of Cuba Street, despite being a completely new development.

Upper Cuba Street represents a transition into a finer-grain, mixed-use building typology. Maintaining this typology, and more importantly its relation to human scale, should be a priority as sites are combined, and the area density increases to accommodate a growing inner city population.

Architectural Project:
Cluster Buildings Case Studies
Working With Historic Grain
Pollyanna Dawes

Rendered Perspective
Context at street level proposed development

Floor Plans
Ground Floor *First Floor* *Second Floor* *Third Floor*

Rendered Section
Note spatial diversity with changes in floor levels, double height spaces and terracing towards the north and smaller scale existing context.

Perspective view
Relationship to existing scale and context

Leeds Street view
Interactive street edge

Courtyard view
Showing use of courtyard, laneways and human-scale balancing privacy and public space

Polly Dawes' case study for the corner of Ghuznee and Leeds Street also works from and with context in a manner that is sympathetic to the local surrounding low-rise backyard vernacular with a human scale. The design is also critical of the hard edge and lack of activity and amenity to the existing apartments accross Leeds Street and delivers an exemplary example of an urban street edge where interaction with the streetfront is encouraged at lower and upper levels. This design also supports intensification through residential expansion breaking down the large scale of the project around a carefully screened courtyard and a series of vertically-accessed apartment blocks. Importantly, Polly's design responds to the small-scale buildings adjacent, terracing down to the north.

Model and Exhibition images

Cuba St 2035 collective model in final split street exhibition School of Architecture 2012. Photograph Paul Hillier.

Mark Southcombe with Cuba St 2035 collective model exhibition, Wellington Town Hall for NZ Society of Earthquake Engineers conference. Dominion Post 27 April 2013. Photograph Kevin Stent Fairfax Media.

Cuba St 2035 collective model exhibition Wellington Town Hall April 2013. Photograph Mark Southcombe.

Cuba St 2035 collective model in final split street exhibition School of Architecture 2012. Photograph Paul Hillier.

Visitor enjoying Cuba St 2035 exhibition Wellington Town Hall April 2013. Photograph Mark Southcombe.

Cuba St 2035 collective model School of Architecture 2012. Photograph Mark Southcombe.

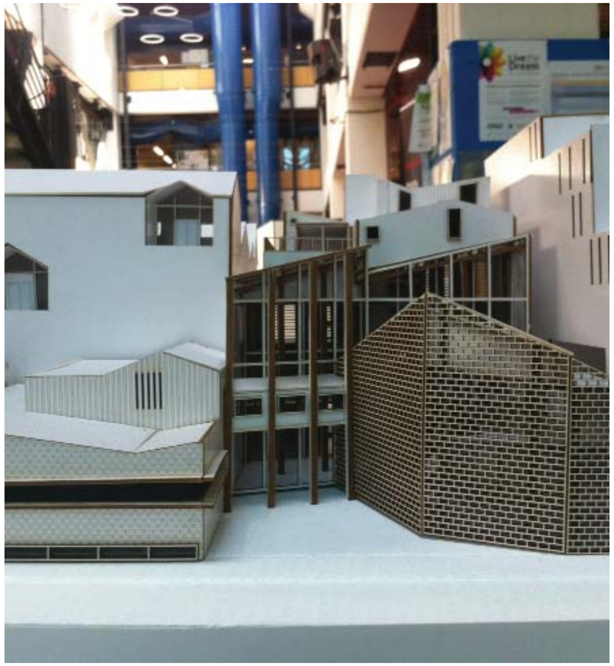
[Re]Cuba collective model during assembly Oct 2013. Photograph Mark Southcombe.

[Re]Cuba collective model street view 2013. Photograph Paul Hillier

[Re]Cuba collective model 2013. Photograph Paul Hillier

[Re]Cuba collective model Upper Cuba Street Block. Photograph Paul Hillier

[Re]Cuba collective model 2013. Able Smith Street - Karo Drive block. Photograph Paul Hillier.



[Re]Cuba collective model 2013.Close up of Jayne Kerstin's building. Photograph Paul Hillier.

Seismic Retrofitting Structural Project

Introduction

Having considered the history of Cuba Street, architectural analyses of the precinct, and the proposed architectural interventions, this section focuses upon the need to improve the earthquake resilience of existing Cuba Street buildings. Due to their age and construction materials, a number of buildings are earthquake-prone and in need of strengthening.

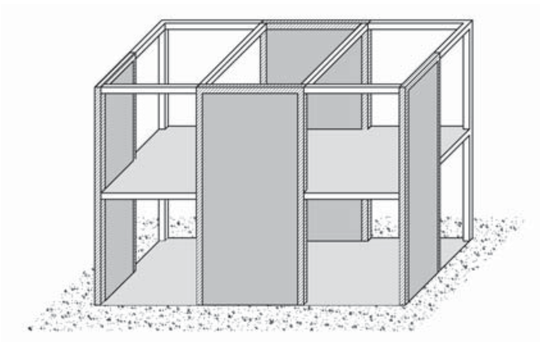
The aim of this section is to inform readers about options and approaches to taking an earthquake-prone building, considered less than 34% of New Building Standard (NBS), to a higher and acceptable standard. Many structural options are available and should be considered before making any final decisions. If building owners have an understanding of typical earthquake retrofitting structural concepts, techniques and structural vocabulary, they are better prepared for discussions with architects and structural engineers.

The approach we take here is to present a small number of retrofitting case studies, all located in Cuba Street. The case studies comprise a small number of the many building retrofit designs that are part of the overall student project. Typical Cuba Street buildings are chosen to illustrate the diversity of retrofitting options open to any building owner. After a description of each building, the retrofitting scheme designed by a student, who was tutored by an experienced structural engineer, is presented. Final comment is added in order to raise additional relevant issues and suggest further options for consideration.

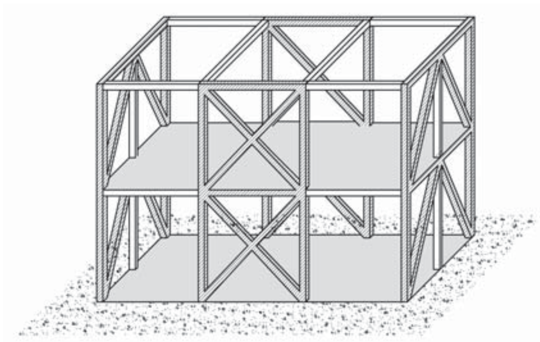
Initially, retrofitting schemes for five *individual* buildings are presented. These cover the majority of current approaches commonly recommended by architects and structural engineers for buildings of similar materials and size. Then, five more projects illustrate the retrofitting of *clusters* or groups of buildings. This is an innovative approach to the problem of upgrading existing buildings, but worthy of consideration from architectural, engineering, legal and economic perspectives. Where two or more adjacent buildings are retrofitted as one complex, not only is damage eliminated from them pounding each other during an earthquake, but a number of potential advantages can be exploited. These final five projects show a range of cluster retrofitting solutions. They include two or more existing buildings tied together, as well as various combinations of tying existing buildings to new buildings and vice versa.

Before commencing the case studies, we recommend that readers unfamiliar with retrofitting acquaint themselves with a general background introduction that can't be covered here. In particular, refer to the publication *Wellington City Council guide: earthquake prone buildings*. It can be downloaded from the Wellington City Council website or a free hardcopy obtained from Council offices. It provides a comprehensive summary of the administrative and technical procedures for dealing with earthquake-prone buildings and includes a glossary of terms. Also refer to the reference section for other resources. However, several introductory points need to be covered here.

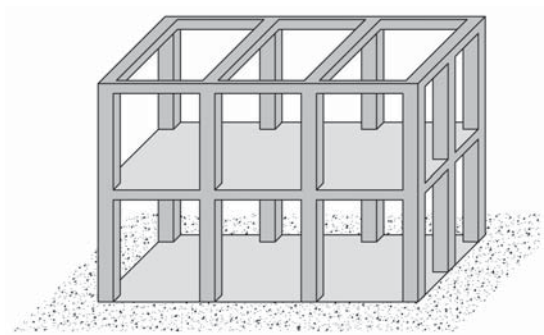
Many retrofit solutions require the insertion of new structural systems. Essentially, there are three to choose from; shear or structural walls, braced frames, and moment frames, as illustrated below.



(a) Shear Walls



(b) Braced Frames



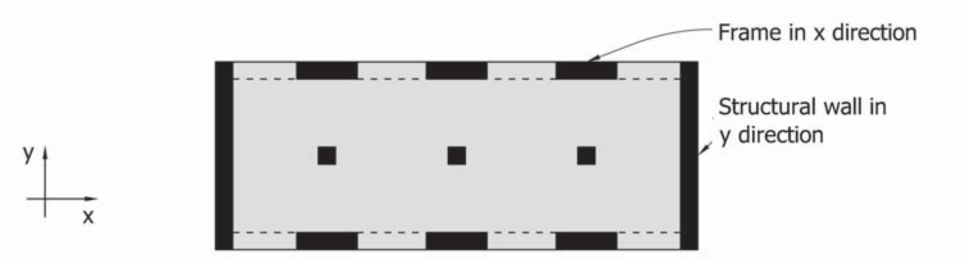
(c) Moment Frames

In order to resist earthquake shaking from any horizontal direction, at least one of these systems must be provided both in the direction along the length of the building (longitudinally), and across the building (transversely). Usually, more than one shear wall or braced frame, for example, is required in each direction to resist twisting or torsion.

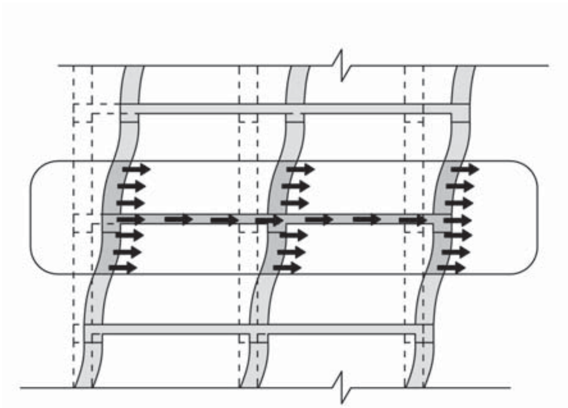
As well as this vertical structure, every building needs strong horizontal structure: floor and roof diaphragms. During earthquake shaking, horizontal inertial forces from every part of the building is resisted and transferred to the vertical structures as shown below. In this case, the transverse inertia forces shown in section are transferred by the floor diaphragm to structural walls at each end of the building. Diaphragms in existing buildings often require strengthening and tying strongly to the exterior walls.

Note that for the purposes of this student project we have assumed that all of the ten existing buildings case-studied are earthquake-prone. In fact, some have already been retrofitted, and not all are earthquake-prone, but that is ignored for this theoretical design exploration. The idea is to provide readers with information and ideas that can be transferred to any individual or cluster of existing buildings. Also, although WCC recommends upgrading to a minimum of 67% NBS, the retrofitting reported here is to 100% NBS. A higher standard of retrofitting future-proofs them against possible future code changes requiring higher levels of earthquake resilience.

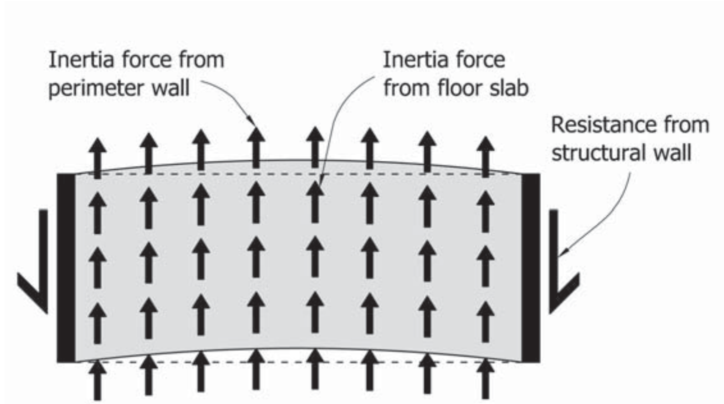
Due to a lack of information about the material strengths of the existing buildings, students adopted the conservative assumption that existing masonry and concrete structures possess no strength to resist horizontal forces.



Plan



Section.
Inertia forces in one storey from y direction shaking



Plan
Inertia forces acting in plan

Individual Retrofit: Case Studies

Case Study: Ben Allnatt

Address : 154- 156 Cuba Street
Construction Date: 1936
Current Name / Use: The Vic
Primary Construction Type: Reinforced concrete

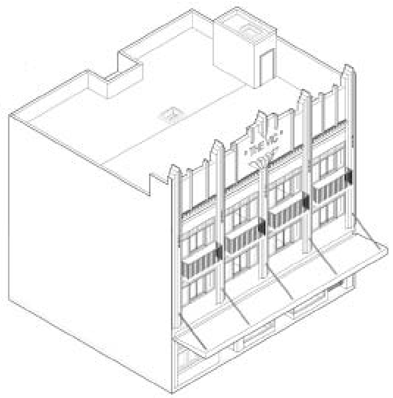
Introduction
'The Vic' is a Category 2 heritage building. It is three storeyed and constructed of reinforced concrete. Designed as a private hotel in typical art deco style, a clothes store and restaurant are currently on the ground floor, and private residential apartments above. It has large windows on its front façade, a moderate level of penetrations on the back façade, and none on its two boundary walls perpendicular to Cuba Street. A stepped parapet, also of reinforced concrete, projects above roof level.

Existing Structure

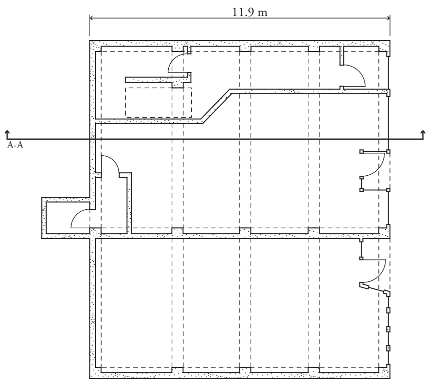
Gravity loads
The existing structure is entirely reinforced concrete. Floors, 125 mm thick, transfer forces into beams, 400mm by 240mm. These primary beams transfer gravity forces to concrete reinforced columns, 400mm by 400mm. These then transfer the forces directly to the ground via the foundations.

Lateral loads
In the longitudinal direction, parallel to Cuba Street, lateral loads are resisted by the less-penetrated back wall and four two-bay reinforced concrete moment frames. They consist of rigidly-connected beams and columns. It is assumed that these frames do not meet current code standards.

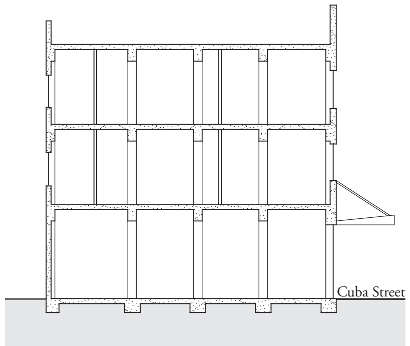
In the transverse direction, three parallel structural walls provide earthquake resistance. They are 180mm thick and without penetrations.



Axonometric



Simplified ground floor plan



Section A-A
Reinforced concrete construction

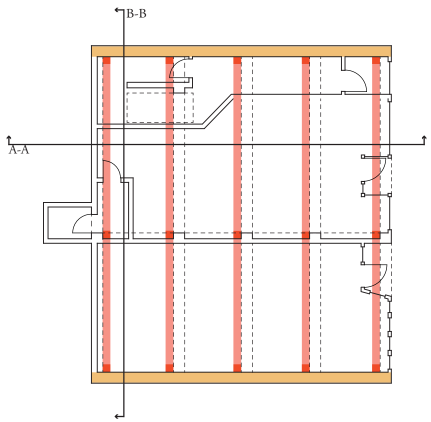
Possible Retrofit Solutions

The chosen retrofit scheme for the longitudinal direction is a series of new two-bay steel moment frames to compensate for the weakness of the existing concrete frames. The new frames are placed against the deficient frames to avoid cluttering interior spaces.

The intention for the transverse direction is to increase the capacity of the existing reinforced concrete walls. They are thickened with an additional 70mm of reinforced concrete. Holes are drilled into the existing walls and short bars that tie new construction to old are epoxied-in. The wall is then sprayed with shotcrete, making the final thickness of the strengthened structural walls 250mm.

Key

Steel moment frames
Strengthened existing concrete structural walls
Possible new foundations
Steel braces to parapet

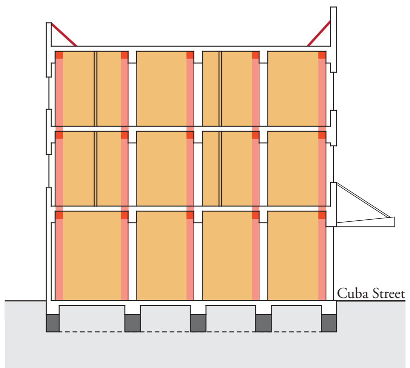


Ground floor plan
with proposed structural solution

Diaphragms and Wall Stability

The existing floor and roof diaphragms are 125 mm thick reinforced concrete. They are assumed to be able to function as diaphragms without retrofit, subject to positive non-destructive material tests.

While the large parapet is constructed in reinforced concrete, there may still be a risk of earthquake damage if any material has deteriorated. Simple steel braces can be constructed along the back of the parapet into the roof diaphragm at 2.0 metre centres.



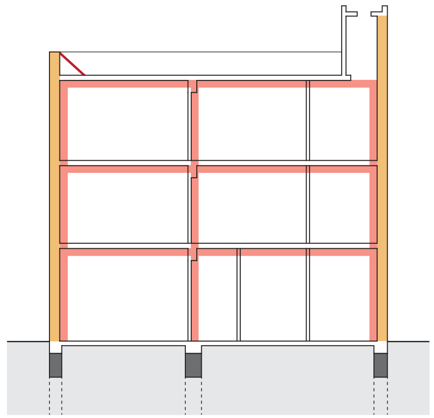
Section A-A
with proposed structural solution

Comments

Due to the extensive use of reinforced concrete in the existing building, two elements that are normally deficient from an earthquake perspective in a building of this age are adequate. First, the floor slabs are strong enough to function as diaphragms. Second, the walls can withstand horizontal inertia forces from their self-weight without collapse. Reinforced concrete walls can withstand face or out-of-plane loads caused by shaking perpendicular to their lengths.

Earthquake deficiencies of concrete moment frames built prior to the mid 1970s are well known. So the new steel frames, with their strong beam-to-column joints resist the entire earthquake load in the direction of their lengths. They are located to minimise spatial disruption and to reduce demolition. Their beams are connected to the existing concrete slabs so as to resist the horizontal forces in the floor and roof diaphragms.

Possible new foundations are indicated on the plans. Structural engineers will assess the capability of the existing foundations to carry the forces from the new steel moment frames and strengthened structural walls.



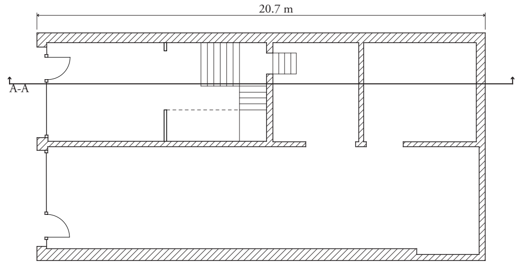
Section B-B
with proposed structural solution

Individual Retrofit: Case Studies

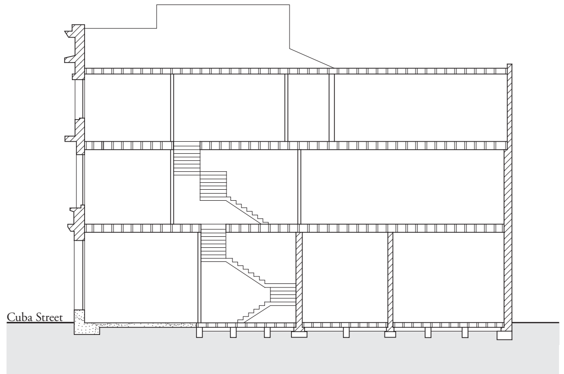
Case Study: Olivia Collinson

Address : 147 Cuba Street
Construction Date: 1900
Current Name / Use: Berry & Co. Photographers Building
Primary Construction Type: Masonry with timber floor and roof

Original West Elevation



Simplified ground floor plan



Section A-A

Masonry construction

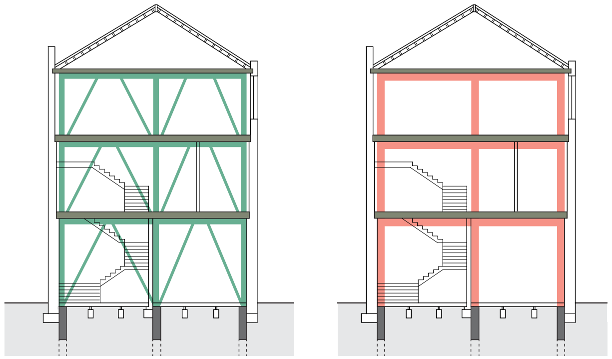
Introduction

The Berry Building was designed by architect William Crichton and was built as a photographic studio for William Berry. It is categorised as a historic building by the Historic Places Trust. This is due to its design by the 19th century architect, the elaborate Edwardian façade and stucco window treatment, and its prominent position and scale within the Cuba Street heritage precinct. Currently, the building is home to retail stores on the ground floor, Enjoy Gallery Trust and the Peter McLeavey Gallery on the first floor, and to Suite Gallery on the second floor.

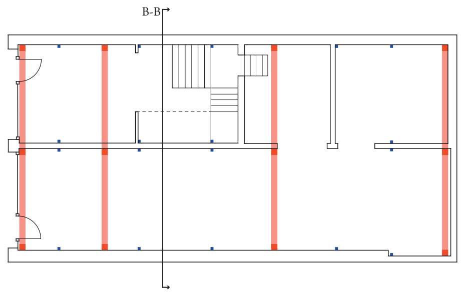
Existing Structure

A corrugated iron and lightweight timber roof bear on two unreinforced load-bearing brick walls running the length of the building. At the back of the building three steel trusses run perpendicular to the walls. Timber flooring on the first and second floors transfer gravity loads to the brick walls.

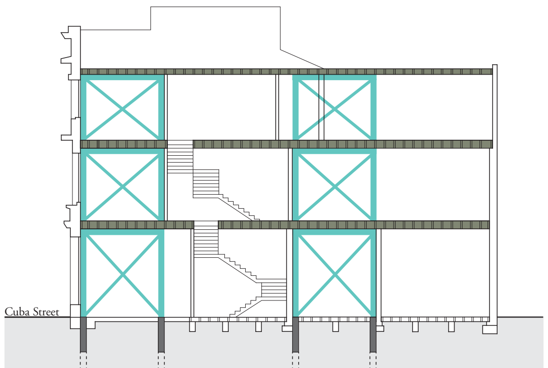
Ground level structure consists of a concrete floor slab at the front of the building and timber flooring elsewhere. The brick boundary walls are supported by strip footing foundations reinforced with railway rails.



Section B-B *with possible transverse structure*
Left: Eccentrically braced frames. Right: Steel moment frames



Ground floor plan
with proposed transverse structure



Section A-A
with proposed longitudinal structure

Possible Retrofit Solutions

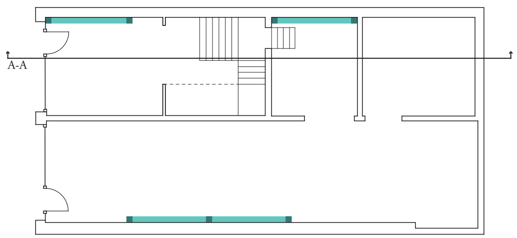
Two new transverse structural frame solutions are considered – four two-bay eccentrically-braced frames and four moment frames. Due to their less spatially-disruptive qualities, even though they are more expensive, moment frames are the preferred option.

In the longitudinal direction, perpendicular to Cuba Street new steel cross-braced frames are proposed as their stiffness against horizontal loads matches the stiffness of the existing walls.

In order to preserve the architecturally-significant plaster mouldings on the ceilings in the first and second floor galleries, the existing weak and flexible timber diaphragms are upgraded. This entails careful removal of floor boards, laying sheets of plywood and then reinstalling the floor boards to retain the architectural integrity of the spaces.

All brick walls are strengthened against face loads by vertical steel supports spanning from floor to floor. They resist horizontal inertia forces from the mass of the masonry walls when they are shaken perpendicular to their lengths. Then the steel supports transfer the forces to strengthened diaphragms above and below.

Foundation strengthening is likely to resist compression and tension forces in the columns of the cross-braced and moment frames.



Ground floor plan
with proposed longitudinal structure

Comments

Whereas the use of transverse steel frames is a conventional solution for this type of building, the use of steel cross-braced frames in the perpendicular direction deserves comment. The advantages of cross-bracing over adding a layer of shotcrete to strengthen the masonry walls include the following: minimal increase to the weight and earthquake forces acting within the building, a reversible system, and the brickwork can be exposed behind the steelwork. Even though steel cross-braced frames are stiff, it may still be necessary to 'soften' the brick walls by vertical cuts to reduce their stiffness and future earthquake damage. The numbers of steel frames provided can be reduced or increased. If fewer frames are provided, structural member sizes are increased and increased demands are made of diaphragms due to their longer in-plan spans.

Even though the weight of the steel frames doesn't represent a significant increase in the weight of the building, the tension and compression forces they impose at foundation level requires foundation upgrading. One solution is to install concrete micro piles. Drilling rigs able to operate within the confines of a ground floor can drill up to 450 mm diameter piles.

Plywood diaphragm upgrades at floor levels are proposed to avoid disturbing existing decorative ceiling details. All viable alternatives necessitate the lifting and re-nailing of the existing floor boards if they are to be retained. An alternative solution to plywood is to create a horizontal steel truss diaphragm that ties to the new frames over the whole floor area. The floor joists are then packed up around the steel members prior to reinstating the flooring.

Key

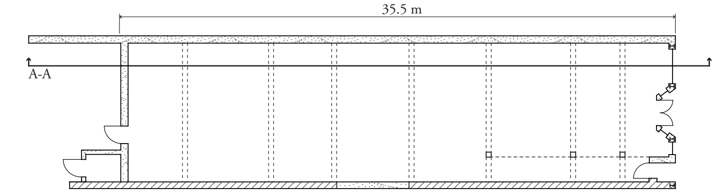
Eccentrically braced frames
Steel moment frames
Cross braced frames
Strengthened diaphrams
Vertical steel face load supports
Possible new foundations

Individual Retrofit: Case

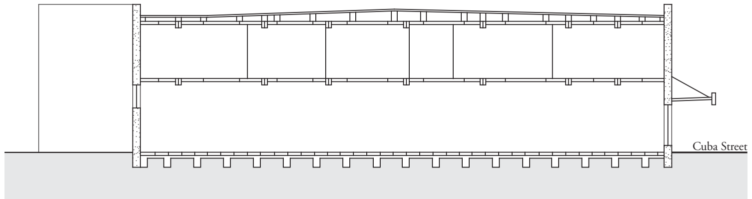
Case Study: Katie Dickens

Address : 104 Cuba Street
Construction Date: 1920
Current Name / Use: Mighty Mighty + Mr Bun
Construction Type: Reinforced concrete with a masonry wall on the south perimeter

East elevation



Simplified ground floor plan



Section A-A

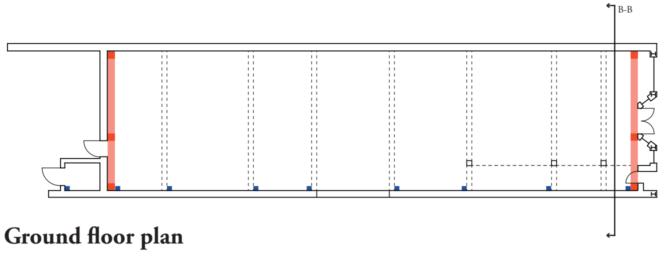
Masonry construction
Reinforced concrete construction

Introduction

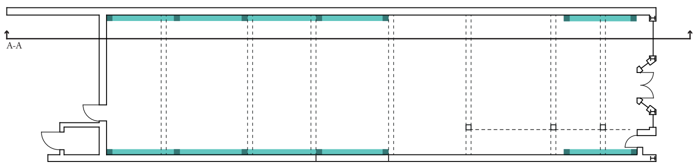
The elaborately articulated Edwardian masonry and concrete building was designed by G. C. Seluray, and built by E.S. King in 1920. It is recognised by its brightly painted façade and its curved bay window on the first floor. It is mainly constructed of concrete with timber flooring and has a shared concrete wall with the Farmers building. The South boundary wall is constructed in brick. The Cuba Street facade has four steel columns cast in concrete and clad with masonry, but is primarily glazed.

Existing Structure

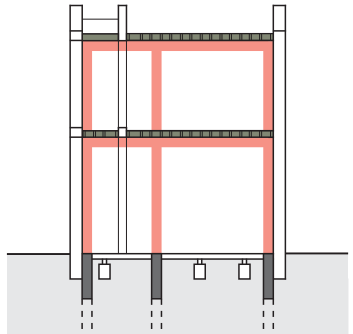
The building roof is supported by a purlin and rafter system. The roof gravity forces move through timber framing into seven steel I beams. These run in the transverse direction across the building, and are connected to concrete bond beams in the perimeter walls. The first floor consists of wooden flooring over timber floor joists that bear on the steel beams.



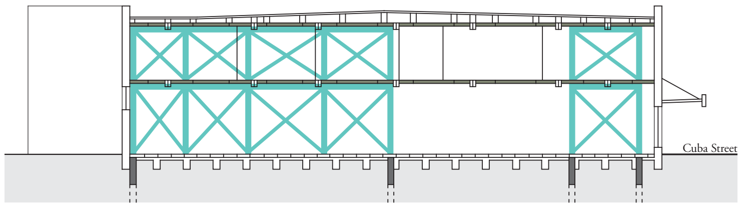
Ground floor plan
with proposed transverse structure



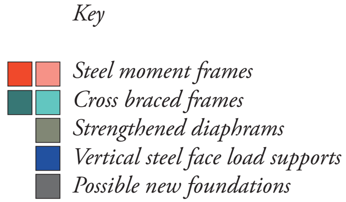
Ground floor plan
with proposed longitudinal structure



Section B-B
with proposed transverse structure



Section A-A
with proposed longitudinal structure



Possible Retrofit Solutions

Either concrete or steel moment frames are the most suitable structural systems for the transverse direction of this building, given its narrow width. Concrete moment frames have shallower beams but deeper columns as compared to steel frames and are far heavier. So steel moment frames are proposed; two two-bay frames, one at each end of the building.

A total of 10 bays of steel cross-braced frames are adequate for the longitudinal direction. Five bays are on each longitudinal wall. The new structure is an additional layer in front of the brick work intended to be visible as part of the heritage value of the building.

The first floor and ceiling diaphragm is of timber construction. Overlaying the flooring with plywood increases the capability of the diaphragm to resist horizontal forces and transfer them to the moment frames at each end of the building. To ensure load transfer from one plywood sheet to another, thin galvanised metal strips are placed on the existing floor underneath the edges of the plywood sheets. Then the plywood and metal strip are nailed to the flooring. The floor diaphragm is also connected to the perimeter walls, and to the steel moment frames at either end of the building. Two continuous steel members attached to each wall running the length of the building enable the diaphragm to span such a long distance.

Comments

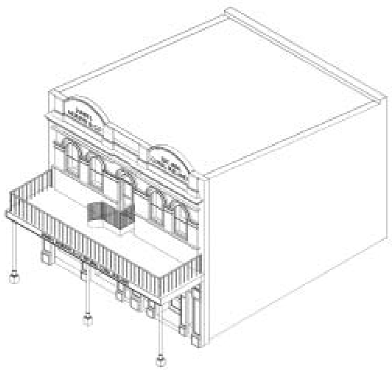
This retrofitting solution highlights the large number of options available to engineers and architects. Consider the new structure to resist transverse earthquake loads parallel to Cuba Street. Only two moment frames are designed, one at each end of the building. The advantages of this solution are that foundation work is minimised and that the frames are located in just two positions. But the disadvantages include deep frame members to achieve the required strength and stiffness, and the need for significant diaphragm upgrading. The diaphragm has to span horizontally between the widely-spaced steel frames. So there is a trade-off. The more closely-spaced the frames, the less diaphragm strengthening is required, but more structural steel and foundation work is required. Bearing in mind these factors, it is likely that the optimum structural solution for this building consists of three or four moment frames.

The new longitudinal structure also illustrates the potential for alternative solutions. The proposed scheme consists of two four-bay cross-braced frames in parallel with two single-bay frames. It is possible, and probably advisable, not to introduce the single-bay frames but to just use the four-bay frames and increase their member sizes slightly to compensate for the loss of the single-bay frames. One-bay frames are prone to overturning and therefore require strong foundations to resist large vertical tension and compression forces. Irrespective of what approach is taken, strong tie members are required along each side of the building. They collect forces along the building length and transfer them to the bracing. The same tie members function as chords or flanges for the floor diaphragms.

Individual Retrofit: Case Studies

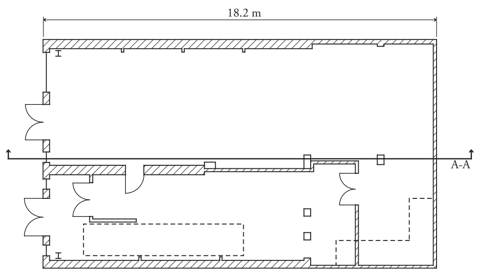
Case Study: Catherine Hall

Address : 119-121 Cuba Street
Construction Date: 1900
Current Name / Use: J J Murphy & Co. Irish Pub
Construction Type: Masonry

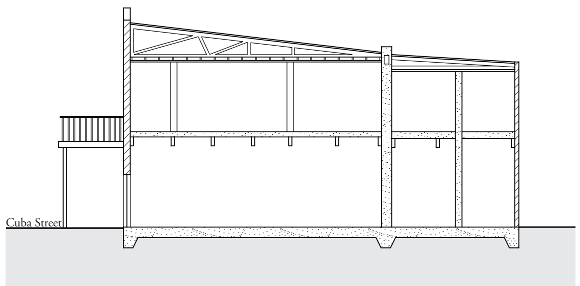


Axonometric

West elevation



Simplified ground floor plan



Section A-A

Masonry construction
Reinforced concrete construction

Introduction

J J Murphy's Irish Pub has undergone extensive alterations over the years due to a variety of different owners and commercial/retail uses. Designed by William Crichton, the building is identified by the New Zealand Historic Places Trust as a positive and significant contribution to the Cuba Street Historic Area. Aspects which ensure that the building is part of the Cuba Street Historic Area include: the pilasters, segmented head sash windows with keystones and the decorative parapet. Although it does not warrant individual registration, buildings on either side are Category 2 buildings.

Existing Structure

Gravity loads from the roof and floor are transferred into the brick masonry walls, as well as some columns. The roof structure includes trusses and timber framing, while the concrete floors are supported by concrete beams spanning between the three load-bearing walls perpendicular to Cuba Street.

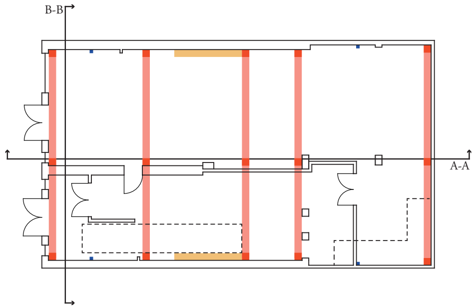
Horizontal forces in the longitudinal direction are resisted through the long masonry walls. The reinforced concrete diaphragm and timber roof diaphragm transfer loads to these three walls. The heavy parapet does not appear to be adequately fastened to the roof and floor diaphragm. In the transverse direction there is little or no resistance against horizontal forces. No existing moment frames or structural walls are able to brace the building in this direction.

Possible Retrofit Solutions

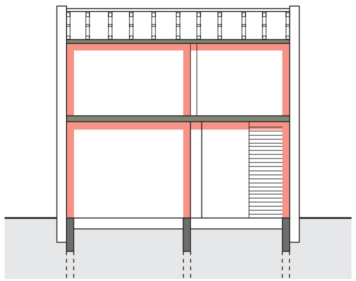
In the longitudinal direction two new 7 m long reinforced concrete walls are cast against the existing brick boundary walls. Shotcrete, reinforcing mesh and epoxied steel rods connecting new construction to old are proposed. New strip foundations are installed under the new walls to ensure stability. Piles may also be required to prevent the walls overturning during an earthquake. Steel brackets tie the parapet back to into roof or ceiling diaphragm. Transverse strength is provided by five two-bay steel moment frames. Their beams will be positioned under the existing floor slabs and connected to them.

Vertical steel posts are placed evenly between moment frames which are further than 3m apart. The posts protect the masonry walls from collapse against face-loads. Bolts are grouted into the wall to tie posts and wall together. The posts are also connected to the upper and lower diaphragms as the final stage to provide out-of-plane resistance.

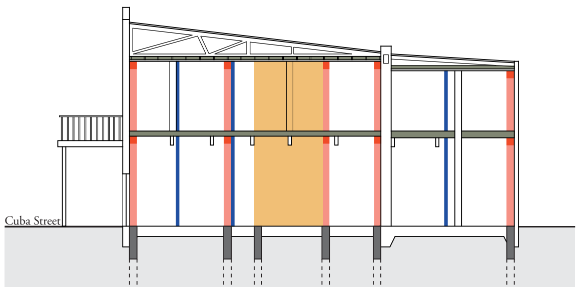
An important issue with the retrofit of this building is the need to 'soften' the front façade. The moment frames need to be able to sway sideways during an earthquake before the façade is seriously damaged. Narrow vertical cuts are made in the façade, including the parapet, to soften it.



Simplified ground floor plan
with proposed structural solution



Section B-B
with proposed transverse structure



Section A-A
with proposed structural solution

Key

Steel moment frames
Reinforced concrete shear walls
Strengthened diaphrams
Vertical steel face load supports
Possible new foundations

The existing floor diaphragm of the building is reinforced concrete 150 mm thick. If it proves to be too weak it can be upgraded by placing new reinforcing mesh and concrete overlay. For the roof/ceiling diaphragm, a 9 mm plywood overlay is proposed. It is fastened to the exterior walls through continuous steel perimeter members.

Comments

The insertion of two new concrete walls is an irreversible, but suitable system given the heavy concrete first floor. It is possible to substitute the concrete walls with single or multiple-bay cross-braced frames. This would be a lighter and reversible solution, but not as strong or stiff. For both scenarios, which have relatively short 7 m structural lengths in plan, new piles are required to stop overturning.

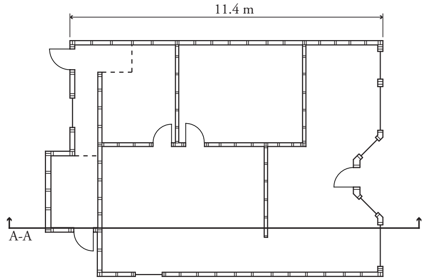
Although five new steel moment frames are specified in the transverse direction, it is possible to use either four, or even three, though their members will be slightly deeper.

The 'softening' referred to above is common practice where new structure is more flexible than existing construction, usually masonry walls. Unless walls are 'softened' by cutting them into panels in relatively unobtrusive ways, they will try to resist horizontal earthquake forces and suffer serious damage before the new structure takes over and resists the forces.

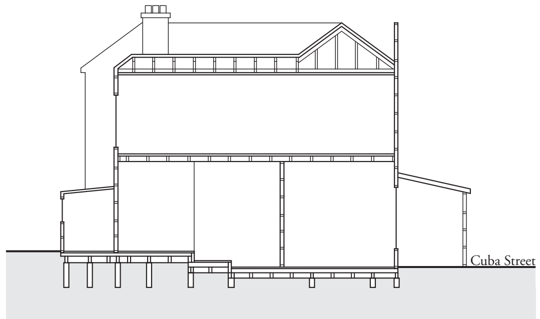
Individual Retrofit: Case Studies

Case Study: Belinda Stuart

Address : 290 Cuba Street
Construction Date: 1889
Current Name / Use: Turning Point
Construction Type: Timber



Simplified ground floor plan



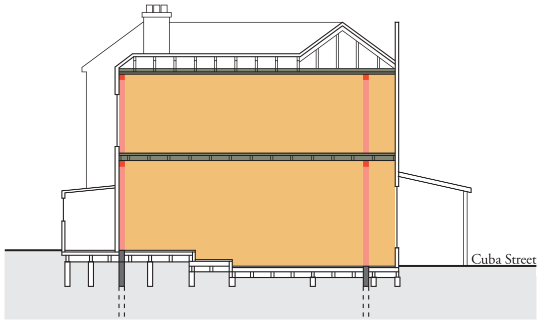
Section A-A

Axonometric

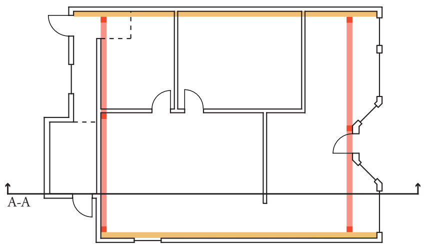
Introduction
'Turning Point' is a heritage-listed building. The building was originally designed as a store, functioning primarily as a grocery until 1968, with a flat located on first floor for the store-owner. Turning Point currently functions in a mixed-use capacity with Charcoal Chicken located on the ground floor and a separate residential tenant above.

Existing Structure
The structure is light timber frame construction. The roof consists of timber purlins and rafters clad with corrugated iron. Timber joists at first floor span between load-bearing timber stud walls. Piles, timber bearers and joists support tongue and groove flooring.

Turning Point is over 120 years old. The majority of the structure has not been upgraded or replaced. Due to their age and condition, many components, such as the flooring require attention. Removal of internal structural walls at ground floor to meet the changing needs of the shop has also negatively affected the strength and stability of the building.



Section A-A
with proposed structural solution



Ground floor plan
with proposed structural solution

Possible Retrofit Solutions
Two lines of steel moment frames resist transverse earthquake (and wind) loads. In the longitudinal direction, new internal ply wall lining provides sufficient bracing strength.

The existing timber piles supporting the light timber framed structure are insufficient to support the weight and forces from the proposed steel frames. Therefore at the footing locations of the steel frames, the timber piles must be replaced by concrete foundations.

Strengthening of the roof diaphragm is achieved by removing the existing roof cladding and nailing 9 mm plywood to the exposed rafters before re-cladding the roof. Alternatively, the ceiling diaphragm is strengthened by fixing plywood or Gibraltar board to the underside of the ceiling structure. The latter solution is less labour intensive.

Key

Plywood structural walls
Steel moment frames
Strengthened diaphrams
Possible new foundations

Comments
Instead of using steel moment frames to resist transverse forces, more consideration could be given to bracing the internal transverse walls with plywood or another sheet bracing material. Due to the presence of four reasonably long transverse walls it is likely that the need for the steel frames can be avoided.

Provision of subfloor bracing is likely to be required as part of the retrofitting.

Cluster Retrofit: Case Studies

Case Study: Katie Dickens

Type of Cluster Retrofit: Two existing buildings tied together

Address : 104 Cuba Street
Construction Date: 1920
Current Name / Use: Mighty Mighty Bar +Mr Bun
Construction Type: Concrete and masonry walls with timber flooring

Address : 106 Cuba Street
Construction Date: 1889
Current Name / Use: Matterhorn
Construction Type: Concrete with suspended timber floors and a concrete slab

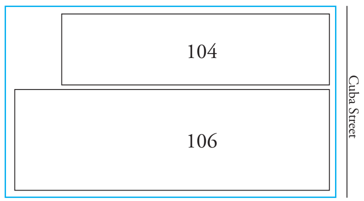
Introduction
The building at 104 Cuba Street is an elaborately articulated Edwardian masonry and concrete building. It is recognised by its brightly painted façade and its curved bay window on the first floor. It is mainly constructed of concrete with timber flooring and has a shared concrete wall with the Farmers building. The South boundary wall is constructed in brick.

The Matterhorn at 106 Cuba Street has had many different occupancies since completion and undergone several renovations and extensions.

East elevation

Key

Existing Building
Cluster of buildings tied together



Layout of the cluster of buildings retrofitted to act as one during an earthquake.

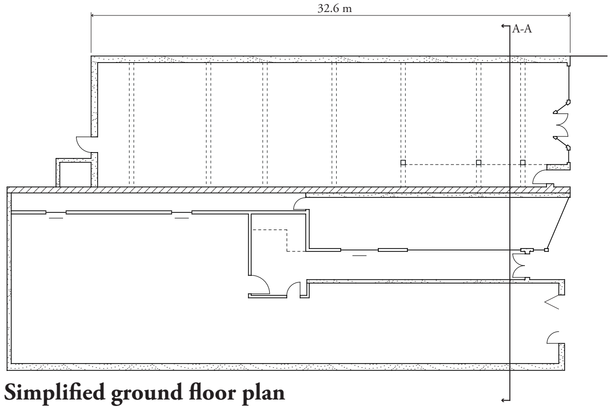
Existing Structure

104 Cuba Street
The building roof is supported by a purlin and rafter system. The roof gravity forces move through timber framing into seven steel I beams.These run in the transverse direction across the building, and are connected to concrete bond beams in the perimeter walls. The first floor consists of wooden flooring over timber floor joists that bear on the steel beams.

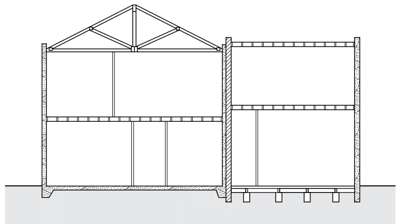
The structure of 106 Cuba Street is essentially the same as that of 104 Cuba Street.

Key

Masonry construction
Reinforced concrete construction



Simplified ground floor plan

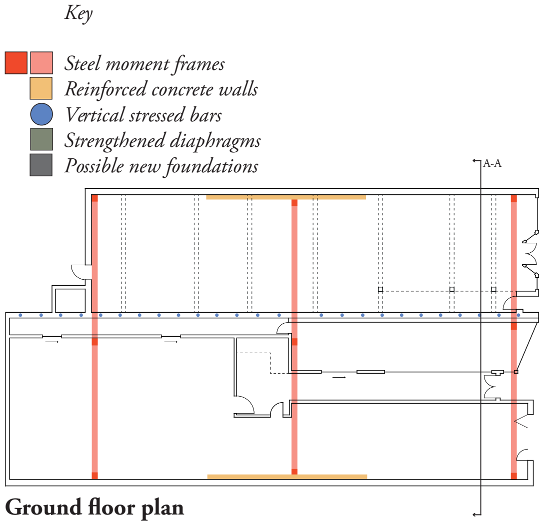


Section A-A

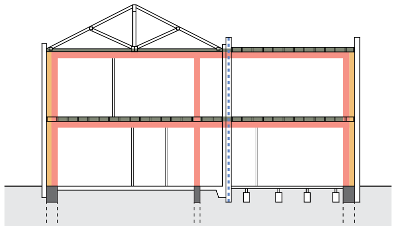
Cluster Retrofit

In order for the two buildings to act as one during an earthquake they need to be tied together to prevent relative movement between them. The roof and floor diaphragms, and horizontal load resisting structure of each building are connected. However, the existing first floor diaphragms don't align. As 106 Cuba Street is not a heritage building, its first floor diaphragm is raised up to the height of that of 104 Cuba Street. Then three two-bay steel moment frames, which resist earthquake loads in the transverse direction, pass through the two buildings, helping to tie them together in that direction.

The central wall between the two buildings is brick. It is strengthened and supported at first floor and roof level to withstand earthquake forces both perpendicular to it as well as along its length. Holes are drilled from the top of the wall, down its height and into the foundations. Then steel bars are grouted into the foundation and stressed at the top. Once the wall is reinforced like this, the additional compression provided makes it much stronger against all directions of loading.



Ground floor plan
with proposed structural solution



Section A-A
with proposed structural solution

The strengthened masonry wall can now help resist earthquake forces acting in the longitudinal direction. However, it is assumed too weak to support the whole cluster, so two new lengths of reinforced concrete walls are bonded onto the two perimeter longitudinal walls to supplement their strength and stiffness.

The strength of the first floor diaphragm is upgraded by overlaying the flooring with plywood. This provides the floor with enough stiffness and strength. The full strength of the diaphragm is realized when it is tied into the perimeter walls and strongly connected to continuous lengths of a steel member, such as a steel angle.

Comments

Since rear walls of both buildings parallel to Cuba Street and the façade of 106 Cuba Street are stiff against horizontal loads as compared to the new moment frames, 'softening' of these elements is likely.

The raising of the first floor of 106 Cuba Street is an unusual but excellent technical solution. Due to the cost involved, this approach also must meet the architectural objectives – perhaps the partial opening up of both ground floors to create one large space. As we see in some of the following case-studies, a more conventional solution for non-level diaphragms is to allow them to remain at different heights but to tie them together with strategically-placed vertical beams. This solution is not as elegant as the former, since forces within the building travel far less directly to the foundations, but is more cost-effective.

In the tying-together of these two buildings the new vertical retrofitting structure is evenly distributed in both. This need not be the case. There are many different options for placing the new strengthening elements in plan. Consider the transverse direction with its three new frames. As well as varying the number of frames, it is feasible to provide say three single-bay frames located in just one building only. This means all the heavy structural and foundation work is confined to that area. The other building will be less affected by the retrofitting although its diaphragms and some other elements might still need upgrading. Strong ties will tie the diaphragms of the less affected building back to the diaphragms of the other building that are connected to the new frames. Of course, since the steel frames have been reduced from two bays to a single bay, more frames will be required or else the member sizes of the original number are increased in depth.

What about the alternative structural options in the longitudinal direction? Once again resistance need not be provided equally in both buildings. For example, if it made sense to try to keep the new vertical structural elements in just one building, then the new concrete wall could be removed from the perimeter of the other. This reduction of strength in the longitudinal direction could be compensated for by further increasing the strengths of the central masonry wall and the other perimeter concrete wall. Now the structural layout is not so symmetrical in plan. A small amount of potential twisting or torsion is introduced, but the structural configuration can handle that quite comfortably. A more radical option is to remove the central masonry wall from the cluster and replace it with a line of posts and beams. This creates a single-space ground floor. To compensate for the loss of that wall, new concrete walls are required on both perimeter walls, and they would have to be lengthened to satisfy the strength and stiffness needs in that direction.

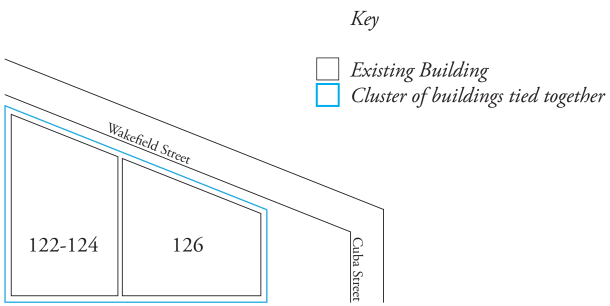
Cluster Retrofit: Case Studies

Case Study: Anna Cowper

Type of Cluster Retrofit: Two existing buildings tied together

Address : 122-124 Wakefield Street
Construction Date: 1923
Current Name / Use: Plumbers Building
Construction Type: Reinforced concrete

Address : 126 Wakefield Street
Construction Date: Unknown
Current Name / Use: Commerce House
Construction Type: Reinforced concrete



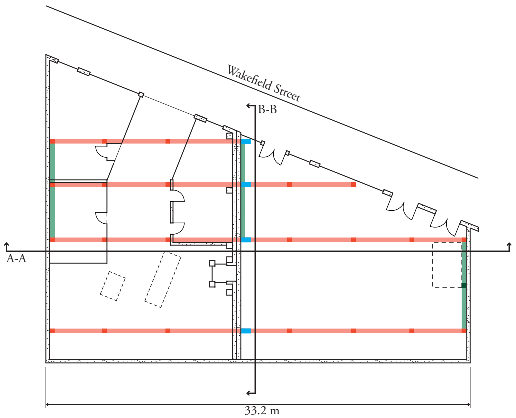
Layout of the cluster of buildings retrofitted to act as one during an earthquake.

West elevation

Introduction

Plumbers Building is a Category 3 building under the Wellington City Council Heritage Buildings List. It was originally built as a warehouse for Alexander & Co, soft-goods manufacturers and importers. Since 1923 there have been twelve amendments to the original plans. An additional two storeys and verandah were added in 1933. A two-storey penthouse was added in 1995 along with the conversion of levels 1-4 into residential apartments with balconies at the back and the car park at the rear. Currently Plumbers building is mainly residential apartments with a café in the front half of the first storey and car parking in the back half. The façade is by far the most important architectural element of this building.

The architectural style of the façade could be described as 'stripped classical' with hints of Art deco in the original storeys. There is an obvious change in detailing around the storeys. There is an obvious change in detailing around the windows in the additional two storeys added in 1933. The façade detailing plays with different depths and thicknesses and its ornamentation fits with the other buildings alongside and opposite.



Ground floor plan
with proposed structural solution. Note: Existing columns not shown

Existing Structure

The structure of Plumbers Building is reinforced concrete and reinforced concrete block masonry. The main vertical structure consists of 400 x 400mm reinforced concrete columns and reinforced concrete masonry walls. Concrete floors are supported by primary and secondary reinforced concrete floor beams.

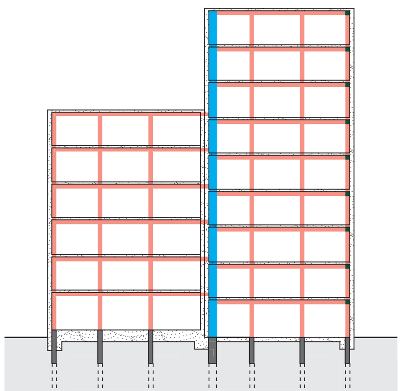
Two-bay reinforced concrete moment frames resist all transverse horizontal forces. Reinforced 190 series concrete blocks resist longitudinal forces.

The structure of 126 Wakefield Street is also of reinforced concrete construction, namely floor slabs, beams, columns and walls.

Cluster Retrofit

The architectural concept for the structural retrofit of the two buildings is to respond to the conflicting grid layouts of Wakefield and Cuba Street. While the majority of the existing reinforced concrete structure in both buildings will be kept, the positioning of new structure reflects this strict grid configuration.

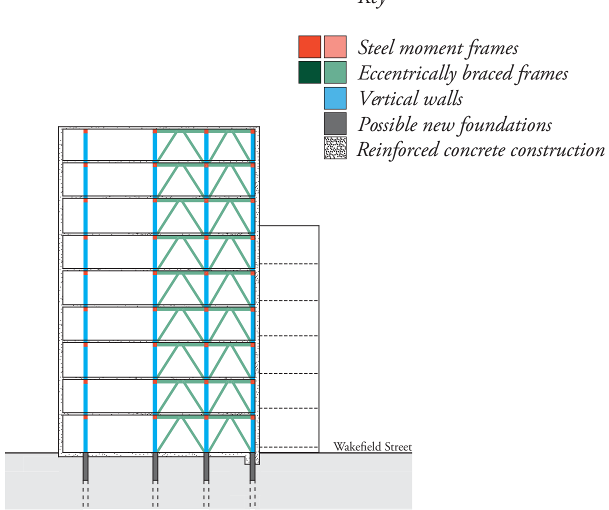
New structure is introduced into the buildings to increase their lateral resistance. Steel moment frames provide resistance in the direction across both buildings (transversely). Eccentrically-braced frames are the means of resisting earthquakes in the perpendicular or longitudinal direction. Moment frames, although a more expensive retrofitting option as compared to braced frames due to the greater amount of steel required, impact less on the functionality and use of interior spaces. They compensate for the assumed weakness in the existing moment frames. Eccentrically-braced frames are located adjacent to boundary walls which are also assumed incapable of resisting longitudinal earthquake forces.



Section A-A
with proposed structural solution

The ground floor of the Plumbers Building is considerably higher than the floors above. In order to eliminate this flexible and soft storey, the ground floor is raised 800mm. However, all floor levels differ from those in Commerce House. Therefore for the two buildings to be tied together, four 1.0 metre by 0.25 metre (approximate) reinforced concrete walls are introduced along the lines of each new moment frame. They act like strong vertical beams to transfer diaphragm loads from the Plumbers Building through to those of Commerce House, and then into the lateral resisting structure. This system ties the two buildings together in the transverse direction.

In the longitudinal direction, three new two-bay eccentrically-braced frames are designed to resist earthquake forces. The inner frame is attached to the wall of Commerce House which is also to be connected to the wall of Plumbers Building. Then, forces from the floor diaphragms of Plumbers Building can transfer into the new eccentrically-braced frame. In this way the two existing walls, located side-by-side, tie both buildings together in the longitudinal direction.



Section B-B
with proposed structural solution

Comments

When designing moment frames, designers keep spans short to avoid overly-deep beams. In this solution, bay lengths have been kept shorter than the existing bay lengths of Plumbers Building, and all bays have been kept uniform through both buildings. Because the new columns don't align with those existing, the loss of functionality caused by the extra columns needs reconsideration along with the new and existing structural layouts in Commerce House.

Another retrofitting option is worthy of consideration; namely to rely on moment frames in the higher Commerce House only and tie Plumbers Building to them. Provided the member depths of these can be accommodated, it would be very advantageous economically. This strategy avoids inserting frames into Plumbers Building. All that is then required there is to construct one new eccentrically-braced frame and to connect the wall on the other side of the building to that of Commerce House.

This cluster retrofit solution illustrates how to overcome the problem where the floor diaphragms of the adjacent buildings don't align vertically. In this case, in the transverse direction, four short walls are needed to transfer forces from the diaphragms of one building into those of the other. Similar strength structure would also be needed in the longitudinal direction if the existing boundary walls were not strong enough.

The new structure, designed to resist all earthquake forces relieves existing structure from any earthquake force-resisting duty. However, the existing structural frames, need to be checked they can move sideways with the new structure during an earthquake without suffering serious structural damage. It they lack such flexibility, the columns might be wrapped with composite fibre to confine the concrete. The walls may also be 'softened' with strategic vertical cuts.

Cluster Retrofit: Case Studies

Case Study: Molly Marshall

Type of cluster retrofit: An existing and new building tied together

Address : 116 Cuba Street
Construction Date: New design
Current Name / Use: McKenzie Building
Construction Type: Timber

Address : 118 Cuba Street
Construction Date: Unknown
Current Name / Use: Former Hellaby Building (Iko Iko)
Construction Type: Reinforced concrete

East elevation

Introduction
This building cluster is located on the corner of Left Bank and Cuba Street. The proposed redesign of these two buildings sees the Former Hellaby Building at 118 Cuba Street, and just the façade of the McKenzie Building, 116 Cuba Street, retained. The interior structure of the McKenzie Building is demolished and rebuilt.

The Hellaby Building is listed on the Wellington City Council heritage buildings list, and designed in Edwardian style, in keeping with many of the buildings in the Cuba Street area. The building façade is elegantly decorated. Its Corinthian pilasters and ribbon garlands on the upper storey create a playful street frontage.

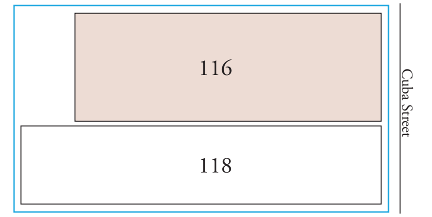
The elaborate façade of the J. R. McKenzie building reflects its period in history. Its unique architectural details add to the vitality of Cuba Street.

The retrofitting approach ties the existing structure of 118 Cuba Street into the new structure on its northern side. While these two buildings will be tied together so that during earthquake shaking they vibrate as one single building, their facades continue to suggest they are independent structures.

Located on a prime corner in the pedestrian zone of Cuba Street, it is essential to open the northern façade of the McKenzie building which partially forms the entrance into Left Bank Arcade. For this reason, a structural system is chosen that allows for good permeability, sunlight penetration, and maximises retail street frontage at ground level.

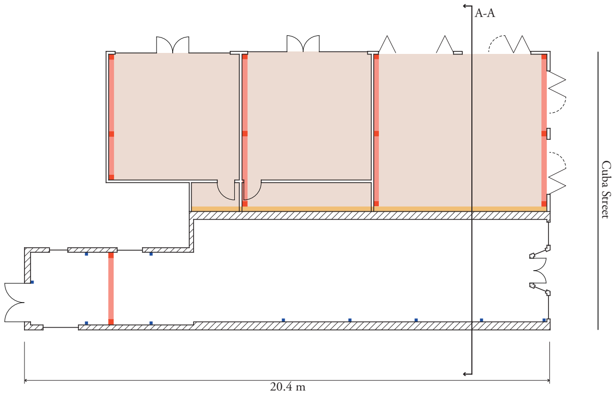
Key

New building addition
Existing building
Cluster of buildings tied together

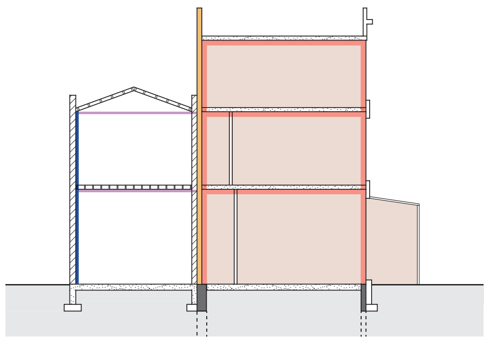


Layout of the cluster of buildings retrofitted to act as one during an earthquake.

Existing Structure
The façade of the McKenzie building is constructed of plastered unreinforced masonry. The same wall materials are used in the former Hellaby building. Its original timber ground floor has been replaced by a concrete slab on grade, but the timber first floor and roof structure remain.



Ground floor plan with proposed structural solution



Section A-A with proposed structural solution

Key

- *Steel moment frames*
- *Reinforced concrete shear walls*
- *Diaphragm tie members*
- *Possible new foundations*
- *New building addition*
- *Vertical steel face load supports*
- *Unreinforced mass construction*
- *Reinforced concrete construction*

Cluster Retrofit

The new structural systems comprise steel moment frames in the transverse direction and a reinforced concrete shear wall in the longitudinal direction. The four moment frames are dispersed evenly along the length of the building, each containing two bays. The frames will support new concrete floors on steel decking that bear on secondary steel beams. The façade of the McKenzie Building will be tied back to the new floor diaphragms. In the longitudinal direction a new reinforced concrete wall is cast against the brick wall of the Hellaby building.

Due to the historic value of the Hellaby Building, it is supported by the adjacent rebuilt McKenzie Building. This means that all earthquake-resisting structure for both buildings is designed into the new construction. Unfortunately, due the greater length of the Hellaby Building, it requires one moment frame near the back of the building. Therefore structural interventions in the historic building are minimized. Unobtrusive upgrading to it includes new supports for face-loads on the masonry walls as well as improved first floor and roof diaphragms.

In order for the two buildings to act as one when resisting horizontal forces, the floor and roof diaphragms in the new building have been designed at the same levels as those in the heritage building. Its existing diaphragms are upgraded to enable forces in them to be transferred to the new structure.

Retaining as much heritage material as possible, the diaphragms are strengthened, if required, by steel cross-bracing under the floor joists as an alternative to plywood sheeting. The cross-bracing system allows for the existing floor boards and their character to be preserved. The same outcome is possible by providing a plywood ceiling diaphragm. Instead of upgrading the two Hellaby Building diaphragms it may be sufficient to provide four to six ties from the new concrete diaphragms of the re-built McKenzie Building to the far wall of the Hellaby Building. The steel ties connect to the existing brick wall, pass through the new reinforced concrete wall to the new floor diaphragms in the McKenzie Building. Horizontal steel members pass around the perimeter of the upgraded diaphragms. They enable forces from the wall-support posts to be transferred into the diaphragms. Note that these steel posts are required for all brick walls. It is also likely that braces are needed to tie the façade of the Hellaby Building back to the roof/ceiling diaphragm.

Comments

This retrofit solution exemplifies how the structure of a (almost) new building can support an adjacent existing building. The degree of structural intervention in the existing building is greatly reduced.
The tying together of existing and new construction is aided by making the floor levels of the new building match those of the existing. If for any reason this is not feasible, then the strategy of using short (in plan) walls as seen in the previous case-study can be applied.

The proposed scheme would not work if the Hellaby building were higher than the McKenzie re-development. The supporting structure must be at least as high as the building it supports.

Finally, it should be noted that in the longitudinal direction the strength of the cluster relies on a single structural wall. Structural engineers would prefer two shorter walls, rather than one, so that the building is more resistant to torsion. If, after further design the torsion issue is considered serious, one option is to remove the proposed reinforced concrete wall and on each side of the McKenzie re-development place a four-bay moment frame. In this case the central brick wall would definitely require softening in such a way as to preserve its fire-rating.

Cluster Retrofit: Case Studies

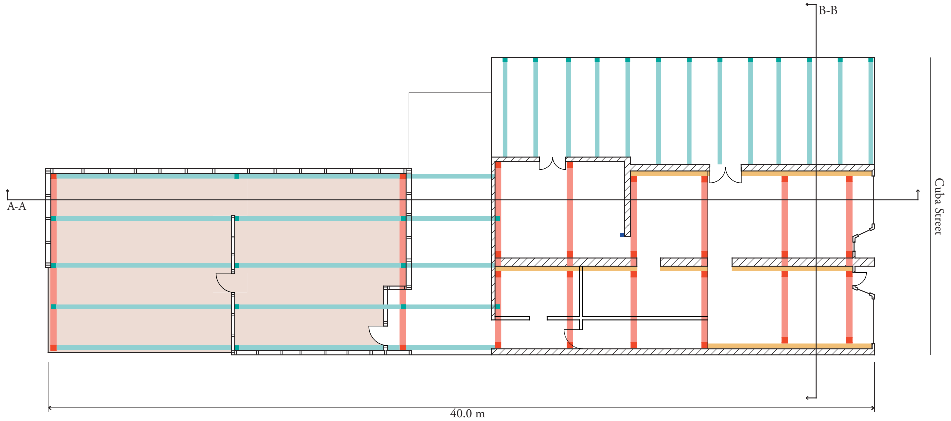
Case Study: Gwena Gilbert

Type of cluster retrofit: An existing building tied to a new building with the existing building providing support to both in one direction

Address : 324 Cuba Street
Construction Date: Unknown
Current Name / Use: Fidel's Cafe
Construction Type: Masonry with timber addition

Introduction
The key significance of 232 Cuba Street is its contribution to the streetscape of Cuba Street. The social and cultural occupations within this building have been continuous since its construction, adding to its urban contribution.

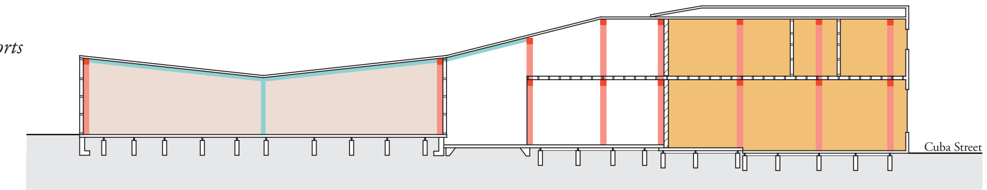
Fidel's Café is a two storey unreinforced masonry building, with a timber floor and roof structure. A light-weight single-storey conservatory is currently located on the northern side. The proposed new structure is a single-storey building located behind the café. The gap between the existing building and the addition is 4.0 meters. The gap creates a link through to Abel Smith Street. The buildings are designed to work separately in their transverse directions, but are tied together longitudinally.



Ground floor plan
with proposed structural solution

Key

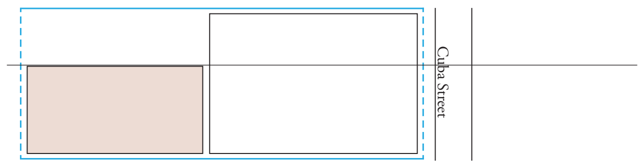
- *Reinforced concrete shear walls*
- *Steel moment frames*
- *LVL members*
- *Vertical steel out-of-plane supports*
- *Possible new foundations*
- *New building addition*
- *Masonry construction*



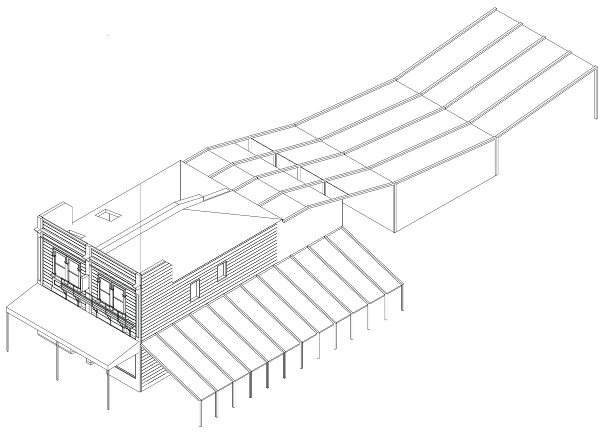
Section A-A

Key

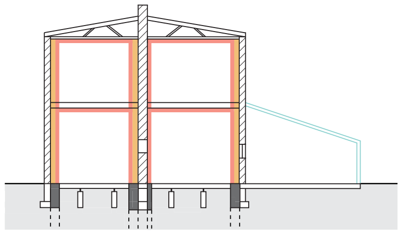
- *New building addition*
- *Existing building*
- *Cluster of buildings tied together*
- *Indication that buildings do not act together in this direction*



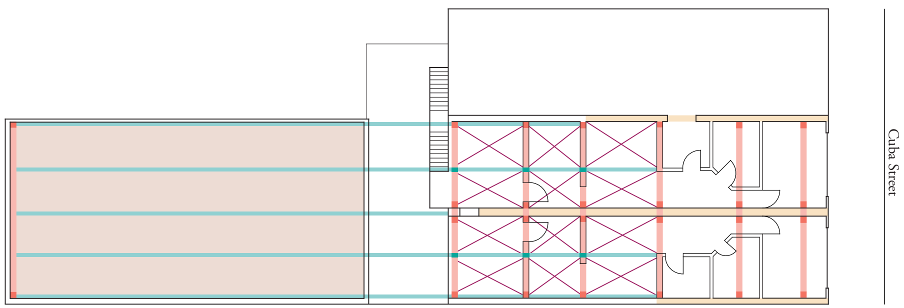
Layout of the cluster of buildings retrofitted to act as one during an earthquake.



Axonometric



SectionB-B
with proposed structural solution



First floor plan
showing the longitudinal beam structure that connects the new and the old

Cluster Retrofit
Fidel's Café is retrofitted within in the transverse direction by new structure while structure in a new building behind provides longitudinal strength. The new transverse structure within the existing building consists of 12 single bay steel moment frames. They allow the existing space to continue operating as usual without imposing on usable floor area. The moment frames are 3.0 metres apart and also act as new vertical face-load supports to the longitudinal walls. Each moment frame column is bolted up its height to a masonry wall.

In the longitudinal direction, Fidel's Café is retrofitted by casting three new reinforced concrete walls against the existing masonry walls. The concrete walls are slightly increased in strength so they can also support the new building at the rear of the site.

Diaphragms within the existing building comprise timber joists and flooring. Because the moment frames are so closely-spaced and the walls are less than 5 m apart, it may not be necessary to upgrade existing diaphragms by the addition of a plywood layer. A cross-braced roof diaphragm is provided within the existing structure to ensure that tension and compression loads within two of the LVL beams that bridge between the two buildings can be distributed sideways into the strengthened masonry walls.

The new addition is therefore supported by the strengthened existing walls in Fidel's Café in the longitudinal direction. Two steel moment frames, one at each end, provide strength and stiffness in the transverse direction.

Comments
Although new concrete walls are designed to resist longitudinal loads, due to the low-rise nature of the buildings it may be possible to upgrade the unreinforced masonry walls with coatings of composite fibre or steel mesh as double-skin overlays. This technique increases in-plan wall strength as well as out-of-place resistance.

The closely-spaced transverse moment frames obviate the need for vertical posts to resist out-of-plane loads. So, if it were decided to reduce the numbers of frames, the remaining frame members would need to be deepened for additional strength, and where frames were removed, out-of-plane support provided.

There are two unreinforced masonry walls at the rear of Fidel's Café. They need out-of-plane support as well as 'softening' so they can move with the moment frames without being severely damaged.

Cluster Retrofit: Case Studies

Case Study: Vinnie Maxwell

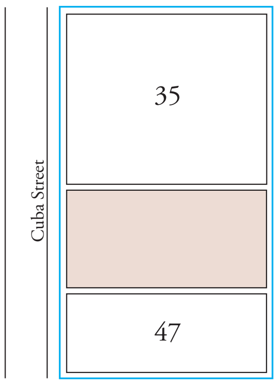
Type of cluster retrofit: Two existing buildings joined by a new building

Address : 35 Cuba Street
Construction Date: Unknown
Current Name / Use: Kennedy Building
Construction Type: Masonry

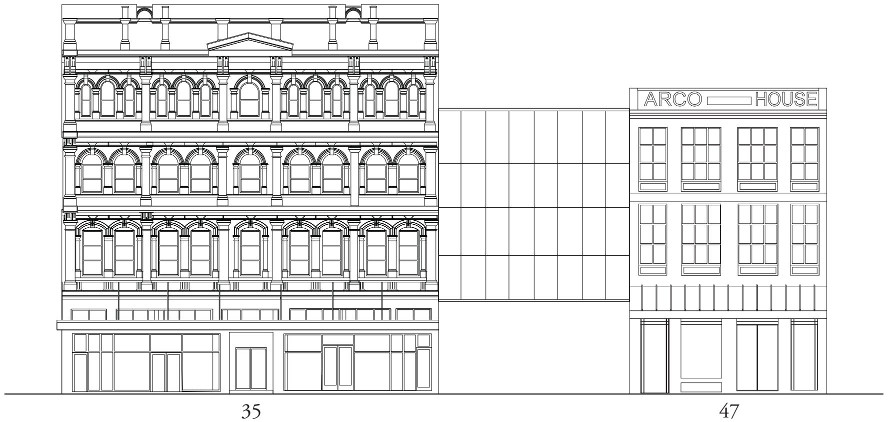
Address : 47 Cuba Street
Construction Date: Unknown
Current Name / Use: Arco House
Construction Type: Masonry

Key

New building addition
Existing building
Cluster of buildings tied together



Layout of the cluster of buildings retrofitted to act as one during an earthquake.

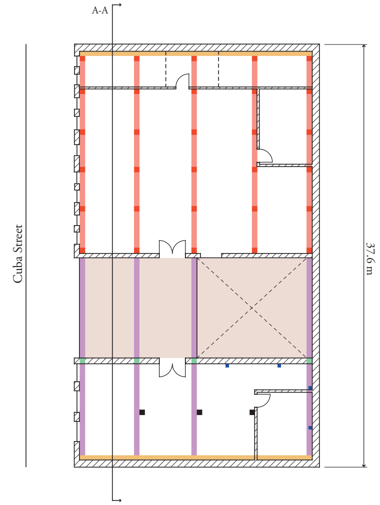


West Elevation

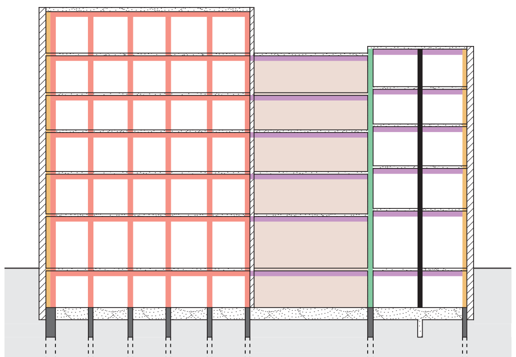
Introduction
The building cluster is located on the east side of lower Cuba Street and includes the Kennedy Building, the Last Shoe Company and Arco House. All three buildings are recognised for their heritage value by the Wellington City Council, and the Kennedy building and the Last Shoe Company are registered with the Historic Places Trust. All buildings were originally constructed in the same decade in the early 1900's. Arco House differs significantly from the other two buildings, with its regular proportions and large windows.

This proposal demolishes the Last Shoe Warehouse while retaining the heritage significance of both Kennedy Building and Arco House. The new building, in between the two to be retained, structurally connects Arco House to the Kennedy Building. It creates a large connected office complex whilst providing a street-level path from Cuba Street to Pringle Avenue.

Existing Structure
Both the Kennedy Building and Arco House are of unreinforced masonry construction with timber floor and roof structures.



Ground Floor Plan
with proposed structural solution



Section A-A
with proposed structural solution

Cluster Retrofit

Two new reinforced concrete walls at each end of the cluster of the three buildings resist earthquake loads in the transverse direction. Moment frames are used to resist longitudinal loads parallel to Cuba Street. These have been placed in the Kennedy Building only, allowing the majority of the retrofitting to be contained in just one of the two heritage buildings. The new construction in the middle of the cluster ties the two buildings together in the transverse direction and enables the earthquake loads from the Arco Building to be transferred back to new moment frames in the Kennedy Building.

The existing floor diaphragms of all three existing buildings do not align. By demolishing The Last Footwear Company Building, the Kennedy Building diaphragm levels extend through the new middle addition. This leaves two diaphragms at slightly different levels. To connect them, strong columns are inserted at the junction of the two diaphragms. Forces from the diaphragms in the Arco building can then be transferred safely to the Kennedy Building diaphragms through new diaphragm tie members. These members will also function as floor beams in the new middle addition.

Key

- *Reinforced concrete shear walls*
- *Steel moment frames*
- *Additional column*
- *Gravity columns*
- *Diaphragm tie members*
- *Possible new foundations*
- *Vertical steel out-of-plane supports*
- *Masonry construction*
- *Reinforced concrete construction*
- *New building addition*

The floor diaphragms of both remaining existing buildings require upgrading. Given the size of the floor plates and the weight of the perimeter masonry walls, new steel cross-braced diaphragms are likely to be required. They will enable the 38 m long diaphragms to span horizontally between the two new concrete walls at each end of the cluster.

Comments

Due to the relative flexibility of the new steel moment frames, the masonry walls parallel to them require 'softening' using vertical saw cuts.

As mentioned above, the new longitudinal resistance of the cluster is provided by moment frames in the Kennedy Building, reducing the extent of structural intervention in the Arco Building. Retrofitting work in the Arco Building could be further reduced by moving the new wall on the Arco Building's boundary wall to the outside of its other wall. This would significantly reduce construction work inside the Arco Building. However, even with the removal of the concrete wall, vertical steel out-of-plane posts are required to support the masonry walls.

The bay lengths of the new moment frames in the Kennedy Building are quite short. This means the columns against each wall can provide out-of-plane support for those walls. However the spatial integration of the new structure with the existing posts that support the timber floors needs further investigation.

The interstorey height of the Kennedy Building ground floor is higher than the floors above. This increase in the height of the bottom floor of a moment frame is of concern as the structure in that storey is more severely affected by earthquake shaking than other storeys. This 'soft storey' will require special attention by the structural engineers and may even necessitate raising the level of the ground floor.

Summary

This section began with five case-studies that illustrate how typical buildings in the Cuba Street precinct can be retrofitted so as to be no longer considered 'earthquake-prone'. Between them, they illustrate that when it comes to inserting new structural systems to resist earthquakes, there are only three conventional systems to choose from. But, once a structural system has been decided upon, many different applications are possible. For example, imagine that moment frames are the preferred structural system in one direction. The following questions are raised, including: how many frames will we use; how many bays per frame, and where are the frames to be positioned in plan?

The answers to these questions depend on structural, economic and architectural considerations. Whereas a single frame, albeit with very deep beams and columns, may possess adequate strength and stiffness, it leads to a structural configuration vulnerable to torsion. Also, the structural system of choice should match the stiffness of the existing structural elements. Moment frames are very flexible compared to unreinforced masonry walls. The number of frames and their bays is decided upon after considering costs and architectural implications. The more frames will mean smaller structural members. They will more easily fit into the existing architecture. However, they necessitate more construction disruption, including new foundations. More bays per frame mean smaller members as well, but the likelihood of structure, especially columns, disrupting the interior architecture increases.

These individual retrofitting case-studies are then followed by case-studies where buildings are not retrofitted individually, but in clusters. This approach to earthquake-prone buildings not only solves the problem of pounding between closely-spaced adjacent buildings, but introduces potential economic and architectural benefits. There are many more potential retrofitting options when treating two or more buildings as a cluster. The retrofitting strategies also depend on the type of the cluster.

The structural cluster building case-studies then, suggest how a limited range of building clusters can be retrofitted. However, it is important to remember that many other configurations of buildings can form clusters. For example, the maximum number of existing buildings in the clusters discussed above is two. Clusters of three or even four buildings may be not only possible but sensible. Considerations of the various retrofitting options may show significant benefits from economic, engineering, and architectural perspectives. Of course legal and insurance issues will require resolution.

Therefore, when a building owner is faced with retrofitting a building, one of the first steps is to consider the neighbouring buildings. Especially if they might pound each other during a medium to large earthquake, it could make a lot of sense from the perspectives above to retrofit the cluster as a whole, and not treat each building individually. The next step entails meeting and discussing the issue with neighbouring building owners.

The table on the following pages 96-97 summarises the retrofitting options raised in the cluster case-studies considered above.

The 6 easy steps to seismic retrofitting below were contributed by *Alistair Cattanach of Dunning Thornton Consultants Ltd* as a quick reference for owners of earthquake-prone buildings.

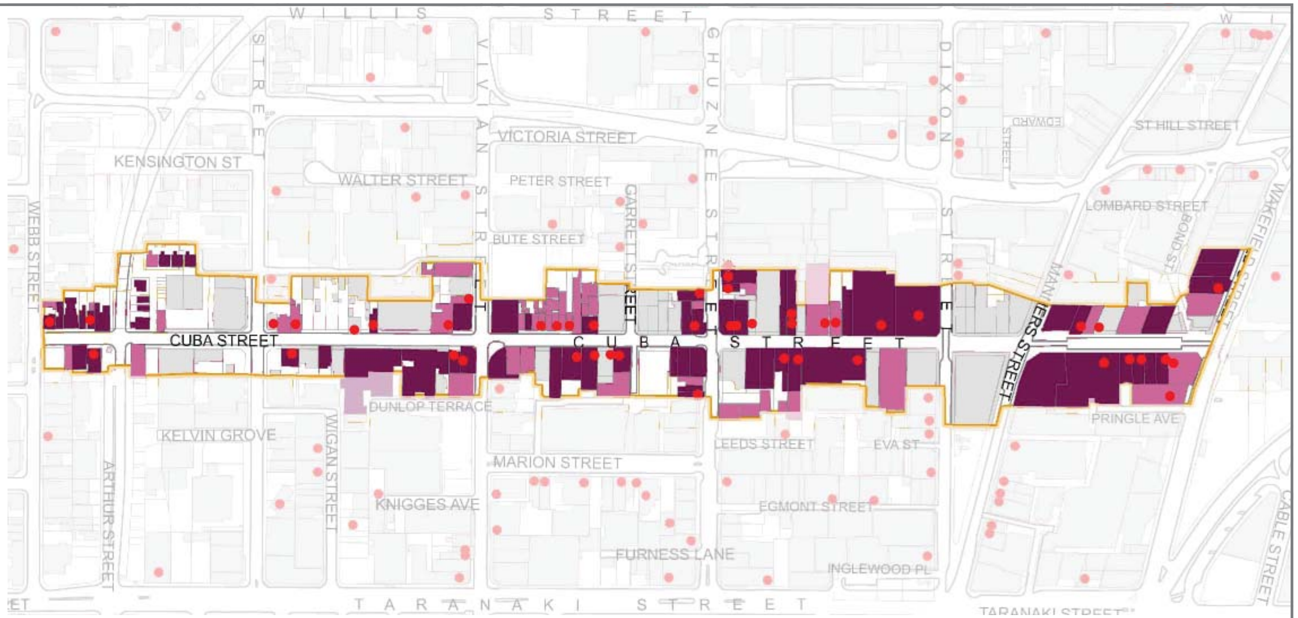
Seismic strengthening is a complex activity that involves balancing between new and old the properties of stiffness, strength, planning, disruption/intervention, aesthetics and more. However, the main structural aspects can be broken down into six easy steps.

1. Firstly, primary bracing should be considered. Forces along and across need to be catered for but one will often find that existing structures are already stronger in one direction with the likes of boundary walls. It is important that the full range of structural forms (walls, frames, bracing) and materials (steel, timber, concrete) are considered to match the nature and planning of the building.

2. Next come the foundations to these elements, to prevent their overturning and sliding. Existing foundations may also warrant consideration if decay or liquefaction are present.

3. The new bracing elements must connect to the rest: we rely on floors and the roofs of buildings as structural diaphragms to link all the parts. Most important is connecting all the parts back to the diaphragms. The diaphragms themselves may need strengthening to withstand the racking and the forces.

4. The integrity of the main building elements should be checked. Brick walls may need assistance to span vertically between floors or columns may need additional binding to be able to rack over with the structure.



WCC Earthquake-Prone Buildings mapping 27 June 2013.

Red dots were earthquake-prone, Shaded buildings were listed Heritage buildings at that time.

5. Parapets, ornamentation and canopies pose a significant hazard to the public outside the building and these are subject to higher shock forces than the building itself. Securing back deeply into primary structure is essential, and a well secured or propped canopy can provide additional protection to the street.

6. Lastly, non-structural elements within the building such as ceilings, services, storage and the like should be braced back.

In order to get best "bang for your buck" these six steps should be worked up in backward order; securing the smaller parts today and planning for the more expensive and disruptive stages in the future.

Type of cluster retrofit	*Structural comment*	*Architectural comment*
Existing building to existing building (104-106 Cuba St.)	New vertical structure (moment frames) pass through the two buildings and also help tie them together. New structure is evenly distributed between both buildings. Each is treated equally from a structural point of view. This approach is valid where both buildings are approximately the same height and scale.	This approach indicates no significant architectural changes are likely for both buildings excepting addition of new retrofitted structure and the consequential changes necessary to existing finishes to accommodate this. No one building is privileged in any way. Possibly a good solution for where both buildings are owned separately. Both owners have similar works of similar costs. There are potential structural synergies from the increased scale of the overall retrofit
Existing building to existing building (122-126 Wakefield St	Unequal floor levels necessitate strong short walls to tie the buildings together. This is irrespective of whether the new vertical structure is distributed evenly or not throughout both buildings. In this solution, the walls and frames of both buildings need to be aligned and connect to the short walls. If the new retrofitting structure is restricted to one building, it has to be in the taller building. Then, for at least one direction, it would support the shorter building.	Need to align frames of both buildings may lead to new columns disrupting interior space if there are areas where there is connection proposed between the buildings.
Existing building to new building (116 -118 Cuba St.)	A higher re-built partially existing building provides new earthquake-resisting structure for its adjacent heritage neighbour. All new vertical structure is confined to one building. Retrofitting of the heritage building is restricted to upgrading floor diaphragms and proving face-load support to masonry walls.	The configuration of this cluster offers the opportunity to open up and merge the floors of both buildings. The centre load-bearing wall could be replaced by posts and beams. By having new construction support existing, it is possible to open-up the existing architecture. Small confined spaces can be enlarged. Significant potential advantages for one building that has reduced changes and consequences from retrofitting

Type of cluster retrofit	*Structural comment*	*Architectural comment*
Existing building to new building (232 Cuba St.)	This project illustrates a retrofitted existing building providing partial strength for a new building. The existing building contains the potential for excess longitudinal strength due to its three unreinforced masonry walls. The retrofitted walls support both existing and new construction.	This is a strategy for an addition with minimal structure, perhaps to achieve maximum transparency, and allowing clear expression of new additions in relation to existing. This approach maintains and reinforces, both literally and figuratively, compartmentalisation of the original building.
Existing building to existing building through new construction (35-47 Cuba St.)	The retrofitted structure in one building supports a second existing building in one direction. Both buildings are connected through new construction replacing a building that was previously between them. With all vertical seismic structure in one building, minimum disruption is caused in the second building. Both buildings are affected by retrofitting equally in the transverse direction. Another option worth considering is placing all the longitudinal structure in the new middle construction. This structure, perhaps five lines of eccentrically-braced frames, would be very dominant, yet would create the structural core for both buildings. Disruption to the two historic buildings could be further reduced by moving the new concrete wall from its current proposed position in the narrower Arco House, to the other side and within the area of new construction. Due to the need to reduce torsion to a minimum, the new wall at the far end of the Kennedy Building remains.	This design tactic requires new architectural work to help negotiate the structural condition of two adjacent buildings. The existing buildings will determine the required new floor levels and major structural elements within the new building. Retrofitting is focused primarily on the new building, resulting in a comparatively large very strong structure to retrofit the two 'saddlebag' buildings. The two existing buildings remain relatively intact with minimal changes and consequences directly from the seismic retrofitting.

Conclusions

Cuba Street is by no means perfect…There are 34,235 pigeons and at least as many drunk teenagers. It's 'alty' because it wants to be alty, because that's its brand, not because of some sort of divine hipster calling. But it isn't meant to be perfect. It's a ramshackle collection of the grand and the gratuitous; the elegant and the cheap living side-by-side. It's a walk through our city's history like no other.[5]

The need for seismic retrofitting was the impetus for this project. In a context where buildings need to adapt to survive, key questions arise for building owners. For example; to what extent and standard should a building be retrofitted? How much of an existing building can be retained without compromising the seismic retrofit needs? How much can be demolished and still retain the integrity of the original? What is the relative heritage value of different parts of a building? How much can be added to an existing building without destroying its essential character? What are the best techniques to upgrade a particular building?

A seismic retrofit needs to be strong enough, resilient enough, and flexible enough to have a long life. An important context for this discussion is the changing nature of regulatory systems. Several of the buildings in Cuba Street had already been seismically retrofitted to minimum requirements in earlier years and are now once again classified as earthquake-prone because standards have changed. It would only take a major earthquake in Wellington to change the political and economic context for existing buildings as has occurred in Christchurch, which was previously considered a low earthquake risk. The history of structural code changes over the years suggests that there will be future changes as well. Acknowledging the extent of consequential work involved in seismic retrofitting, it is clearly highly desirable to upgrade to the highest structural standard possible, or to allow for potential future changes as current upgrading occurs.

Our students know the Cuba Street environment well. This familiarity assisted the development of their architectural judgement as they worked to bridge gaps between their ideas and the design implications. The project tested and extended their abilities. They honed their predesign judgment, observation and analysis skills, and learned to look deeper into contexts to determine underlying patterns and factors that are changing environments over time.

We adopted an architectural practice model where students worked collectively in groups for the initial parts of the project. They learned to draw and document with the subtlety and clarity expected in professional practice. Macro and micro mapping and cross-sections occurred in groups and required co-operation and co-ordination to produce a consistent series of outcomes and even out workloads. An extensive cohesive resource resulted that all students could access and work from during the project design phases. Students also learnt to document existing buildings and produce simple and beautiful drawings to act as base information for the subsequent redesign work. This apparently simple task required many students

5. *http://salient.org.nz/features/cuba-street-past-present-and-future.*

[Re]Cuba collective model during assembly 2012. Photograph Paul Hillier.

to upskill in computer aided design programmes, and focus on representational conventions. The drawings that resulted had an elegant simplicity and clarity.

Students also learnt that architecture is a collective and multi-disciplinary enterprise, and that there is considerable efficiency possible through collaborative work in a design-led-research laboratory format. Students integrated existing structural and services information through their design practices. They also developed their design work and focused detail design and documentation at smaller scales through working architectural drawing sections and details.

The findings of this design-led-research demonstrate a series of exemplar approaches to the seismic retrofitting problem, *and that there are potential synergies when buildings are considered together rather than as isolated islands*. Through the project, students found that by working together on predesign analysis, and identifying potential seismic retrofitting synergies, they also identified opportunities for better urban design solutions. For example, a number of shared laneways became possible to access intensified parts of the relatively narrow and deep sites. Collaboration was found to be key, not only for the seismic retrofitting, but also to achieving good urban design linkages.

The range of student design responses to architectural heritage and the necessary seismic and amenity retrofitting are likely to be representative of a wider public range of responses over time. Most students were sympathetic towards the value of heritage architecture, some extremely so. Some students played fast and loose with good heritage architecture and compromised parts of it. A few had an antipathy to heritage architecture, regarding the buildings as completely without value; an "*old dungers have to go*" approach to heritage architecture, as advanced by Gerry Brownlee in Christchurch post earthquake. The diversity of approaches suggests that in the future we will lose a few heritage buildings from Cuba Street in whole or in part, and that there will be a range of design quality in the design of the seismic retrofits and new building work that will occur. The good news is that the street is clearly resilient enough not be adversely affected. Good heritage investigation and advice is clearly of great importance as a tool to identify and protect key heritage fabric.

The collaboration between VUW, Wellington City Council, and Heritage New Zealand has been noteworthy and leads the way forward for actual projects. Our experience of both groups in terms of their ability to work collaboratively with stakeholders is the complete opposite of a stereotyped bureaucracy that many perceive in such organisations. Their team approach to the facilitation of seismic retrofitting is a significant resource and supporting mechanism available to owners of earthquake prone buildings that should be sought at an early stage in any project.

The project considered as a whole demonstrates that there are many innovative single and clustered approaches to the *interwoven structural and architectural issues posed by structural upgrading* required to earthquake-prone heritage buildings, and that this diversity of approaches is consistent with the underlying character of the street. There is a fresh collective architectural vision represented by the project that is way greater than the sum of its parts. The vibrant character of Cuba Street has a potentially very positive hybrid new-old architectural future that is likely to emerge from the famed Cuba Character areas seismic challenges.

The Cuba Street projects' aimed to draw attention to the need to seismically retrofit buildings in Cuba Street, and the diversity of ways that this might occur has been fruitful. There was a ripple of public engagement with the project. There was a number of public meetings, lectures, and exhibitions. There were articles published in *Heritage New Zealand*, the *Dominion Post*, and *Salient*. A keynote conference presentation was invited based on the project, and now this publication supported by the three partners in the original project.[6] The project had a further life in late 2014 as a smaller version focused on the need to seismically retrofit Newtown buildings.

Board member of Heritage New Zealand, Wellington Architect Ian Athfield, often states "*Architectural Heritage starts with good architecture today*". There are qualitative design issues that emerge from this project and can underlie the debate about the value or otherwise of heritage buildings. Reusing existing buildings is a sustainable tactic that minimises the extent of new material required. Typically, heritage buildings do certain things well. They have particular scale and material qualities arising from an earlier era. They are designed and constructed differently to contemporary buildings, often of superior materials and craft, and with a greater attention to design detail than occurs today. They also carry the patinas and traces of their previous human occupations. The general public fear that new buildings replacing demolished heritage buildings will be of lesser quality. Unfortunately, too often this is correct. While new buildings are designed to meet contemporary structural and amenity standards, commercial buildings are likely to be reduced to investment formulas that prioritise capital returns over the value of environmental quality. Good design, materials, and construction standards create buildings with enduring value that are tomorrow's heritage architecture.

The extent of architectural work required in seismic retrofitting projects is very much an architectural matter. Part of the current problem is that wider recognition is needed of the extensive architectural work that seismic retrofitting requires, and that this work requires design in the same way that structural work requires design. Project managers prioritise management. Engineers prioritise structure. Architects prioritise design and environmental quality. New Zealanders need to demand better design quality for seismic retrofitting projects if their standard is to improve. This begins with appointing an architect to work with an engineer on seismic retrofitting projects. This is also more than an individual building matter. The city, and Cuba Street as a precinct is a collection of individual buildings. The city gains from well-designed buildings, and is incrementally diminished by poor quality and mean buildings.

The range of approaches to heritage highlighted by the project is also significant. A number of less purely conservative heritage adaptations demonstrate the potential flexibility of adaptive reuse of less significant heritage building fabric.

Since starting this project there have been a number of buildings in Cuba Street seismically upgraded. There is an interior retrofitting aesthetic tactic emerging within some of these where the layers of a building's history are peeled back to expose a palimpsest with underlying surfaces visible, complete with imperfections and inconsistencies. This exposition and embracing of the full richness and patina of the various histories of a building over time also provides a transparent framework for the introduction and integration of new work within and over existing building fabric. This approach is complementary to the patina and diversity of the existing exterior street aesthetic. There is no doubt that there is a special character to Cuba Street that goes beyond the planning documents and design guidelines. It is a place that is loved by Wellingtonians for its diversity, its smaller scale independent mixed uses, and its heritage and patina, as much as its architectural character. This is unique and precious and at risk from renewal by attrition; by incremental change. The risk of the loss of the special urban character of the street and precinct as a whole was an important issue. Students found that Cuba Street between Abel Smith Street and Karo Drive has already lost much of its original scale and character. Project designs for this part of the street demonstrate the importance of the underlying historical smaller scale site size and a diversity of building vertical scales in addressing this problem. Henry Read and Pollyanna Dawes' projects demonstrate that attention to these factors in larger scaled redevelopment can help recover Cuba Street's special urban character in a manner that will reflect its roots and essential qualities.

Following research into the history and multi-scaled urban context of Cuba Street, the project involved architectural and structural upgrading of the historic buildings to extend their lives. While respecting the historic qualities of the buildings, they were subject to intensification of occupancy and architectural modifications to ensure their future relevance and viability. A significant outcome of the architectural projects is the rich diversity of architectural approaches to heritage. The following list of design case studies indicates the depth and range of potential architectural strategies:

- Complimentary façade design
- Inside out: Internal Augmentation
- Replication
- Contrasting: existing and new + rooftop
- Strengthening from the outside: exoskeleton
- Critical editing
- Existing building as seed
- Contrast and co-dependence
- Building within a building
- Formal separation and visual contrast
- Scale contrast: big building behind smaller
- Scale transition
- Architecture as changing heritage
- Major surgery
- Working with historic grain

[Re]Cuba collective model Webb Street to Karo Drive 2013. Photograph Paul Hillier.

[Re]Cuba collective model Wakefield to Manners Street 2013. Photograph Paul Hillier.

Regarding the seismic retrofitting of clusters of buildings, our design-led-research approach shows a wide diversity of structural design strategies. Potential retrofitting approaches explored include tying:

- Two or more existing buildings together. The retrofitted structure can be evenly distributed between both buildings or mainly concentrated in just one.
- An existing building to a new building where the new building provides some or all of the retrofitting needs of the existing building, reducing the impact on the existing building
- An existing building to a new building where the retrofitted existing building is sufficiently strong to partially or fully support the new building.

Each of these structural strategies implies a certain desired architectural outcome for the cluster of buildings that can be realised by close integration of the retrofit structure with all the other architectural elements and requirements.

We are confident that this VUW research has created a dialogue and improved awareness of the need for seismic upgrading and the range of ways this might occur. We trust that the continuing architectural refurbishment and redevelopment of Cuba Street buildings will reflect the diversity of the design ideas documented in this book, and preserve and enhance the unique character of this historic precinct.

6. *Public meetings, lectures and exhibitions occurred on the 26 July, 19th Nov 2012, 17th July and the 7th Nov 2013 at VUW TeAro Campus and the Wellington Town Hall, and 26-28th April 2013 at the Wellington Town Hall with the NZ Society for Earthquake Engineering conference. Publication occured in Heritage NZ Autumn 2013 pg.28-33, the Dominion Post 27 April 2013 and Salient as noted in Reference 5. A conference presentation occurred on 21 March 2014 to the NZIA Western Branch Seismic Resilience Conference.*

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