UNIVERSITY OF SYDNEY

FACULTY OF ARTS
AND
SOCIAL SCIENCES BUILDING

STRUCTURAL DESIGN BRIEF

DESIGN BRIEF: - 3152 DB1

Prepared by:

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ISSUE: D

REVISION	DATE	ORIGINATOR	CHECKED	APPROVED	REMARKS
D	JUNE 16	PT	PT	PT	

1. PROJECT DESCRIPTION

1.1 General

The project will involve the construction of a six storey teaching development.

The development will consist of a lecture theatre, teaching and plant on the lowest level, which will be partially underground and surrounded by shoring walls. At the podium level, the space will be occupied by lecture theatre and assembly areas.

The upper floors will be occupied by teaching areas, communal study spaces and offices. The roof level will house plant and function space spilling onto roof terrace.

The project also includes the upgrade and modifications to the existing RD Watt Building.

2. SCOPE OF WORK

2.1 Design and Documentation of the following:

- Footings,
- Shoring to basement/lower ground floor (to be co-ordinated with electrical easements).
- Retaining walls to external areas.
- Stairs and stair walls
- Columns
- Steel frame to lifts
- Basement slab on ground
- Post tensioned floor slabs including P/T and conventional reinforcement detailing.
- Structural steel to plant, atrium and function roofs plus façade strengthening
- Strengthening to RD Watt Building.

3. CODES

The structural design of the project will be carried out in accordance with the following Australian Standard Codes of Practice.

- Building Code of Australia
- AS 1170 Part 0 General Principles
- AS 1170 Part 1 Permanent, imposed and other actions
- AS 1170 Part 2 Wind actions
- AS 1170 Part 4 Earthquake
- AS 2159 Piling Code
- AS 3600 Concrete Structures Code
- AS 4100 Steel Structures Code
- AS 3700 Masonry Code

4. CIS BUILDING AND ARCHITECTURE STANDARD

The new building will be designed to comply with the CIS Building and Architectural Standard. The structural will be designed to comply with **AS/NZS1170** and all other relevant standards and provide a 100 year design life.

Noting the above the services zone designations in the respective floor to floor levels do not allow for 25% spare capacity for additional augmented or future services across all areas of the structure. As a consequence the requirement to include the corresponding spare 25% capacity in the structure has not been allowed for in the structural design.

5. DESIGN DEAD LOAD

5.1 Unit Weights

Design dead load shall include all self-weight and dead loads of elements. Unit weights shall be in accordance with Appendix A of AS 1170.1 (2002)

5.2 Superimposed Dead Load

Due consideration shall be given to superimposed dead loads due to: partitions, floor finishes and toppings, ceilings and services, racking systems, plant and equipment, hobs and kerbing, perimeter screens and walling, escalators and stair flights, planters and landscaped areas, and any imposed dead loads from roof framing, glazing and linings. Reference shall be made to the architectural drawings for the extent and location of these loadings.

5.3 Roof Loads

If the roof is framed in structural steel, roof loads shall be evaluated in a systematic fashion as set out in the Pro-Forma at Appendix A of this Design Brief. Services and Acoustic Consultants are to be requested to supply the necessary loadings to allow completion of the Pro-Forma. A copy of the Pro-Forma shall be included in all calculations and shall be summarised on the roof-marking plan for each building.

Suspended ceilings, major service ducts and pipe work required to be supported by purlins shall be designed and specified to be attached to the webs of the purlins.

6. DESIGN LIVE LOAD

The floor slabs in the specifically designated areas shall be designed for the live loads nominated in Appendix B of this Design Brief.

Design loads shall be clearly designated on all structural floor plans. Live Load reductions shall be applied in accordance with AS 1170.1.

7. DESIGN WIND LOAD

Design shall be in accordance with AS1170.2 – 2002 using the parameters set out in the Site Wind Analysis in Appendix C.

Design event for wind shall be 1/1000 for ultimate wind and 1/20 for serviceability wind.

The design of façade elements and their connections to the structure shall make provision for all local peak wind pressures effects, calculated using AS 1170.2 local pressure factors.

Projecting canopies and awnings, particularly at street level shall be designed to resist the wind forces caused by deflected pressure flows from the surrounding buildings, using the method nominated in AS1170.2 (2002).

8. EARTHQUAKE

Design shall be in accordance with AS1170.4 – Part 4 "Earthquake Loads" (2007) using the following parameters:-

Structure	:	
Importance Level		2
Earthquake Design Category	:	II
Annual Probability of Exceedance	:	1/1000
kp	:	1.3
Z	:	.08
Site Sub-soil Class	:	C to be confirmed by geotechnical investigations

9. OTHER DESIGN LOADINGS

9.1 Minimum Lateral Loads to Interior Walls

Interior walls and permanent partitions and their fixings and supports, shall be designed to resist all loads to which they are subjected, but not less than a lateral force of 0.25 kPa (working), 0.40 kPa (ultimate) shall be applied perpendicular to the walls.

All walls should be designed for Earthquake forces as per AS 1170.4 – 2007.

9.2 Temporary and Construction Loads

The building structures shall be designed to resist all loads imposed during construction. In all instances, the building components in their temporary partly constructed state shall remain structurally stable.

A minimum construction live load of 2.0 kPa shall be adopted.

The Builder shall advise the extent of all areas which they require to be designed for additional loads from construction and material storage to suit construction arrangements.

9.3 Horizontal Loads to Handrails and Balustrades

All handrails and balustrades shall be designed in accordance with AS1170 Part 1. Where applicable, the design shall include for the effects of crowd loading or impact. Under maximum load conditions, these elements shall deform by following a plastic deformation mechanism.

Carpark perimeter screens and barriers shall be designed for low speed impact loads specified in AS 1170 Part 1.

10.0 SERVICEABILITY

10.1 Vibration Effects

Vibration due to plant should not be structurally critical or unacceptable to occupants. SCP assumes all plant to be base isolated on spring and damper mounts.

Floors shall be designed to ensure that they comply with the recommended acceleration and velocity limits in the relevant Standards. SCP will use the R factor method outlined in Annex A of AS 2670.2 and Appendix A of BS 6472.

10.2 Deflection Limits

The following floor deflection limits shall apply unless more stringent deflection limits are required for special conditions:

General Floors	
Incremental deflection	<span/500
Total long term deflection	<span/250, or 25mm
Roof Structures (Concrete)	
Total long term deflection	<span/250, or 25mm
Compactus Areas (Concrete)	
Incremental long term deflection	<span/500

10.3 Lateral Drift

Serviceability levels shall be designed and constructed to limit inter-storey lateral drift of the storey height such that the integrity of all connected building elements are maintained.

In particular the effects of lateral drift needs to be addressed in the performance of the façade system.

Maximum allowable lateral and interstorey drift to be .015H under earthquake actions.

10.4 Durability

The structure shall be designed giving due consideration to durability and the functionality of the building and its components. All concrete elements shall be designed for the following exposure classifications in accordance with AS3600.
Interior: A1
Exterior : B1

11.0 MATERIALS

The structural design shall take into consideration the possible changing building uses and the local environmental conditions during its design life. The selection of materials, specifications and detailing of the structural elements shall be such as to provide optimum durability to the structure.

11.1 Concrete

Concrete will comply with the project ESD requirements.

11.2 Reinforcing Steel & Structural Steel

Steel will comply with the project ESD requirements.

11.3 Glass Facades and Balustrades

Glass shall be designed and certified by the glass supplier/façade engineer.

12.0 WATER PROOFING

Exposed slabs shall be designed as watertight and have an additional applied waterproof membrane applied to architects detail**.**

13.0 FOUNDATIONS AND SHORING WALLS

All footings, shoring walls and retaining walls are to be designed in accordance with the recommendations contained in the geotechnical report.

14.0 STRUCTURAL FRAMING SYSTEM

14.1 Foundations

All columns to be supported on pad footings or piles founded on rock.

14.2 Floor Framing

The floor framing will be a post tensioned band beam structure supported on reinforced concrete columns and walls.

14.3 Stair cores

These will resist the lateral loads on the buildings due to wind and earthquake. They will be insitu reinforced concrete and will be anchored down by tension piles or permanent rock anchors.

APPENDIX A – STEEL ROOF LOADING

	ALLOWANCE		
ELEMENT DESCRIPTION	**UNIFORM (KG/SQ.M.)**	**CONCENTRATED (KGS)**	**LINE (KG/M)**
ROOF SHEETING	5		
PURLINS	5		
INSULATION	3		
NORMAL CEILING 2 Layers 13mm Gyprok and to suit acoustic requirements	20		
ELECTRICAL CABLING	TBA		TBA
LIGHTING	TBA	TBA	
AUDIO		TBA	
MONITORS		TBA	
A/C DUCTING	20 kg/m^2 Purlins 10 kg/m^2 Rafters		TBA
FAN COIL UNITS		TBA	
EXHAUST UNITS TO ROOF		TBA	
GAS PIPES (including AIR)			TBA
HYDRAULICS PIPES			TBA
SPRINKLERS	5		TBA
CATWALKS/WALKWAYS			TBA
ROOF ACCESS SYSTEM ANCHOR LOADS		TBA	
OTHER	TBA	TBA	TBA
ROOF LIVE LOAD (In accordance with AS1170.1)	25 MAX 50 kN	110	

TBA – TO BE ADVISED BY RELEVANT CONSULTANT

APPENDIX B -FLOOR LOADS

BUILDING COMPONENT	LIVE LOAD	SUPERIMPOSED DEAD LOADS
CAR PARKING	2.5 kPa min	0.25 kPa
BASEMENT	7.5.kPa min	1.5 kPa
STORAGE	7.5 kPa min	0 kPa
SUBSTATION/SWITCH ROOM	7.5 kPa min	5.0 kPa
AHU PLANT AREAS *	7.0 kPa min	2.0 kPa
AUDITORIUM / LECTURE THEATRE	3.0 kPa min	2.5 kPa
OFFICE SUITES	3 kPa min	1.0 kPa
PUBLIC SPACE	4.0 kPa min	1.2 kPa
CONCRETE ROOFS	4.0 kPa	4.0 kPa
CAFE, SEMINAR ROOMS	4.0 kPa	1.2 kPa

Note:

- The design of the structure assumes Lightweight partitions throughout
- Services allowance = .5 kPa at underside of all slabs
- All toppings no greater than 50 mm thick

* Denotes all equipment loads shall be submitted to SCP for assessment.

An acoustic vibration assessment shall also be undertaken.

APPENDIX C – SITE WIND ANALYSIS

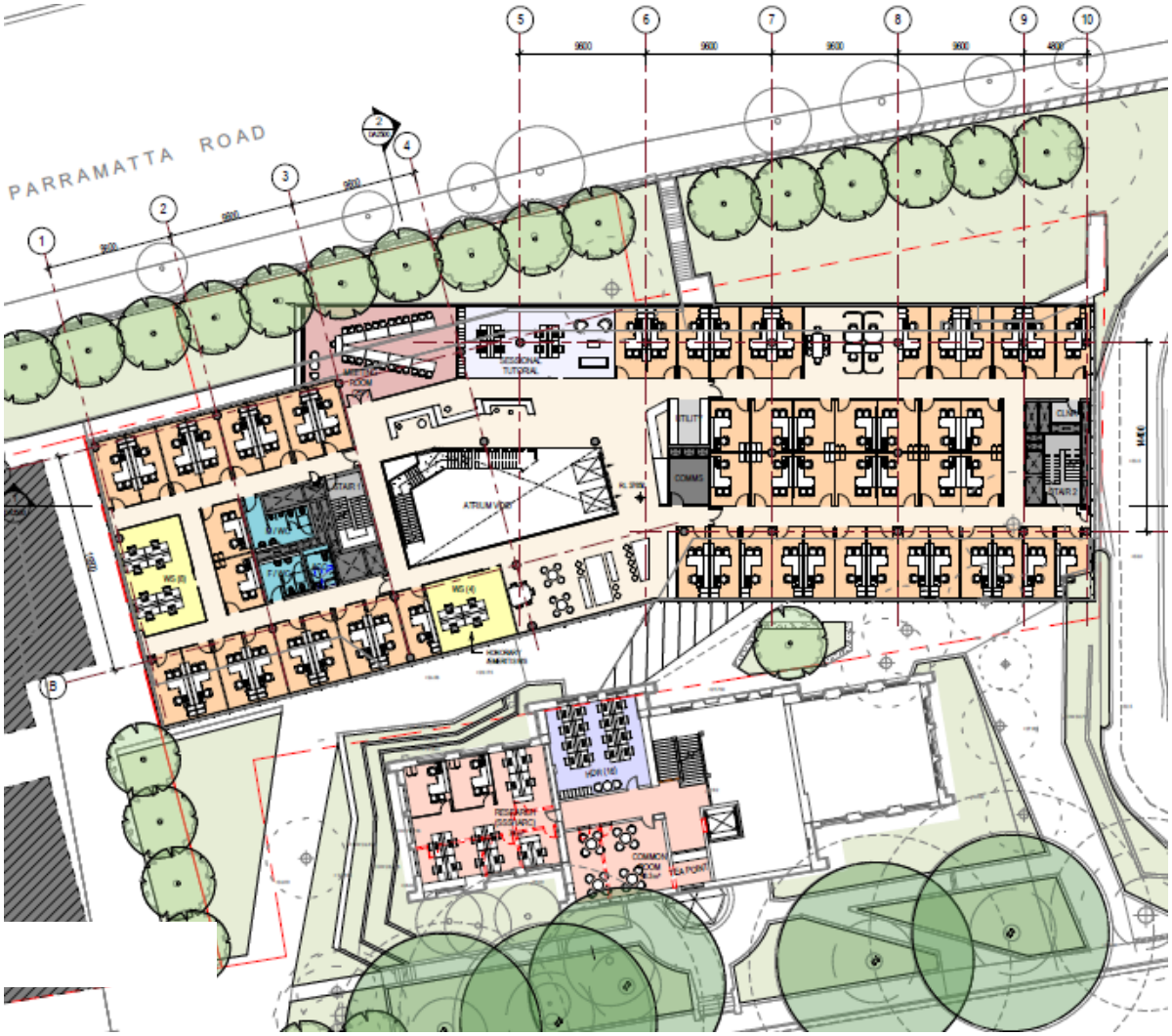
Importance Level = 3 (Buildings designed to contain large number of people)

Annual Probability Exceedence : 1 in 1000 – ultimate

Region : A2 1 in 25 – serviceability

V1000 – ultimate limit state = 46 m/s

V25 – serviceability limit state = 37 m/s



Wind Direction Multipliers	N NE E	1.0
	S SE	1.0
	SW W NW	1.00
Terrain Categories	faces of buildings	3
Shielding Multipliers	– 1.00	

APPENDIX D – POST TENSIONED REINFORCEMENT DESIGN BRIEF

UNIVERSITY OF SYDNEY BUSINESS FACULTY OF ARTS AND SOCIAL SCIENCES BUILDING

POST TENSIONED FLOOR SLABS

DESIGN BRIEF: 3152 DB1

PREPARED BY: SCP CONSULTING PTY LTD
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SCP JOB NO: 2989
TEL: (02) 9267 9312
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ISSUE : A:

REVISION	DATE	ORIGINATOR	CHECKED	APPROVED	REMARKS
A	MAY 2016	PT	PT		

1. DESIGN LOADS

The post-tensioned floors are to be designed for the following design loads:

Live Loads: As shown on drawings

Dead Loads: As shown on drawings

Lateral Loads: The structure is generally a braced system.

Lateral load actions on frames resulting from earthquake or wind will be shown on the final design drawings.

2. CODE COMPLIANCE

All floor slabs and beams are to be designed for strength and serviceability in accordance with the requirements of AS3600 – Concrete Structures.

All floors carrying masonry walls are to be designed to comply with the deflection and vibration criteria nominated on the drawings.

All frame analysis shall use 100% of the equivalent column stiffness.

3. CRACK CONTROL

Sufficient post-tensioning and reinforcement shall be provided in both directions so as to satisfy crack control provisions for moderate degree of cracking as per AS3600 Clause 9.4.3.4.

If post-tensioning alone is to provide crack control, a minimum level of 1.4MPa after final losses shall be maintained.

Where restraint by piers, core walls and other vertical elements is likely to reduce the level of prestress below the minimum level, adequate reinforcement is to be provided to properly control shrinkage cracking in the slabs and bands.

All exposed external slab areas to be designed as watertight. The post tensioning contractor shall increase the stressing level and add top mesh to achieve this requirement.

4. CONCRETE STRENGTH

Project assessment is required for all concrete placed.

All concrete is to have a characteristic compressive strength F'c=32 MPa at 28 days, and f'cm = 22 MPa at 5 days.

Concrete in all post-tensioned slabs and beams to have a maximum drying shrinkage of 600 microstrain at 56 days.

Initial (25%) prestress is to be applied when the concrete compressive strength reaches 9 MPa.

Final (100%) prestress is to be applied after a minimum of 5 days, when the concrete has reached a compressive strength of at least 22 MPa.

5. SHOP DRAWINGS

The prestressing sub-contractor shall prepare shop drawings showing the cable layout, all cable profiles, jacking loads and theoretical extensions and details of all required anchorages and couplers, including all anti-burst anchorage reinforcement required additional to the flexural reinforcement shown on the structural drawings.

The two (2) copies of the Shop Drawings are to be submitted to the engineer for approval at least 10 working days prior to installation of cables on site.

6. POST TENSION SPECIFICATION

i). Workmanship, materials and stressing shall comply with the Australian Standard AS3600 – Concrete Structures.

ii). Design Assumptions are:

a) Minimum level of prestress in concrete slabs and slab bands after final losses shall be sufficient to satisfy Part 3.

b) Fire rating of floors - Refer to architects drawings.

c) All strands shall be 12.7 or 15.2 diameter 7 wire-super-grade, stress relieved, low relaxation strands to AS1311 with a minimum breaking load of 184 kN. Maximum tendon force prior to transfer (behind anchorage) – 156 kN per strand.

d) Co-efficient of friction in Duct u=0.2
Estimated angular deviation B = .025 RAD/M
Anchorage draw-in 6mm assumed

e) All concrete outlines have been based on 100% column stiffness. Final Post Tensioning Design shall use 100% column stiffness.

Tension ducts shall be fitted to smooth curves between positions shown. Ducts shall be semi-rigid steel sheeting (galvanised). The design assumes that 4 & 5 strand tendons are contained with 70 x 19 flat ducts. Duct profiles are measured from the soffit of the concrete slab or band to the underside of the duct. Except the anchorages where dimensions are to the centreline of the anchor.

Contractor shall submit calculations of assumed friction losses and total tendon elongations for approval of a minimum of 7 working days prior to commencement of stressing.

All ducts to be fully grouted within 5 days of stressing and after approval of elongations by the engineer.

Anchorages and splices shall be capable of developing the ultimate strength of tendons without excessive deformation. When required, satisfactory test data confirming the adequacy of the proposed devices shall be submitted.

Ducts, tendons and anchorages shall be firmly supported to prevent displacement during subsequent operations. They shall be placed with a tolerance of plus or minus 3 mm in concrete dimensions of 200 mm of less, plus or minus 5 mm in concrete dimensions between 200 mm and 600 mm, and plus or minus 15 mm in concrete dimensions over 600 mm.

7. STRESSING

Calibrate stressing jacks to an accuracy of 2% pressure gauge readings shall be based on instruments having a calibrated accuracy of $\pm$ 0.5%. Calibration curves for the equipment to be used shall be made available to the engineer prior to stressing. The initial cable load between jack and anchorage shall not exceed 85% of the specified minimum ultimate cable load.

Stressing Sequence
Initial Stress: Jack each strand to 40 kN when concrete compressive strength reaches 9 MPa.
Final Stress: Apply full jacking load of 156 kN after a minimum of 5 days, when concrete has reached a compressive strength of at least 22 MPa.

All test cylinders used for early age strength determination are to be site cured under similar temperature and exposure conditions to the concrete floor slabs.

Keep complete stressing record for each stressing operation for each cable as follows:

i). Identification particulars of tendons.

ii). Initial force or pressure when tendons are marked for measurement of elongation.

iii). Final force or pressures before anchoring tendons.

iv). Elongation at final force.

v). Elongation remaining after anchoring tendon and release jacks.

Submit these records to the engineer for acceptance within 48 hours of completing each stressing operation.

8. GROUTING

Grout shall consist of a mixture of cement and water.

Fly ash conforming to AS1129 and 1130, for use in concrete may be used. Fly ash shall not exceed 14kg per bag of cement.

Aluminium powder of the proper fines and quantity or other approved materials may be added to obtain a maximum of 10% expansion of the grout when measured unconfirmed.

Mix grout in a high-speed mechanical mixer and pass through a strainer into pluming equipment, which has provision for recirculation. Pumping of grout shall begin as soon as possible after mixing and may be continued as long as the grout retains the proper consistency.

APPENDIX E

UNIVERSITY OF SYDNEY FASS BUILDING

SCHEDULE OF CONCRETE MIXES

Mix Design	Location	Grade MPa	Cement Type	Fly Ash Allowable 25% Maximum	Silica Fume	Max. Shrinkage At 56 Days Micro Strain	Max. Aggregate Size (mm)	Super Plasticiser	F'cat 4 Days (MPa)	Max. Slump At Batching mm	Low Heat Character -istics	Water Proof Agent
1	• Mass Concrete (Pads) • Blinding Concrete	S15	GP	25%	Nil	750	20	Nil	N/A	80	N/A	N/A
2a	• Bored Piers	S32	GP	25%	Nil	750	20	Nil	N/A	80	N/A	N/A
2b	• Pad Footings • Strip Footings	S25	GP GP	25%	Nil	750	20	Nil	N/A	80	N/A	N/A
3	• Slab on Ground – Light Duty	S25	SL	25%	Nil	550	20	Yes	N/A	40	N/A	N/A
4	Post-tensioned Slabs Summer & Winter mixes to be Submitted Separately	4a S32 4b S40	SL	10%	Nil	650	20	Nil	22	80	N/A	N/A
5	• Reinforced Slabs / Stairs • Retaining Walls	S32	SL	25%	Nil	650	20	Nil	N/A	80	N/A	N/A
6	Core Walls / Lift Walls	S32	SL	25%	Nil	750	20	Yes	N/A	80	N/A	N/A
7	Slab on Ground – Heavy Duty	S32	SL	25%	Nil	550	20	Yes	N/A	40	N/A	N/A
8	Columns (Normal)	S40	GP	25%	Nil	750	20	Nil	N/A	80	N/A	N/A
9	Carpark Ramps/Pile Caps	S40	SL	25%	Nil	650	20	Nil	N/A	80	N/A	N/A
10a	Columns (High Strength)	S50	GP	25%	Nil	750	20	Nil	N/A	80	N/A	N/A
10b	Columns (High Strength)	S65	GP	20%	Nil	750	20	Nil	N/A	80	N/A	N/A
10c	Columns (High Strength)	S80	GP	20%	Nil	750	20	Nil	N/A	80	N/A	N/A
11	Blockwork Core Fill	S20	GP	25%	Nil	N/A	10	Nil	N/A	230	N/A	N/A
12	Shotcrete	S32	GP	25%	Yes	750	10	Nil	N/A	60	N/A	N/A
13	Lift Overrun Pit	S32	SL	25%	Nil	750	20	Nil	N/A	80	N/A	N/A
14	Roadway Slabs	S40	SL	10%	Nil	600	20	Nil	22	80	N/A	N/A
15	Loading Docks	S40	SL	10%	Nil	600	20	Nil	22	80	N/A	Xypex

APPENDIX F – FIRE RATINGS

SUMMARY OF BUILDING USE AND CLASSIFICATION

Building Use	Assembly Building
Building Classification	Class 9b
Type of Construction required	A

FIRE RESISTANCE OF BUILDING ELEMENTS

- Fire Isolated Passageways discharging from fire isolated stairs or ramps : FRL 120/120/120
- Concrete slabs between all levels : FRL 120/120/120
- Stairs connecting all levels : FRL 120/120/120
- Lift and stair shafts : FRL 120/120/120
- Columns : FRL 120/120/120
- Plantroom Roof : FRL 120/120/120

Fire Resistance of Building Elements

FRL OF BUILDING ELEMENTS		
Building Element	Class of Building – FRL: (in minutes) Structural adequacy/integrity/insulation	
	5, 9 or 7 (carpark)	6
EXTERNAL WALL (including any column and other building element incorporated therein) or other external building element where the distance from any fire-source feature to which it is exposed is -		
For loadbearing parts-		
Less than 1.5m	120/120/120	120/120/120
1.5m to less than 3m	120/90/90	120/120/120
3m or more	120/60/30	120/120/90
For Non-loadbearing parts-		
Less than 1.5m	-/120/120	-/120/120
1.5m to less than 3m	-/90/90	-/120/120
3m or more	-/-/-	-/-/-
EXTERNAL COLUMN not incorporated in an external wall where the distance from any fire source feature to which it is exposed-		
Less than 3m	120/-/-	120/-/-
3m or more	-/-/-	-/-/-
COMMON WALLS and FIRE WALLS	120/120/120	120/120/120
INTERNAL WALLS		
Fire-resisting lift and stair shafts-		
Loadbearing	120/120/120	120/120/120
Non-loadbearing	-/120/120	-/120/120
Bounding public corridors, public lobbies and the like-		
Loadbearing	120/-/-	120/-/-
Non-loadbearing	-/-/-	-/-/-
Between or bounding sole-occupancy units-		
Loadbearing	120/-/-	120/-/-
Non-loadbearing	-/-/-	-/-/-
Ventilating, pipe, garbage, and the like shafts not used for the discharge of hot products of combustion-		
Loadbearing	120/90/90	120/120/120
Non-loadbearing	-/90/90	-/120/120
OTHER LOADBEARING INTERNAL WALLS, INTERNAL BEAMS, TRUSSES and COLUMNS	120/-/-	120/-/-
FLOORS	120/120/120	120/120/120
ROOFS	120/60/30	120/60/30

APPENDIX G

SCP CONSULTING
CHECKLIST OF DOCUMENTATION
REQUIRED BEFORE CERTIFICATION

PROJECT:_____ **DATE:** _____

BUILDING:_____

GENERAL **COMPLETED**

- Engineering Inspection Reports not signed off

Concrete Footings

- Copies of all inspection reports by geotechnical engineer _____
- Copies of certification of bearing pressures by geotechnical engineer _____
- Copy of concrete mix design _____
- Copies of all concrete cylinder test results _____
- Certificate for reinforcement stating grade _____

Concrete Slabs on Ground

- Copy of Sub-Base Compaction Tests and Reports _____
- Copy of Mix Design for Approval _____
- Copy of All Concrete Cylinder Test Results _____
- Copy of Shrinkage Test Results _____
- Details of Curing Compound applied including Compliance with Standards _____
- Details of Jointing Material used in Expansion Joints, Key Joints _____
- Copy of Results of Tolerance Check _____
- Certificate for any reinforcement stating grade _____
- Details of Post-Tensioning Extensions _____
- Details of grout used around tendons _____
- Grouting Records _____

Structural Steelwork

- Copies of Fabrication Inspection Reports including extent of NDE _____
- Copy of Paint Records and Testing/Galvanizing Records _____
- Copy of Applicators Warranty on Paint System/Galvanizing _____
- Copy of Inspection Reports of Paint System _____
- Copy of check on Fabrication and Erection Tolerances/Survey Certificate _____
- Copy of Certificates of steel grade and bolts _____
- Details of grout used _____

Suspended Concrete Work

- Copy of Mix Design for Approval _____
- Copy of all Concrete Cylinder Test Results _____
- Copy of any Shrinkage Test Results _____
- Details of Curing Compound used _____
- Certificate for any Reinforcement Stating Grade _____
- Details of Post-Tensioning Extensions _____
- Details of grout used around tendons _____
- Grouting Records _____

APPENDIX H

SCP CONSULTING
CHECKLIST OF DOCUMENTATION
REQUIRED BEFORE CERTIFICATION

PROJECT: _____ **DATE:** _____

BUILDING: _____

COMPLETED

Precast Concrete

- Copy of Certification from Practising Structural Engineer that Design and Construction Complies with Specification _____
- Copy of Certification as to Fire Rating and Copy of Supporting Documentation _____
- Copy of Construction Proposal Regarding
  - Concrete Mix Design
  - Curing Method
  - Joint Sealant _____
- Copy of Check of Tolerances after manufacture _____