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Apartment Design Guide

Guidelines for the Design of Multi-Storey Apartment Buildings in New Zealand

Concrete New Zealand

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BUILDING RESILIENCE

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CONTENTS

Page

CREATING A HOME

1 Home - An Interpretation 5

2 Dwelling Types 6

DESIGNING THE APARTMENTS

3 Minimum Apartment Sizes 9

4 Footprint Options for Minimum Apartment Sizes 11

5 Interior Climate 14

6 Parking and Storage 17

7 Communal Areas 19

DESIGNING THE BUILDING

8 Urban Design 21

9 Access 26

10 Designing a Sustainable and Structurally Sound Building 27

11 Energy Efficiency 29

12 Water 31

13 Sound Proofing 32

14 Fire Safety 35

RESOURCES

15 Inspiring Designs 39

16 Glossary 45

17 Appendix 47

PREFACE

This guide is for planners, architects, investors and everyone with an interest in good quality apartment design.

Apartment living is becoming increasingly common in New Zealand, especially in the more densely populated cities of Auckland, Wellington and Christchurch. While reasons for this include increased immigration and land constraints, the fact is that New Zealanders' lifestyles are also changing.

There are more households comprising couples and singles, more people renting because they can't afford to buy, and more city dwellers moving in from the suburbs because they enjoy the proximity to work, shops and nightlife. There are also increasing numbers of retirees who want the convenience of apartment living and who require less space after their children have left home.

However, as a country we are still relatively inexperienced when it comes to apartment design. Copying international practice isn't always the answer: what works for someone in New York or Berlin won't necessarily keep a Kiwi happy. We value our connection to the outdoors, we like to drive, and we have more bulky possessions needing storage such as tools and sporting gear. As well as providing extra room, New Zealand designers have the added challenge of tackling earthquake protection within the structural design.

This guide sets out some key considerations for designing New Zealand apartment buildings, their amenities and shared spaces. We include some tips on recommended minimum sizes, daylight and interior climate requirements, effective soundproofing and fire protection.

We also look at how to design a sustainable and durable building that enhances rather than detracts from the urban landscape. Finally, we include some links to interesting and innovative apartment complexes.

We hope this guide will provide inspiration for your apartment design.

Ralf Kessel, Architect (NZIA, ARB UK), June 2013
Concrete New Zealand

CREATING A HOME

1 HOME - AN INTERPRETATION

Home is the most important place for most humans. Home is 'our place' where we can relax and be ourselves. We associate the word 'home' with positive attributes such as health and wellbeing, recreation, socialising, inspiration, shelter, protection, safety and comfort - to name but a few.

Home is also a place where personal development can blossom. The inviting design of our own place has a huge influence on our happiness: the person who feels well in their home plans more positively, takes part in life more actively and remains sane.

If our home is in an apartment building, there are some specific challenges to ensure it remains 'our place' and can adapt to our own and our family's changing needs.

Key influences on our sense of home include:

- The space, light and thermal condition of our dwelling
- The journey from the street to our front door
- The overall building design, including the location and layout of any spaces we share, and
- The balance between privacy and access to places to meet easily with others.

A survey[1] of apartment dwellers in Wellington identified some key likes and dislikes about apartment living.

Top five likes:

1. Lifestyle and city living (23%)
2. Proximity to work (20%)
3. Proximity to shops and cafes (11%)
4. Low maintenance (11%)
5. Better safety and security (7%)

Top five dislikes:

1. City noise and noise from neighbours (27%)
2. Lack of outdoor space (17%)
3. Living too close to neighbours (9%)
4. Apartment size and lack of storage space (8%)
5. Parking issues (7%)

As New Zealanders, we have a strong connection to nature and to the land, mountains and sea. We're used to spending a lot of time outdoors, having barbeques with friends, gardening and playing sports.

Creating a sense of outdoors in an apartment complex is not impossible. One way is to provide more generously sized balconies, while another is to create community gardens either at ground level or on the roof.

Another key consideration is flexibility with space, whether it's providing enough storage for sporting, camping and DIY gear, or making room to store other possessions to meet changing family needs. We'll provide tips on how to do this as well as other ways to enhance people's enjoyment of apartment living through good quality apartment design.

[1] www.wellington.govt.nz/~/media/services/environment-and-waste/urban-development/files/apartment-survey-report.pdf

2 DWELLING TYPES

People have different lifestyles and for every lifestyle there is a residential solution. Typical dwelling types for New Zealand are:

Detached home	A house built on its own land and surrounded by a garden.
Semi-detached home	Two houses attached to each other and surrounded by a garden on three sides.
Terraced houses	Several houses attached to each other with a small front section and a larger back garden, and usually located in suburban environments.
Townhouse	Several houses attached to each other with a small back garden, usually located in urban environments.
Loft apartments	An apartment created from the conversion of former industrial spaces. Loft apartments are known for their large adaptable open spaces and large floor to ceiling height.
Two level apartments	A home over two levels with an internal stairway, which is stacked together with other apartments in an apartment building.
Single level apartments	A home which is stacked together with other apartments in an apartment building.
Penthouse	A house on a roof top which generally has a roof deck, if not a roof garden.
Bach	A house which is usually located in rural areas and is used for holidays.

As this design guide arises from the need to intensify the use of space in our cities, especially in Auckland, it includes examples of floor plans for single level apartments as these are the most space-efficient designs. However, it is important to offer a mix of dwelling types to suit people’s different lifestyles as well as ensuring a vibrant and inspiring atmosphere in apartment developments.

A townhouse or two level apartment can be a good option for a larger family who would like to live in town. A penthouse is ideal for more affluent residents who enjoy entertaining, while a loft apartment may appeal to artistic people working from home.

The following page shows an example of a mixed development where townhouses, penthouses, two level and one level apartments are combined.


SINGLE LEVEL APARTMENT
TOWNHOUSE
PENTHOUSE
Summer
Winter
Dual solar shading

DESIGNING THE APARTMENTS

3 MINIMUM APARTMENT SIZES

Enclosed spaces provide the room for our daily activities. We live, recharge our batteries, invite friends to socialise, follow our hobbies or work in our homes. All these activities require space. No design, no matter how excellent, can compensate for a space that is too small.

The following are some recommendations for minimum apartment sizes. However, sizes above these minimums are always encouraged. We also suggest you provide extra storage for each apartment somewhere within the complex (see section 6.4).

Table 1a	Minimum apartment sizes
Studio	30 m²
1 bedroom	45 m²
2 bedrooms	70 m²
3 bedrooms	90 m²
4 bedrooms	110 m²

Private outdoor spaces, ground floor decks or balconies should be provided for each apartment unit in addition to these recommended minimum sizes.

Apartments with more than four bedrooms are not common. If more than this number of bedrooms is required, the usual approach is to combine two apartments. This option should be considered when you are designing footprints for apartment buildings.

A rule of thumb for designing larger apartments is to increase the apartment size by 20 m² for every additional bedroom.

Of this, at least 13 m² should be set aside for the bedroom itself. Most of the remaining 7 m² should be used to enlarge the lounge. You could also consider a slight increase in the size for the kitchen, main bathroom and storage spaces.

In addition, for each two bedrooms added, may consider including another bathroom of at least 4.5 m².

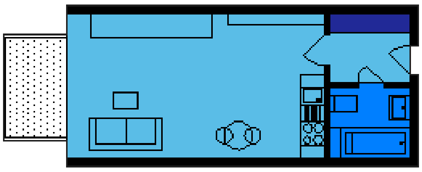
Table 1b	Ceiling heights
2.4 m	The absolute minimum, ideal from an energy and construction cost saving point.
2.5 m	Standard in many countries. Rooms > 35 m² may be perceived as crammed.
2.7 m	Provides reasonable generosity also for larger rooms, rooms up to 9m length.
3 m or taller	Enables for appealing overhead glazing design. Light can penetrate deeper into very large rooms. Disadvantage: higher building costs and more heating energy consumption.

Table 2	Minimum room sizes within apartments	
Studio	**30 m²**	
Room (lounge, bed, pantry)	23 m²	minimum width 3.6 m
Bath with toilet	3.5 m²	minimum width 1.5 m
Lobby, Storage		remainder to 30 m²
Balcony (additional to 30 m²)	*3.75 m²*	*minimum width 1.5 m*
1 Bedroom	**45 m²**	
Bedroom	13 m²	minimum width 2.8 m
Lounge	17 m²	minimum width 3.6 m
Kitchen area	5.5 m²	minimum width 1.8 m
Bath with toilet	3.5 m²	minimum width 1.7 m
Storage	2 m²	minimum width 0.6 m
Lobby		remainder to 45 m²
Balcony (additional to 45 m²)	*4 m²*	*minimum width 1.5 m*
2 Bedrooms	**70 m²**	
Bedroom 1	13 m²	minimum width 2.8 m
Bedroom 2	13 m²	minimum width 2.8 m
Lounge	22.5 m²	minimum width 3.8 m
Kitchen area	7.5 m²	minimum width 2.4 m
Bath with toilet	4.5 m²	minimum width 1.7 m
Storage	3.0 m²	minimum width 0.6 m
Lobby		remainder to 68 m²
Balcony (additional to 70 m²)	*5 m²*	*minimum width 2 m*
3 Bedrooms	**90 m²**	
Bedroom 1	13 m²	minimum width 2.8 m
Bedroom 2	13 m²	minimum width 2.8 m
Bedroom 3	13 m²	minimum width 2.8 m
Lounge	25 m²	minimum width 4.0 m
Kitchen area	9.0 m²	minimum width 2.4 m
Bath with toilet	5.5 m²	minimum width 1.7 m
Toilet	1.5 m²	minimum width 1.0 m
Storage	4 m²	minimum width 1.0 m
Lobby		remainder to 90 m²
Balcony (additional to 90 m²)	*6 m²*	*minimum width 2 m*
4 Bedrooms	**110 m²**	
Bedroom 1	13 m²	minimum width 2.8 m
Bedroom 2	13 m²	minimum width 2.8 m
Bedroom 3	13 m²	minimum width 2.8 m
Bedroom 4	13 m²	minimum width 2.8 m
Lounge	27 m²	minimum width 4.0 m
Kitchen area	11 m²	minimum width 2.4 m
Bath with toilet	5.5 m²	minimum width 1.7 m
Toilet	1.5 m²	minimum width 1.0 m
Storage	5 m²	minimum width 1.0 m
Lobby		remainder to 110 m²
Balcony (additional to 110m²)	*8 m²*	*minimum width 2 m*

4 FOOTPRINT OPTIONS FOR MINIMUM APARTMENT SIZES

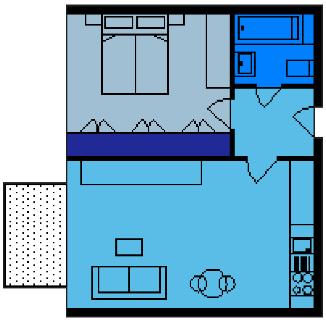
Studio **30 m²**

Sound and fire wall to neighbours, corridors and stairs



1 bedroom **45 m²**

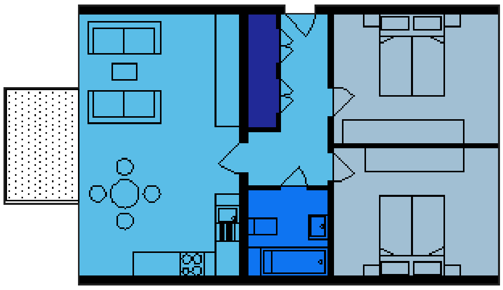
Sound and fire wall to neighbours, corridors and stairs



2 bedrooms **70 m²**

Fire wall to neighbours, corridors and stairs

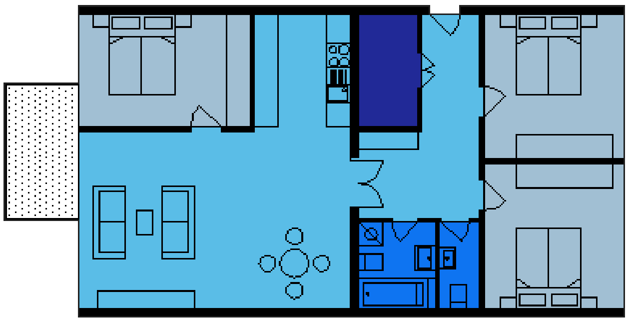
Sound wall to neighbours, corridors, stairs, but optional between living and sleeping



3 bedrooms **90 m²**

Fire wall to neighbours, corridors and stairs

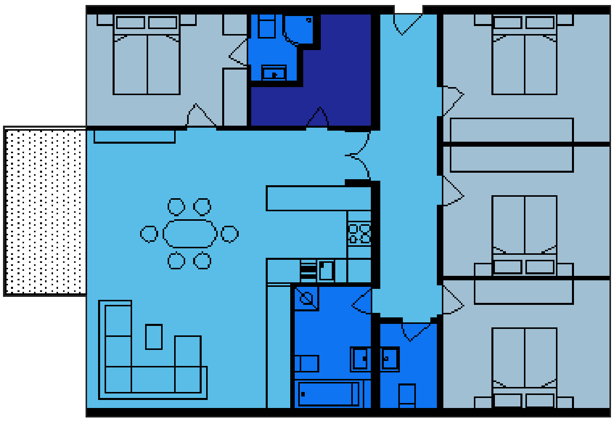
Sound wall to neighbours, corridors, stairs, but optional between living and sleeping



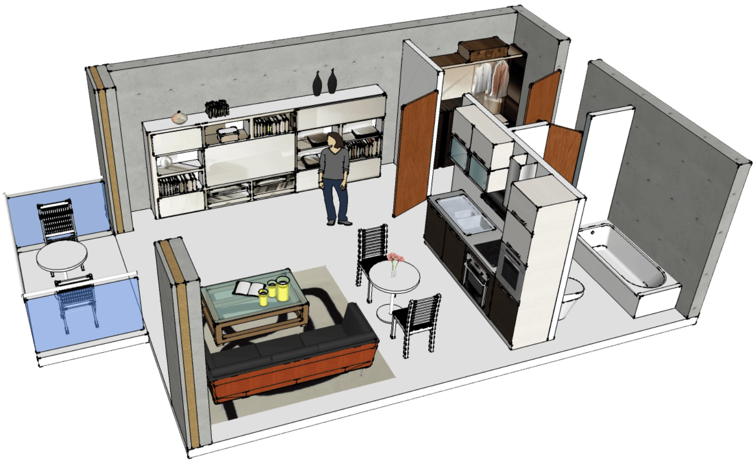
4 bedrooms **110 m²**

Fire wall to neighbours, corridors and stairs

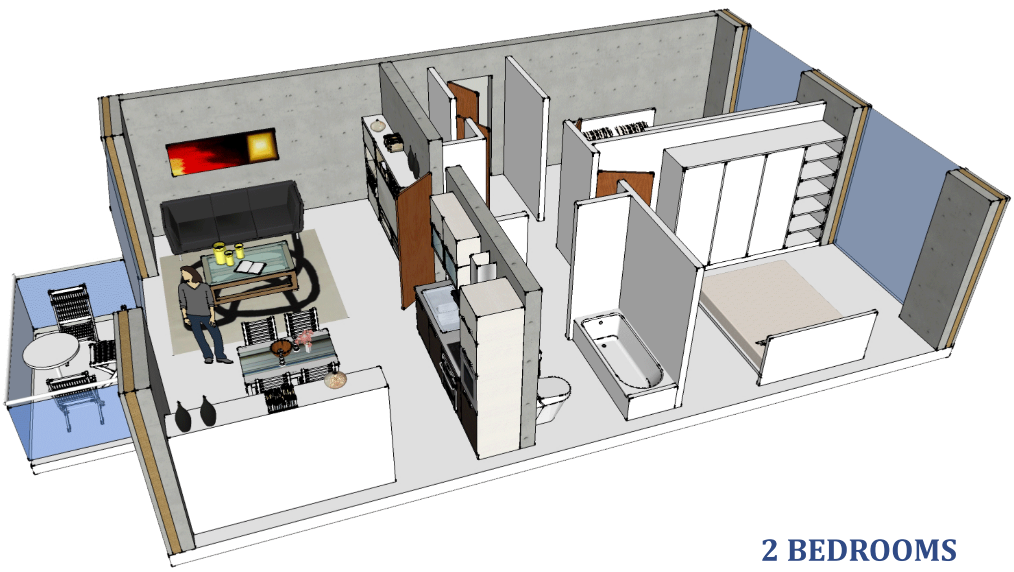
Sound wall to neighbours, corridors, stairs and optional between living and sleeping



STUDIO



1 BEDROOM



2 BEDROOMS

3 BEDROOMS

4 BEDROOMS

5 INTERIOR CLIMATE

Five major elements are responsible for a good interior climate:

1. Natural light providing daylight and sunlight
2. Thermal mass to balance temperature swings
3. Fresh air provided through controlled ventilation
4. Thermal insulation to reduce heat loss in winter and overheating in summer
5. Airtight construction.

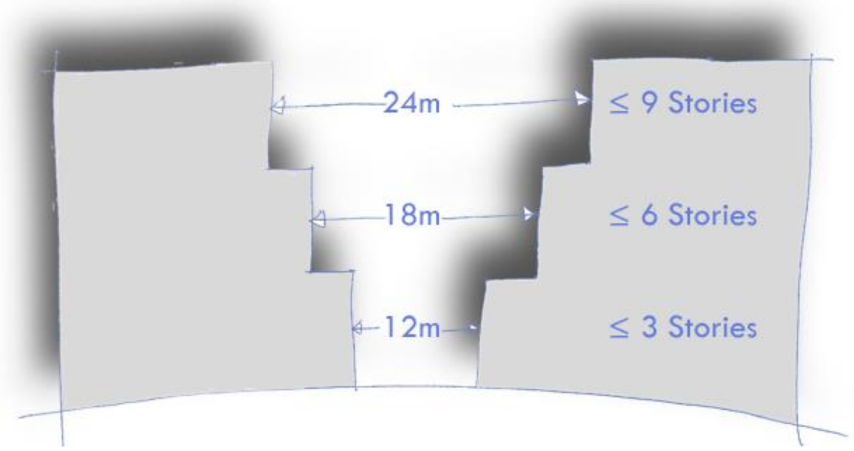
As natural light, especially sunlight, has a significant impact on our health and wellbeing it's important to consider this carefully in your apartment design. Daylight and sunlight animate indoor spaces and enhance apartment residents' enjoyment of an interior. Views outside keep people in touch with their wider surroundings, the prevailing weather, and the rhythm of the day and seasons.

Good natural light also reduces the energy needed to provide artificial light for everyday activities. Controlled sun penetration can also help meet part of the apartment's winter heating requirements when thermal mass is used correctly and if windows in the main living areas face north.

5.1 DAYLIGHT AND SUNLIGHT

As a rule of thumb, each room should have at least one window and a total window area of at least one fifth the room's footprint size.

Apartment blocks should keep a minimum distance to opposite units to ensure sufficient daylight within the units. The image to the right provides some guidance to acceptable minimum distances in dependence of the total building height. The taller the building the further the buildings have to be apart to allow for day light into the lower floor apartments.



Recommended minimum distances between apartment buildings

All apartments should allow for direct sunlight in the main room for at least four hours during the shortest winter day. The lounge, dining and kitchen area should also face north to capitalise on passive solar design, while bedrooms and bathrooms are better oriented to the south.

In general, the best ways to control sunlight through large north-facing windows are either by sliding or operable sunshades or by fixed overhangs above windows. The latter screen high summer sun while allowing low winter sun to penetrate. For lower apartment complexes, planting deciduous trees can provide useful seasonal shading in summer, while letting in more sunlight in winter when they have lost their leaves.

Ideally, all apartments should have windows looking in at least two different directions. However, exceptions can be made for small units (studios to up to two bedroom apartments) if the windows face northeast, north or northwest.

If possible, apartments should also have windows out on opposite sides. This gives residents a visual connection to the building's public face as well as its more private side.

5.2 VENTILATION

All dwellings need either fresh air or air exchange to help carry away internally generated moisture, caused by cooking, washing, bathing and human respiration. If an apartment is not ventilated sufficiently, internal moisture can condense and then lead to mould. This can cause respiratory health problems - and it's thanks to poor ventilation and insulation of New Zealand homes that this country has one of the highest rates of childhood asthma.

Internal moisture and mould can also be unsightly and can eventually cause severe damage to the building, rotting building materials such as wall and ceiling linings, and even structural elements should they not be made of concrete.

As apartments are often relatively small spaces, it's important to make sure you have provided adequate ventilation for health and comfort. The recommended ventilation rate for an entire dwelling is between 0.5 ACH and 1.5 ACH (air changes per hour, which is a measure of how many times the air within a room is replaced).

The humidity level in the apartment should lie between 40% and 60%, as less than that provides ideal conditions for insects, particularly borer, to breed. We recommend designing each apartment so residents can get enough ventilation simply by opening their windows. The opening window area should be at least 4% of the total floor area.

Mechanical ventilation is not a good option: plant devices are expensive and energy consuming, require maintenance, and take up precious space. However, for best functionality of apartment footprints, designs with internal bathrooms are often hard to avoid. In this case, install an exhaust fan with an air flow rate of at least 1.5 m^3 per minute if intermittently operated.

As a general rule, opening bedroom windows fully for about ten minutes each morning and each evening after and before bedtime will provide a decent air exchange. Windows in bathrooms, laundries and kitchens should also be kept open for at least ten minutes after these rooms have been used.

Cross ventilation shown in the penthouse apartment to achieve fast air exchange

Base isolation: here on concrete piles for seismic protection in areas prone to liquefaction

5.3 THERMAL INSULATION

Thermal insulation is required to prevent heat from escaping dwellings in winter and entering them in summer.

There are a variety of insulation materials on the market ranging from mineral wool and glass wool to polystyrenes and other rigid foams. The efficiency of thermal insulation is recorded either in U-values or, more commonly in New Zealand, in R-values. The R-value is a measure of thermal resistance: the larger the number the better the material's thermal resistance.

The best placement of thermal insulation is on the outside of the building or within a ventilated cavity for the reasons explained below. Thermal insulation can be directly applied to the external wall, be a part of a sandwich component such as a core-insulated concrete wall or placed in a ventilated cavity system.

Applying thermal insulation to the interior side of a building assembly is generally considered a poor option because of the risk of internal water vapour condensation. The temperature at which condensation occurs (i.e. when the air is no longer warm enough to hold moisture) is known as the dew point. Within a building system the dew point occurs at the location where the temperature changes, which will be within the insulation.

This is especially true in winter, when more internal moisture-generating activities occur. If thermal insulation is applied to the interior side of a building assembly, it can trap any condensed water vapour and this can in turn lead to mould (see section 5.3).

However, if the insulation is placed on the exterior side of a building assembly, within a ventilated cavity or further to the outside when core insulated, water can always escape to the outside.

A second disadvantage of internal insulation is that the thermal mass of the wall is isolated from the room (see section 5.2).

A third reason to avoid insulation internally becomes apparent when it comes to joints, such as floor-to-wall or wall-to-ceiling details. These areas are most likely to create cold bridges at those junctions. If you apply insulation to the exterior, the protection will completely wrap around the house, similar to a protective coat we would wear in winter.

While it is most important to insulate the roof and walls, underfloor insulation also provides an energy and comfort yield. Avoiding cold bridging (unwanted heat transfer) is important too. One of the most common cold bridges happens at the slab edge, where the perimeter is not insulated.

5.4 AIRTIGHTNESS

Air leakage is the uncontrolled movement of air in and out of a building that is not for the purpose of venting stale air or bringing in fresh air. Air leakage is a major cause of heat energy loss, especially in older houses.

Air leakage is measured as the rate of leakage in cubic metre per square metre of the external envelope per hour, at an artificial pressure differential through the envelope of 50 Pascal (Pa). A result of 5 $m^3/hr/m^2$ at 50 Pa is recognised internationally as good practice.

Airtightness can be measured with the 'blower door test', which is being used increasingly in New Zealand.

Table 3	Airtightness guidelines
Good practice	5 $m^3/hr/m^2$
Average	10 $m^3/hr/m^2$ (*most New Zealand single-dwelling homes*)
Leaky	15 $m^3/hr/m^2$
Draughty	20 $m^3/hr/m^2$

You can improve a building's airtightness by sealing joints around openings, penetrations, and areas where material changes occur, such as floor-to-wall and floor-to-ceiling joints. It is relatively easy to improve airtightness in concrete or concrete masonry buildings, because the only joints to seal are around openings and penetrations.

5.5 THERMAL MASS

Sunlight has a significant impact on thermal comfort and energy consumption. In winter it can make an important contribution to heating. However, this can be a disadvantage in summer when excessive solar gain can cause overheating and discomfort.

One solution is to include thermal mass in your design, such as an exposed concrete slab. This absorbs heat in summer and prevents rooms from overheating. When it turns colder at night or during short winter days, heat is released back into the rooms again. In particular, thermal mass contributes to overall energy saving by creating a comfortable interior climate and balancing the room temperature.

6 PARKING AND STORAGE

As most apartment developments are situated in city centres, this has the advantage of proximity to amenities such as shops, work and community spaces. Commuting is easier and residents may no longer require a car as often, or at all. Transport alternatives include cycling, public transport or simply walking.

Most well-conceived apartment designs provide car parking, bicycle parking and storage below ground. However, although underground or basement areas don't require natural light, they still require ventilation. Options to minimise or even omit mechanical ventilation include half buried car parks or cleverly arranged ventilation shafts.

Half buried car park and bicycle park

6.1 CAR PARKING

As a general rule, provide one car park for each unit. Residents who do not own a car always have the option to lease their car park to those who require additional parking. However, the decision on the number of car parks you provide may depend on discussions with the local building consent authority as, in areas of intensification, the infrastructure may only allow a certain number of cars without causing major traffic congestion.

To comply with NZBC Clause D1, a wheelchair accessible car park shall be considered as follows:

a) 1 for up to 10 total spaces provided,
b) 2 for up to 100 total spaces provided,
c) Plus 1 more for every additional 50 spaces.

A typical arrangement allows an area of 2.4 m x 5 m for a car park with a 6 m wide double access lane between the car parks. A wheelchair-accessible car park should be at least 3.2 m x 5 m.

6.2 BICYCLE PARKING

As a recommendation, one bicycle space should be provided for a studio unit and two spaces for a one bedroom unit. After that, add an additional bicycle space for each extra bedroom. The size for one bicycle to park is 2 m x 1.2 m. However, a typical arrangement for six bikes parking horizontally with an access corridor of at least 1.8 m in between takes a space of 1.5 m x 5.8 m; i.e. about 9 m^2. If bikes can be hung from the wall, the area can be reduced to about 5.5 m^2 with a middle corridor of at least 1.5 m.

6.3 MOTORCYCLE PARKING

A motorcycle will need a parking space of 2.5 m x 1.2 m. As a rule of thumb, provide one motorcycle parking space for every five apartment units.

6.4 STORAGE

Storage outside the apartment should be provided for each unit. This space is mainly intended for bulky items not in daily use such as hobby equipment, travel, sports and holiday gear. This storage area can usually be arranged within an underground car parking area.

We suggest you provide at least the following storage areas for each apartment: 2 m^2 for a studio, 3 m^2 for a one bedroom apartment, and an additional 1 m^2 for every extra room. This should be provided in addition to the storage within the apartment as described in section 2.0, Table 2.

6.5 REFUSE AND RECYCLING

A common area for refuse collection, including recycling, should be provided. You can locate this within the underground car park or at ground level, paying special attention to fire safety and ventilation. The area will need suitable access for rubbish trucks.

The refuse area can also be integrated into the landscape design of the common gardens and hidden by attractive walls, hedges or plants. Refuse storage should be positioned so that unpleasant smells don't reach the inhabited spaces. The refuse area should provide for waste separation to glass, plastic, paper, metal and organic materials.

7 COMMUNAL AREAS

Many urban space planning guidelines stress the importance of open spaces and green areas in residential developments for improving the quality of life for their inhabitants. There is good reason for this. Outdoor common areas such as gardens and children's playgrounds are valuable social areas and also allow connection with the wider community.

Common spaces encourage people to interact, exchange information and share their daily lives. Landscaping with plants and trees in ways that create both smaller and larger spaces allows room for different activities and various group sizes. Communal areas also provide space for relaxation, such as reading or resting in an outdoor setting.

7.1 PLAYGROUNDS

Playgrounds should ideally be located near the centre of the development and be visible from all units. This allows for family members to watch children without always having to be physically present.

7.2 VEGETABLE GARDENS

Space set aside for small vegetable gardens will pay huge dividends for apartment residents' health and well-being. Growing their own vegetables and herbs will not only help them feel more connected to their homes and environment, and offset some of the negatives of apartment living, but will also save them money.

A recommended vegetable garden size is at least 2 m^2 per apartment unit. Planting a few fruit trees in the communal area will also allow produce to be shared.

Small patches to grow your own vegetable increases identification with the development

7.3 INDOOR COMMUNAL AREAS

Communal indoor spaces can open up new opportunities for learning and support. These might be areas where people from within the apartment or from the wider community come to teach skills such as carpentry, cooking, entrepreneurship or where people celebrate and organise functions. Community members are generally to be happy to bring their skills and knowledge to share with residents when a space existed to do so. As a result, they were able to offer their residents more resources without increasing their funding.

7.4 ROOF GARDENS

Roof Gardens are a great option to provide communal space in a dense city centre's area. Thermal insulation, deck-paving and soil contribute to the finished floor level and have to be considered when designing for access from the interior of the building.

Enjoying an evening with friends on a roof deck

DESIGNING THE BUILDING

8 URBAN DESIGN

Urban design forms our built environment and is responsible for the appearance and identity of a city. The way buildings, roads and spaces are arranged, scaled and designed influences how functional and attractive a neighbourhood is. Spaces for private, semi-public or public use are created with positioning the buildings to each other.

Creative architecture and well landscaped spaces are a way to stimulate people's inspiration.

In urban design the built environment professions come together, from urban planning via civil engineering and landscape design to architecture.

Highlights of good urban apartment design:

- Scale of blocks tends towards human dimension (this helps people relate their own physical size to the architecture)
- There is a 20 m minimum distance to the opposite building (for privacy, views and direct sunlight in all seasons)
- Buildings are slightly angled from those opposite (to avoid direct view into apartments)
- Front of apartment block is the public side (to street and shops)
- Front of apartment block contains living, dining rooms and kitchens (depending on solar orientation)
- Rear of apartment block is the private side (to private and community gardens and playground)
- Rear of apartment block contains bedrooms
- Monotone façades are avoided (use three-dimensional elements, such as balconies and bay windows of different sizes)
- Landscape furniture, plants and paving materials are used to enrich the space
- There's a mixture of private, semi-public and public spaces
- Good quality materials with low maintenance requirements are used

8.1 ARCHITECTURE IN URBAN DESIGN

The architectural design of a multi storey building should clearly identify its different zones to the external face.

Table 4	The Building's zones
Ground floor zone (base zone)	…should be recessed to widen the pavement and to provide shelter from rain or glaring sun.
Centre zone (bulk zone)	…makes up the major part of the building, providing room for apartments or offices.
Roof zone (top zone)	…should be set back to allow for attractive penthouses and private and public roof gardens.

8.1.1 GROUND FLOOR ZONE

The ground floor zone, at the base of the building, is the area that receives the most prominence and interaction between residents and the building. Apartment buildings where the ground floor is oriented to the public side are vital for a well working and well accepted urban environment, as they contribute substantially to the identity of the city.

Desirable ground floor design elements that contribute to public areas:

- Shop windows, cafes and restaurants
- Green spaces
- Art over blank walls
- Protected walkways (from rain and sun).

Undesirable design elements:

- Car parks or car park underground access
- Louvres and access doors to plant areas
- Blank solid walls
- Walls rising up the entire building two-dimensionally, without any recesses or canopies.

The ground floor zone oriented to the rear of the building should provide access to the communal spaces. Ideally, apartment buildings should be able to be accessed from both the front and rear. The front (public) side is used by residents when they walk to shops or to the city and is also where non-residents and guests arrive. The rear (private) side provides access for residents if they want to join other residents or their children in the communal garden, or if they want to access car and bicycle parking.

8.1.2 CENTRE ZONE

The centre zone is the majority of the building and contains the actual apartments. Therefore, it can project above the ground floor outline and so provide shelter from weather and rain for people walking below.

Again, it is important to provide a variety of design elements to the centre zone to provide visual relief. These elements can be randomly distributed and might include differently sized balconies, bay windows or setbacks in the façade, as well as a change of facing material, colour or texture.

Other elements that add interest include sun shutters and small sun canopies. Besides being functional and keeping the elevation visually interesting, they signify that every owner or tenant occupant has his or her own unique unit. Residents can easily identify ’my place in town’.

8.1.3 ROOF ZONE

The roof zone should be set back towards the outline of the centre zone perimeter to provide a decisive ’cap’ of the building. A building lacking a roof zone setback can appear unfinished or rough, and seems lost against the city skyline.

The roof zone can provide the most attractive penthouses with stunning views as well as lively roof gardens and terraces, both for private (penthouse) and common use.

8.2 SPACES IN URBAN DESIGN

Spaces in urban environment contribute to our health, provide the opportunity for recreation and to initiate social gathering.

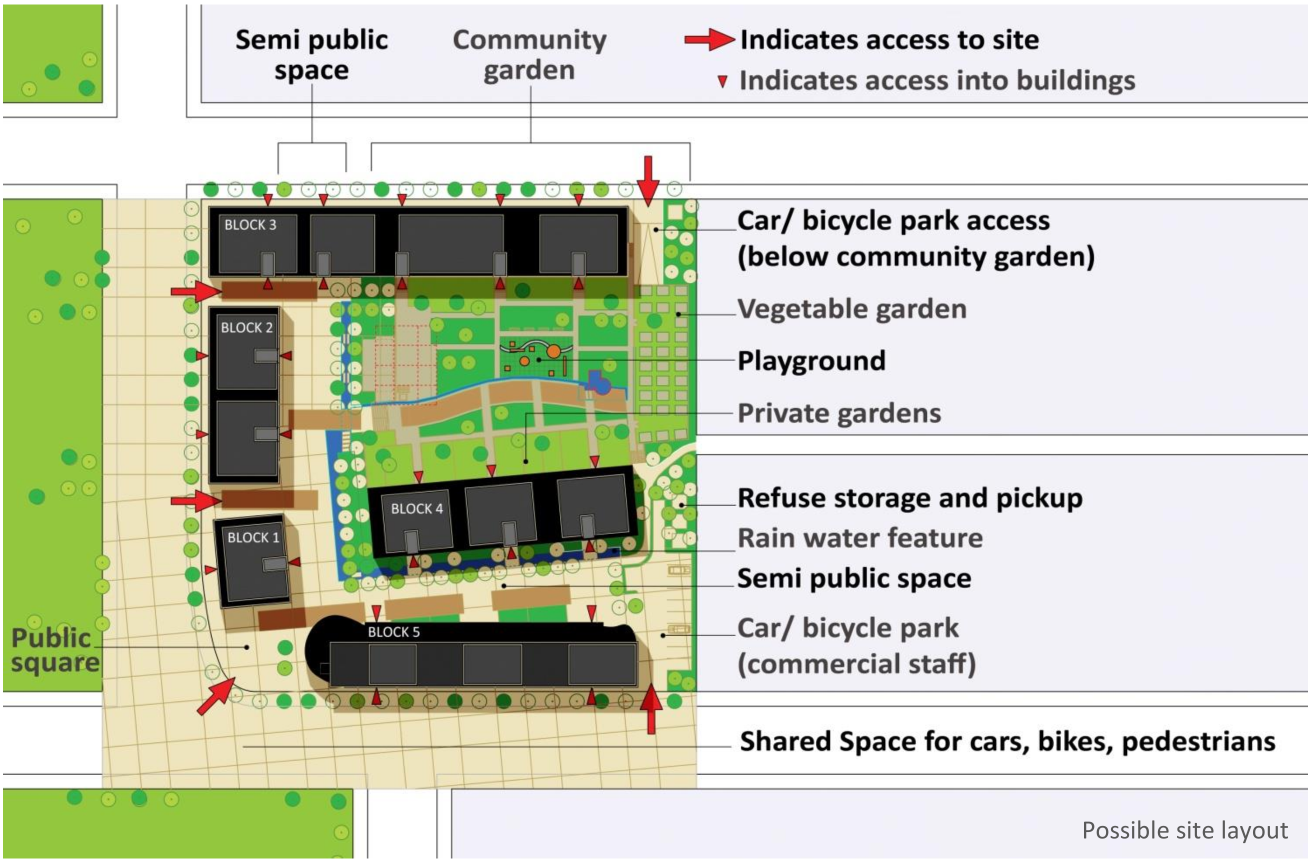
There are three forms of urban spaces: private, semi-public and public (including ‘shared spaces’, described further below). It is important to distinguish between the three kinds of space when dealing with urban design elements in apartment dwellings.

Desirable spaces:

- Allow people to gather without the disturbing noise of motorised traffic
- Let people feel protected but still have contact to the outside world
- Have dual access
- Have green planting
- Use high quality, aesthetic surface and furniture materials
- Are surrounded by inspiring architecture.

Undesirable spaces:

- Have no direct sunlight
- Have no green plants
- Contain blank, unrelieved hard surfaces, such as monotone asphalt
- Contain small, trapped corners – so-called "peeing corners"
- Are overly large so that scale is lost.



Possible site layout

8.2.1 PRIVATE SPACES

Private spaces are spaces accessible only by residents or by a particular group or community. Examples of private spaces include gardens attached to a ground floor dwelling or community gardens that can be locked.

8.2.2 SEMI-PUBLIC SPACES

Semi-public spaces are spaces that are publicly accessible but where the access may be hidden from view because of a narrow or obscure entry. Semi-public spaces are overseen from the apartment units of a community. They often host playgrounds, small greens or community and neighbourhood meeting centres. Semi-public spaces can be in private or council ownership.

Mixed use design surrounded by shared spaces

8.2.3 PUBLIC SPACES

Public spaces are accessible to everyone. They allow for social gatherings, a lunch break, certain sporting activities, street busker events, or even simply for 'people watching' – one of the most popular pastimes in city centres.

8.2.4 SHARED SPACES

Shared spaces are public spaces used by cars, pedestrians and cyclists. The concept of shared spaces is relatively new and was pioneered by Dutch traffic engineer Hans Monderman. Shared spaces can have outside seating for cafés as well as roads and bus routes. However, they have no provision for traffic signs, traffic lights or curbs.

Studies in the Netherlands have shown that motorists automatically slow down in shared spaces because of the lack of traffic rules and the mix of café seats, pedestrians and bicyclists, which makes them aware of the shared nature of the space. The fact that there are no longer distinct spaces for the different kinds of traffic makes people cautious and encourages eye contact before they proceed through shared spaces.

Shared spaces require a hard and durable surface, allowing for cars and buses. The surface should be distinct from the typical asphalt-grey look of most roads. Suitable paving, such as concrete paving of different sizes and with a variation in colours, contributes to a more interesting appearance of the space and to an awareness of being in a shared space environment.

8.3 MIXED USE DESIGN

A mixed use design is a development which combines shops, offices and dwellings on one site. Mixed use developments are likely to reduce traffic and commuting times, as some of the residents may have work in the ground floor shops, while others may work in offices or have their own studio or office on the site.

A café with an external deck can function as a social spot to meet people, including other residents. Food stores and markets on public or semi-public squares can offer fresh food and other commonly used items, again reducing the need for travel and providing the opportunity for residents to 'just go downstairs' to get some milk or eggs for breakfast.

A mixed use design also ensures that the development is occupied day and night, contributing to a productive and vibrant community.

DESIGN STATEMENTS

Auckland Council proposes the use of Design Statements to clarify the urban design outcome, use/activities and impacts to the environment of a development at an early stage.

The information required in a Design Statement typically relates to:

a) natural and cultural environment
b) movement networks and street design
c) building form and character
d) land uses and activities, and
e) landscape design.

A Design Statement provides useful information to bring to pre-application meetings with building consent authorities.

9 ACCESS

A building's access is important for the acceptance and appreciation of the development. Good design and ample space are perceived as high value. A public view of the entrances, good visibility, and sufficient light both in the daytime and at night will also contribute a feeling of safety.

9.1 VISIBILITY AND SECURITY

All main entrances to the buildings should be visible from the street or public realm, clearly identified, and well lit at night-time. The approach to all entrances should preferably be level or gently sloping. Each apartment should have an answering phone at the building entrance and a door lock release. Access controls should be mounted at an accessible height for children and wheelchair users.

9.2 MEASUREMENTS

A wider access path at the front entrance provides additional space for residents stopping to chat when they meet, while still allowing others to enter or leave the building. A good width for such a path is about 2 m.

All communal doors should have a clear opening of at least 800 mm width x 2000 mm height and a clearance of at least 300 mm to the opening or pull side. Corridors in communal areas should be at least 1.5 m wide. Corridors that are used only in an emergency should be designed to NZBC Clause D Access.

9.3 CONSTRUCTION MATERIALS

Access areas are highly frequented areas where people carry goods or move prams, bicycles and sometimes furniture. All building materials used in communal spaces should be extremely durable.

9.4 OVERCROWDING

Ideally, the number of apartment units accessible from one access core and floor level should not exceed four or a lack of privacy and security will result. Larger numbers of units may also cause overcrowding and noise disturbance, and may make it difficult to distinguish a neighbour from a potential intruder.

9.5 LIFT ACCESS

All dwellings from the third floor and higher should be provided with lift access. Every wheelchair accessible unit above the ground floor should have wheelchair accessible lift access.

9.6 WHEELCHAIR ACCESS

The gradient for wheelchair ramps should not exceed one in 12 (ca. 0.83%). The width of the ramp should be at least 1.2 m and the ramp should provide a half landing of 1.2 m^2 after each 6 m.

Wheelchair accessible car parks need to be sized at 3.2 m x 5 m. Ideally, wheelchair accessible car parks would be adjacent so that the extra width is effectively doubled.

The distance from the accessible car parking space to the unit or to the relevant block entrance should be kept to a minimum and should either be level or gently sloping.

10 DESIGNING A SUSTAINABLE AND STRUCTURALLY SOUND BUILDING

For your apartment building to perform well, it's important to:

- Choose construction materials that are sustainable, durable and low maintenance
- Choose building methods to suit New Zealand's seismic conditions.

10.1 SUSTAINABLE MATERIALS

Key considerations when choosing building materials that will minimise long-term environmental impact include:

- Locally produced and sourced
- No additional weather protection required
- No additional fire protection required
- Long lasting and durable, and
- Low maintenance.

Using strong and durable materials can also reduce the risk of structural failure of your building.

10.2 WEATHERTIGHTNESS

To ensure the building remains weathertight, we recommend only using qualified builders such as licensed building practitioners. In addition it is important to use appropriate materials. Ideally, the structure will use a material which has a certain weather resistance. Therefore, if there is any leakage through the rain screen or weather protection layer, the structure is not damaged as happened with many houses during the 'leaky homes' problems of the 1990s. Some structural materials may be damaged if the leak is not recognised at an early stage, and this can then compromise the structural integrity of the building. If the structure is built of resilient material such as concrete, the leak could be sealed at any time without having caused damage.

A free download of the CCANZ CP 01, Code of Practice for Weathertight Concrete and Concrete Masonry Construction (cited by MBIE as NZBC E2/AS3) is available online at www.ccanz.org.nz.

10.3 STRUCTURAL REQUIREMENTS

Because of New Zealand's geographical location on the Pacific and Australian plate fault line, the country's buildings require sound structural designs that can withstand the forces of strong earthquakes. The Napier earthquake in 1931, and the Christchurch earthquakes and aftershocks of 2010 and 2011 are stark reminders of the importance of earthquake-sensitive structural design.

While a damage-resistant building design's main purpose is to save lives, it can also save the building. At a relatively small additional cost, new buildings can be designed to withstand larger earthquakes with minimal damage, thus saving time and cost for planning and rebuilding. Given its earthquake prone location, not surprisingly the two most common and successful seismic designs originated in New Zealand. These methods are briefly described below.

10.4 BASE ISOLATION

If it's possible to protect the people of New Zealand, and Christchurch in particular, from a repeat of their recent earthquake experiences, every effort should be made to achieve this. Apartment blocks house many people in a relatively small area and should be designed to a damage-resistant structural system.

New Zealander Dr Bill Robinson developed the lead-rubber base isolation system, which was first used in Wellington in 1982 and is now used worldwide in earthquake-prone areas. The system proved its worth in the February 2011 Canterbury aftershock when the base-isolated Christchurch Women's Hospital escaped relatively unscathed.

The base isolation system uses base isolation pads to separate the building from the ground, leaving the building in a relatively unshaken condition in an earthquake. Ideally the building itself should be a rigid construction so that any movement will take place across through the entire structure, including lining and glazing.

Base isolation is not suited to a lightweight frame as it lacks sufficient rigidity. Structural damage is likely to occur during an earthquake, with claddings, linings and façade elements incurring inevitable damage, and potentially come loose to endanger life when falling down.

Building stairs should also be constructed of a rigid material . Rigid stairs will be able to slide on extended bearings at the landings and so be prevented from shifting out of place and from collapsing.

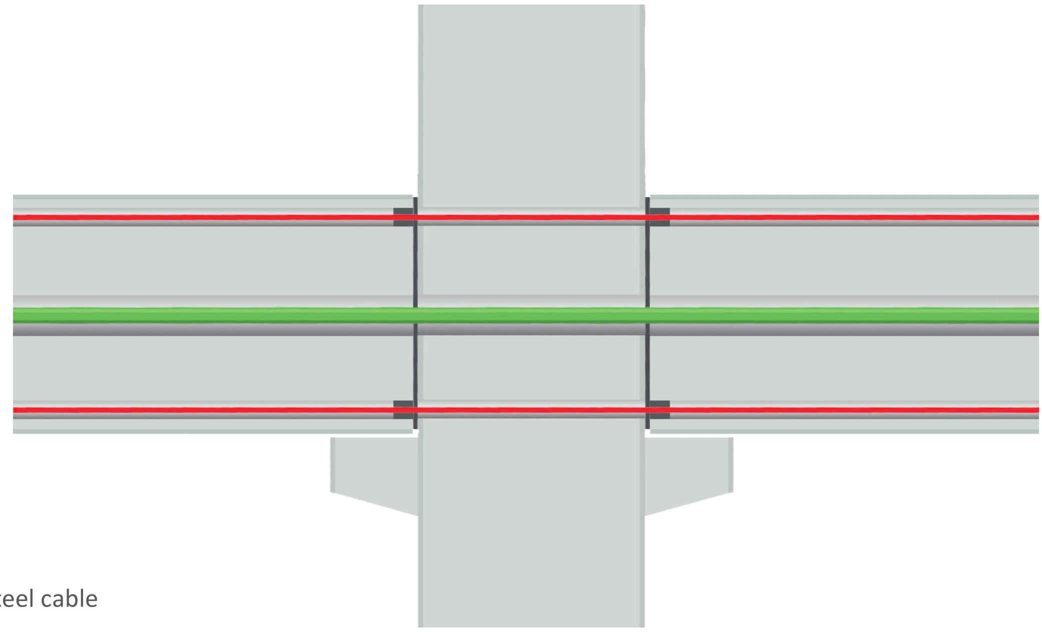
10.5 PRESSS

The PREcast Seismic Structural System, known as PRESSS, was developed in the 1990s during a ten year joint U.S./Japanese program at San Diego State University. The program initiator and head was New Zealander Nigel Priestley.

Using PRESSS, concrete precast walls, beams and columns are jointed in a ductile manner. Mild steel cables hold the structural elements together when the building shakes. Energy dissipaters dampen the impact of the seismic forces, while post-tensioned cables placed in the centre of the structural members let the building elements snap back into their original position once the shaking stops.

Priestley's research found that PRESSS buildings are simple to construct and cost about the same compared to conventional reinforced concrete structures.

Christchurch has one PRESSS building, the endoscopy clinic finished in 2010, which withstood all the earthquakes since 2010 without major damage.



Column/ beam joint:
Red: mild steel
Green: post tensioned steel cable

11 ENERGY EFFICIENCY

An important step towards energy efficiency is the passive solar design of the apartment complex. This can be achieved by orienting living areas to the north for winter sun, shading northern and western windows in summer and providing sufficient thermal mass in slabs and walls to conserve heat energy and balance interior temperatures.

11.1 SOLAR POWER

Electricity can be generated by photovoltaic arrays sited on roofs. Installed inverters transfer any unused electricity back into the grid, which means power is generated onsite for exporting.

An important advance beyond photovoltaic array design is dye-sensitized solar cell systems (DSSC). Although not as efficient as photovoltaic systems, they don't require direct sunlight and they come in translucent screens, so they can be used for some glazing applications such as canopies or stairwell windows.

Hot water can be generated by solar energy collectors fixed onto the roof in combination with an insulated hot water tank.

11.2 WIND TURBINES

Wind turbine farms generate electrical energy quite efficiently in New Zealand and, in recent years, the development of smaller domestic or on-site wind turbines has also progressed. While these are not yet cost-efficient, the technology is rapidly advancing and it may only take a few more years before smaller turbines can be cost-effectively installed within an apartment complex and used as a valuable energy source.

11.3 HEAT

A central heating scheme provides a good option for energy-efficient heating. One heat source delivers heat into a central hot well, from which heating water is delivered to the units as needed. The heat source used for this option could take one of two forms. A good option is a ground source heat-pump system using high-efficiency heat pumps connected to bores in the ground. A suction well and a discharge well on the site then take up water from the local aquifer, extract heat from it and inject it back into the aquifer.

Another heating option includes boilers that burn wood chips or pellets. Central heating systems that use oil, gas, timber or solar energy to generate heat are also feasible. The heat is stored in a tank and then distributed into radiators or an underfloor heating system.

Radiators or heat pumps using electrical energy are commonly used in New Zealand but they are rather high energy consumers and in particular heat pumps do only provide convection heat which is felt as uncomfortable by humans.

11.4 RADIANT VS CONVECTION HEAT

Radiant heat is heat that directly radiates onto objects or people, which is usually perceived by humans as comfortable. Examples include fireplaces and heated concrete floors.

Convection heat warms up the air of a room by providing the warmest air near the ceiling. It also creates a permanent airflow of colder and warmer air, which most people perceive as less comfortable. A common example of a convection heat generator is a heat pump.

11.5 UNDERFLOOR HEATING

Underfloor heating systems work best with concrete floors, where water-heated coils warm up the thermal mass of the floor and provide a pleasant, radiant heat into the room.

11.6 LIGHTING

For optimum energy efficiency in lighting, fluorescent lighting and LED are the best choices for interiors. For external areas, solar street or precinct lighting can be used.

11.7 VENTILATION

Mechanical ventilation of common spaces above ground should be avoided. Instead, provide for natural ventilation with operable windows. Underground storage and underground car parking spaces can be naturally ventilated by putting these spaces only half below ground or by installing cleverly arranged and designed ventilation shafts.

For more information on ventilation see also Section 5.3.

11.8 THERMAL INSULATION

External facing building elements such as walls, roofs and floors have to be thermally insulated to avoid expensive heat energy loss and to provide minimum comfort.

To reduce heat energy loss, insulating all roofs, walls and floors is essential. This includes any glass areas, which should have well-performing double- or triple-glazing with thermal broken frames. It is also important to insulate any apartment slabs that are above ground or are above any unheated spaces such as storage areas and car parks.

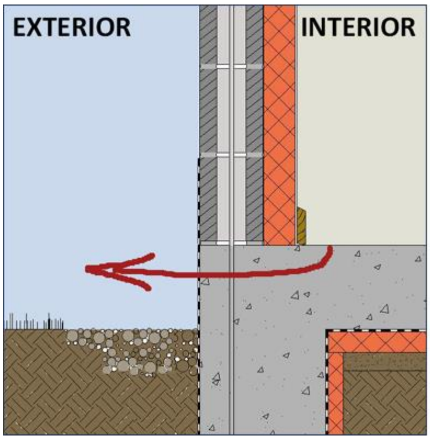
For more information on thermal insulation see also Section 5.4.

11.9 THERMAL BRIDGING

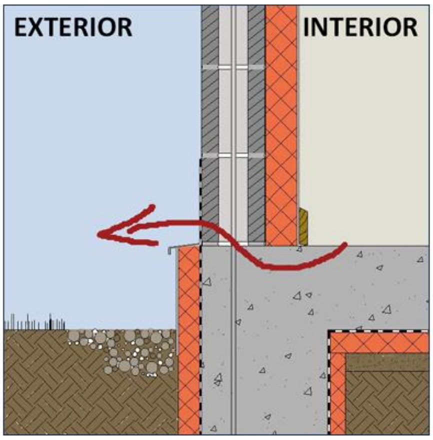
Thermal bridging is where heat loss occurs through uninsulated building elements.

Images 1 and 2 below show examples of poor design that results in cold bridging via or near the slab edge.

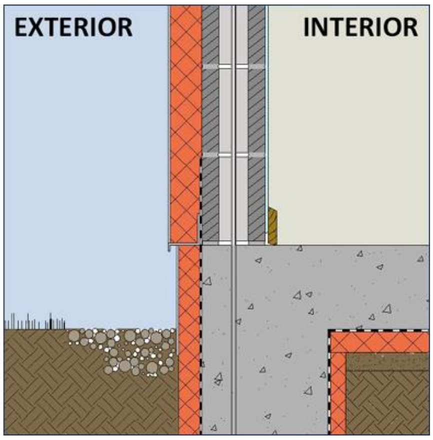
Image 3 shows an example of good design that avoids thermal bridging by fully applying external insulation wrapped around the entire building.



1 Thermal bridging via slab edge



2 Thermal bridging via bottom of wall



3 No thermal bridging!

12 WATER

Currently there is no limitation to domestic water usage in New Zealand; however, considering recent droughts, the likelihood that this will soon change is very high.

12.1 FRESH WATER

Ideally new buildings will have only water-efficient fixtures and appliances. This enables more conscious use of resources, appeals to most apartment dwellers, and makes sense if water metering exists or is proposed.

12.2 RAINWATER

It is relatively straightforward to collect rainwater falling on roofs and terraces for storage and use in irrigation systems. Incoming water should be held in storage tanks provided with appropriate treatment measures.

Harvested rainwater can then be used for irrigating any garden beds, lawns and site landscaping, and can also be fed into landscape water features. If desired, it can also be used to flush toilets. Permeable concrete paving can reduce the amount of runoff water being released into the mains.

Rainwater can also be collected and stored in a back-up tank that could feed a sprinkler system independent of the public water reservoirs. However, pipes to the sprinklers could be damaged in an earthquake and might not provide the required water.

12.3 GREYWATER

Greywater is water from bathroom sinks, showers, tubs or washing machines. It does not include water from the toilet, and should not include water that has been used for washing nappies.

Greywater can be used to irrigate plants or flush toilets. More complicated and expensive systems allow for greywater cleaning and reuse as fresh water.

12.4 BLACKWATER

Blackwater is water from toilets containing urine and faecal material. It is also referred to as sewage, foul water or brown water. Blackwater contains pathogenic germs which have to decompose before being released safely into the environment.

Blackwater can be recycled and used for irrigation of plants and gardens, but installing costs for necessary water cleaning equipment are rather high from today's perspective. More responsible handling of water in future and the awareness of global water shortage will undoubtedly result in more advanced technologies and a decline in cost.

12.5 SINK POSITIVE SYSTEMS

A sink positive system diverts a toilet's cold water inlet to hand basins and purpose-built taps on top of the toilet flush container. The water used for hand-washing then drains into the flush container. Sink positive systems conserve both water and space. However these may not work as a fully basin solution but be an option for small guest toilets or powder rooms.

13 SOUNDPROOFING

Image www.west-norfolk.gov.uk

In 2008 Wellington City Council sent surveys to about 5500 apartment dwellers to find out what they liked and disliked about urban apartment living. The top 'dislike' was noise from neighbours and from the city.

A similar survey has been commissioned by CCANZ and BRANZ in Auckland in 2013[2] where 12 % of the participants stated that noise disturbance had prompted them to move.

Constant noise from neighbours and from the cit y itself - whether from traffic, people or construction - can make it difficult to view an apartment as a sanctuary and can be stressful enough to cause illness. Differing interpretations of what is 'noisy' and different perceptions of disturbance levels can also cause friction between residents.

Therefore, one of the most important challenges in modern apartment living is providing appropriate sound insulation. This prevents two kinds of sound transmission: airborne sound and impact sound (performance requirements for these are set out in NZBC Clause G6 Airborne and Impact Sound).

13.1 AIRBORNE SOUND

Airborne sound is the term used to describe sound waves travelling through the air. It is sound caused by such things as speaking, music, machinery and traffic. The most common airborne sounds in apartments are neighbours talking and traffic noise.

Airborne sound is measured in RwdB, which is the difference in sound levels either side of a barrier, such as a building partition. The higher the RwdB figure, the better the sound attenuation.

The airborne sound attenuating performance of a material or system is described by its sound transmission class (STC), which classifies its ability to resist airborne sound transfer at the frequencies 125 Hz to 4000 Hz. The NZBC Clause G6 requires the STC of walls, floors and ceilings to be no less than 55.

However, the human ear can perceive frequencies as low as 50Hz, which is below the frequencies considered for a building material or system's STC. Sounds at these frequencies, such as bass tones from deep voices or stereo systems, can be some of the most penetrating and disturbing.

The conventional rule for reducing airborne sound transmission is the mass law. This says that the heavier the structure, the less sound it will transmit (i.e. the more attenuation for airborne sound and sound at low frequencies). R'w is the weighted apparent sound reduction index.

Concrete options that achieve the weighted apparent sound reduction index (R'w) required to comply with the acceptable solution G6/AS1 for walls, floors and ceilings between occupancies are as follows. Denser concrete structures can also help to reduce the transfer of low frequency sounds.

STC 55	- 150 mm concrete wall	- 52 db R'w
STC 55	- 200 mm concrete masonry	- 55 db R'w
STC 55	- 150 mm concrete slab	- 52 db R'w

[2] See section 17 Appendix, pg 47

13.2 IMPACT SOUND

Impact sound is the term used for sound waves that are generated on a partition and caused by such things as footsteps on the floor, hammering onto a wall, slammed doors and windows, or vibrating plant devices. The most common impact sound in apartments is caused by people walking on the floor above a unit.

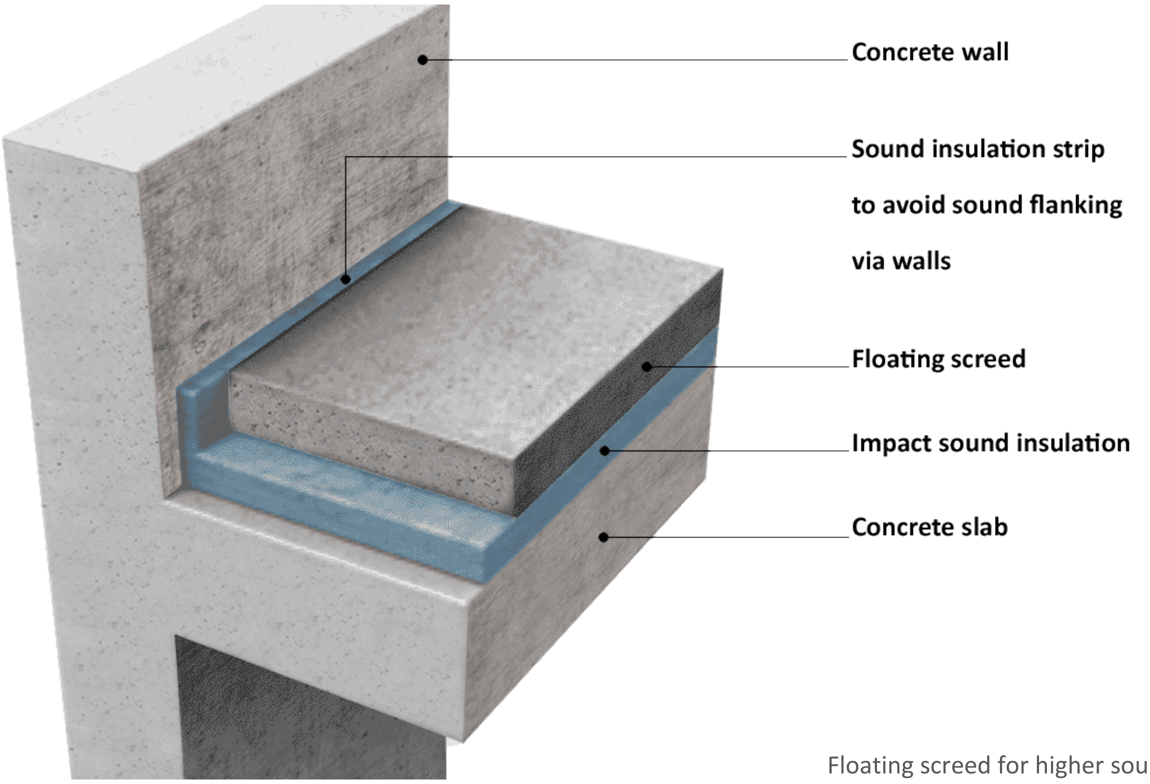
Impact sound is measured in LnwdB, which is the sound level transmitted below a floor from impact applied to the floor from above. The lower the LnwdB figure, the better the sound attenuation.

The impact sound attenuating performance of a material or system is described by its impact insulation class (IIC). IIC indicates the amount of impact noise isolation provided by a floor/ceiling assembly. The NZBC requires the IIC of floors to be no less than 55.[3]

Impact sound can only be minimised by uncoupling the building elements. Therefore, to reduce the noise from people walking in the apartment above, it is necessary to separate the stepped-on surface from the structure.

IIC 55 is the minimum required by the NZBC for impact sound insulation.[2]
This can be achieved by a 150mm concrete slab with carpet over an underlay applied on top.

Higher sound comfort can be achieved by use of a floating screed, which is standard in some European countries such as Germany. The screed is separated from the structural slab via a rigid but soft, light and airy material; for example, boards made of rubber or cork granulate, or mineral wool and polystyrene of between 5 mm and 30 mm. This insulation prevents sound transfer via the structural slab, while using 5 mm side strips minimises flanking sound to the walls.



Floating screed for higher sound comfort

[3] NZBC G6 Airborne and Impact Sound

13.3 ACCEPTABLE SOUND LEVELS

If noises are louder than the figures shown in Table 5, they are perceived as a disturbance.

Table 5	Acceptable noise levels in sound- receiving rooms	Decibels (db)
1. Bedroom		
	permanent noise	≤ 30
	interval peak noise	≤ 35
2. Living room		
	permanent noise	≤ 35
	interval peak noise	≤ 40
3. Kitchen		
	permanent noise	≤ 40
	interval peak noise	≤ 45
4. Bathroom		
	permanent noise	≤ 45
	interval peak noise	≤ 50

13.4 SOUND SOURCES

Sound sources in relation to their distance to humans and their impact on hearing are shown in Table 6.

Table 6 Noise source	Decibels (db)	Distance (m)
Whisper (library)	30	1
Conversation	60	1
Loud singing	75	1
SLIGHTLY PAINFUL	**90**	
Pneumatic (jack) hammer	90	15
Underground train or truck	100	3
Drums played loudly or trumpet	110	3
PAINFUL, DEAFENING	**120**	
Plane	130	30
Military jet	150	30
DESTROYING HEARING TISSUE	**180**	

14 FIRE SAFETY

In densely populated developments, fire is a serious threat to property and to lives. The Great Fire of London in 1666 devastated that city, much of it built from wood, and left an estimated 70,000 of its inhabitants homeless.

By the 1660s, London had become the largest city in Britain. Comparing London to the Baroque magnificence of Paris, John Evelyn, the great English writer of that time, called it a "wooden, northern, and inartificial congestion of Houses", and expressed alarm about the fire hazard posed by the wood and about the congestion.

In modern times, the Great Fire of Lisbon (1988) caused 18 five-storey heritage buildings to collapse. Two people were killed and 73 injured. Many historical shops were lost.

Fire safety in buildings depends on six key factors:

1. Escape routes
2. Structural stability during a fire
3. Material resistance to fire
4. Measures to minimise spread of fire and smoke
5. Access for fire fighters to extinguish a fire
6. Access for fire fighters to rescue people

How buildings must perform in relation to fire is spelt out in NZBC Clause C: Protection from Fire. One way for apartment design to comply with this clause is to follow the compliance document C/AS2: Acceptable solution for buildings with sleeping (non-institutional) risk group SM.

14.1 ESCAPE ROUTES

For apartment units at ground level, external windows and doors can enable escape. For units above or below ground, all safe paths of the escape routes must be built of fire- and smoke-protected corridors and stairwells.

Ideally two escape routes for each apartment should be provided. This is not always practical. If only one escape route exists, the distance from the farthest corner of the unit to the safe exit from the building (taking into account any furniture in the way) should be no more than 20 m. If the apartment has a functioning sprinkler system, the distance can be increased to 30 m.[4]

Escape routes should not contain any combustible material. The routes should be fully enclosed by a material that provides at least 60 minutes of fire resistance, or 30 minutes if a sprinkler system with smoke alarm system is installed.[5]

Some European building codes require "waiting lots" within the safe path of an above ground escape route where disabled people can be rescued from. This waiting lot is generally about 1 m^2 in size, based on wheelchair use, and does not block the safe path. Though this is not a requirement in New Zealand, it's worth considering as a safety upgrade for apartments likely to house wheelchair-dependent residents.

[4] NZBC C/AS2, Table 3.2 and Table 2.1 (for retail see NZBC C/AS4, Table 3.2 and Table 2.1)
[5] NZBC C/AS2, 2.3.1 and 2.3.2 (for retail see NZBC C/AS4, 2.3.1 and 2.3.2)

14.2 STRUCTURAL STABILITY

A building must be able to withstand a fire without losing its structural stability and integrity. Non-combustible construction materials, such as concrete, should be considered.

Materials that are inherently combustible can be coated or clad by non-combustible material. However, the structure may not be protected if an impact or earthquake damages the fire-protecting layer before the minimum time required for fire resistance.

14.3 MATERIAL RESISTANCE TO FIRE

The fire resistance rating (FRR) of a building element is expressed in minutes as for example 60/60/60, where the minute sequence represents the following:

1. Structural stability: time to collapse (here 60 minutes)
2. Integrity: time before flames are able to pass (here 60 minutes)
3. Insulation: time before a specified heat transfers through the component (here 60 minutes)

For compliance with NZBC, the minimum FRR for structural building elements, for separations of and between fire cells and for elements of escape routes of apartment buildings is 60 minutes. If sprinklers with smoke alarm detectors are installed, the FRR can be reduced to 30 minutes. [2]

However, the functionality of sprinklers could be problematic after an earthquake. In order to retain water supply after an earthquake, most water reservoirs are equipped with seismic auto-shut valves.

These valves are not reset until sometime later, which means that sprinkler systems might not be fed by an adequate water supply following an earthquake.

Some European building codes for apartment design prescribe that materials must resist the effects of fire for a minimum of 90 minutes. This guide supports a 90-minute requirement, regardless of whether additional features such as sprinkler and smoke detection systems are installed. This increases residents' safety, extends the time for rescue and increases the likelihood that the apartment building will be saved.

A 100 mm-thick concrete or concrete masonry wall can easily achieve 90 minutes of fire resistance before losing stability and integrity.

14.4 MEASURES TO MINIMISE SPREAD OF FIRE AND SMOKE

As sprinkler systems may provide only some protection from fire and smoke, because they might off automatically in an earthquake, it is safer to design the apartments with non-combustible building materials.

Doors between fire cells and to escape routes should have smoke seals. Automatic opening vents at the top of escape stair wells will be able to let any smoke escape.

14.5 ACCESS FOR FIREFIGHTERS TO EXTINGUISH A FIRE

The landscaping of your apartment complex should provide appropriate hard standing (hard surfaced areas for vehicles) to allow access for fire engines to extinguish a fire. Ideally, this access can be reached from all sides of the building.

Appropriate hard standings, such as concrete slabs or concrete paving, should be within 20 m of a building entrance and any inlets to water hydrants or sprinkler systems. Access areas should be at least 4 m wide. Hard standings should be able to take laden loads of up to 25 tonnes and axle loads of up to 8 tonnes.

14.6 ACCESS FOR FIREFIGHTERS TO RESCUE PEOPLE

The landscaping of the development should consider appropriate space to allow access for fire-fighters to rescue people with ladders and rescue nets.

RESOURCES

15 INSPIRING DESIGNS

Lighter Quay Apartments
Auckland
New Zealand

www.stephensonturner.com

Regent Park Apartments
Wellington
New Zealand

www.dgse.co.nz

Ellis Apartments
Chatswood
Australia

www.utzsanby.com

Nordlyset Apartments
Copenhagen
Denmark

www.cfmoller.com

Sluseholmen
Copenhagen
Denmark

www.arkitema.dk

Osterbrogade
Copenhagen
Denmark

www.cfmoller.com

28 Social Housing
Paris
France

www.koz.fr

Wohnwerft
Cologne
Germany

www.roemerpartner.com

Hafencity Apartments
Hamburg
Germany

www.hafencity.com

Milanfiori Apartments
Milan
Italy

www.openbuildingresearch.com

Borneo-Sporenburg
Amsterdam
Netherlands

www.west8.nl

Granida Conversion
Eindhoven
Netherlands

Toon Kandelaars Architects

Ekostaden
Malmo
Sweden

www.ekostaden.com

14 King's Mews
London
UK

www.aplusdstudio.co.uk

Donnybrook Quarter
London
UK

www.peterbarberarchitects.com

Nile Street Housing
London
UK

www.marshallarchitects.co.uk

Dockside Green
Victoria
Canada

www.perkinswill.com

Richardson Apartments
San Fransisco
USA

www.dbarchitect.com

16 GLOSSARY

Term	What it means
Acceptable solution	A means of establishing compliance with a particular clause of the New Zealand Building Code. For example, a design following C/AS2 (Acceptable Solution 2 for Clause C Protection from Fire) must be accepted as complying with the provisions of that clause.
Air changes per hour (ACH)	A measure of how many times the air in a room is replaced per hour.
Blower door test	Blower door tests determine the rate of air infiltration of a building. A blower door is a fan fixed over the front door opening of a building pulling the air out of the house. At the same time, air is flowing back into the building through air leakage gaps which can be detected by use of a smoke pencil.
Building	A structure as defined in the Building Act 2004.
Cold bridging	Heat loss through uninsulated building elements.
Dew point	The temperature at which air becomes saturated and condenses, and water drops then form. The dew point will vary according to air pressure and humidity.
Fire resistance rating (FRR)	A three-figure rating assigned to a building material, expressed in minutes, that measures its structural stability (time to collapse) integrity (time before flames pass) and insulation (time before specified heat transfer).
Floating screed	A floating screed is a concrete topping usually between 50 mm and 80 mm thick used to protect from impact sound transmission within a building. The screed is separated from the structural slab and the surrounding walls by a sound insulating layer of between 5 mm and 20 mm.
Impact insulation class (IIC)	A single number rating which provides an estimate of the impact sound insulating performance of a floor-ceiling assembly. The IIC is derived from measured values of normalised impact sound pressure levels in accordance with ASTM E492 -09 Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine (Annex 1).
LnwdB	Measurement unit for impact sound, which is the sound level transmitted via an impact onto a floor or wall into an adjacent room.
New Zealand Building Code (NZBC)	Schedule 1 of the Building Regulations 1992. All new building work must comply with the relevant clauses of the NZBC, which states how a building and its components must perform (as opposed to describing how the building must be designed and constructed).

Term	What it means
R-value	Measure of thermal resistance expressed in (K·m²)/W, which is the thickness of a material divided by its thermal conductivity. A higher R-value means better building insulation. The R-value is the reciprocal of the U-value.
R'w	Weighted apparent sound reduction index, which is a single number rating of airborne sound insulation between rooms over a range of frequencies (field measurement).
RwdB	Measurement unit for airborne sound which is the difference in sound levels either side of a barrier.
Sound transmission class (STC)	A single number rating which provides an estimate of the airborne sound insulating performance of a partition. The STC is derived from measured values of transmission loss in accordance with ASTM E413 - 10 Classification for Rating Sound Insulation.
U-value	Measure of thermal transmittance expressed in W/(m²K), which is the rate of heat transfer through one square metre of a wall, roof or floor divided by the difference in temperature across the structure. The U-value is the reciprocal of the R-value.

17 APPENDIX

A. Post-Occupancy Survey - medium-density residential dwellings in Auckland

CCANZ, in partnership with BRANZ, has commissioned CRESA (Centre of Research Evaluation and Social Assessment) to undertake an analysis of resident's Post-Occupancy Evaluation survey data. While the surveys did not specifically target noise and how people value a quiet environment, we were able to create two statistically relevant comparison groups of people who were living in buildings constructed of both high and low-mass materials. The aim of the research was to put some statistical rigour around the concept of 'quiet' as a premium feature in dwellings, particularly with the expected increase of medium and high density environments in Auckland and Christchurch.

The results showed to a statistically significant level that high-mass construction materials protect an occupant from noise resulting from traffic and neighbours. Furthermore, it was clear from the data that merely placing a high-mass inter-tenancy wall between dwellings is not sufficient and the acoustic performance of the dwelling needs to be considered as a whole with a consistent use of high-mass construction materials.

CCANZ believes that a quiet living environment will become an important design feature for medium and high density dwellings and that tenants will increasingly demand a higher verified threshold prior to occupancy. With that in mind, we are intending to use the results of this survey to inform and educate designers and developers of the acoustic benefits of high-mass constructions.

CCANZ intends to make the survey available on its website (www.ccanz.org.nz) in due course.

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