World Housing Encyclopedia Report

Country: Malaysia

Housing Type: Reinforced concrete frame building with timber roof.

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1 General Information

1.1 Country
Malaysia

1.3 Housing Type
Reinforced concrete frame building with timber roof.

FIGURE 1: Typical Building

1.4 Summary
This housing type is commonly used for family housing and it is found in urban areas of Malaysia. Columns and beams are of reinforced concrete to provide structural strengths. Roof consists of timber trusses. These houses are designed according to the British Code BS 8110 without seismic design considerations.

1.5 Typical Period of Practice for Buildings of This Construction Type

How long has this construction been practiced	
< 25 years	
< 50 years	X
< 75 years	
< 100 years	
< 200 years	
> 200 years	

Is this construction still being practiced?	Yes	No
	X	

1.6 Region(s) Where Used
This housing type is found in both urban and rural areas. It exists almost all over Malaysia.

1.7 Urban vs. Rural Construction

Where is this construction commonly found?	
In urban areas	
In rural areas	
In suburban areas	
Both in rural and urban areas	X

Additional Comments: About 30-40% are located in semi-urban areas.

2 Architectural Features

2.1 Openings

A typical house has approximately several windows, with average size of 2.4 m².

2.2 Siting

	Yes	No
Is this type of construction typically found on flat terrain?	X	
Is this type of construction typically found on sloped terrain? (hilly areas)		X
Is it typical for buildings of this type to have common walls with adjacent buildings?		

The typical separation distance between buildings is 10 meters

2.3 Building Configuration

The typical shape of a building plan for this housing type is rectangular shape.

2.4 Building Function

What is the main function for buildings of this type?	
Single family house	
Multiple housing units	X
Mixed use (commercial ground floor, residential above)	
Other (explain below)	

2.5 Means of Escape

2.6 Modification of Buildings

3 Socio-Economic Issues

3.1 Patterns of Occupancy

One family occupies a single apartment or housing unit.

3.2 Number of Housing Units in a Building

10 units in each building.

Additional Comments: There are more than 10 units in one building usually. These housing unites are usually clustered.

3.3 Average Number of Inhabitants in a Building

How many inhabitants reside in a typical building of this construction type?	During the day / business hours	During the evening / night
< 5	X	
5 to 10		X
10-20		
> 20		
Other		

3.4 Number of Bathrooms or Latrines per Housing Unit

Number of Bathrooms: 2
Number of Latrines: 2

3.5 Economic Level of Inhabitants

Economic Status		House Price/Annual Income (Ratio)
Very poor		/
Poor	X	6250/2100
Middle Class	X	25000/4500
Rich	X	30000/4600

Additional Comments: The house price indicated is just for one tenement.

3.6 Typical Sources of Financing

What is the typical source of financing for buildings of this type?	
Owner Financed	X
Personal Savings	X
Informal Network: friends and relatives	
Small lending institutions/microfinance institutions	
Commercial banks / mortages	X
Investment pools	
Combination (explain)	
Government-owned housing	X
Other	X

Additional Comments: Government loan.

3.7 Ownership

Type of Ownership/Occupancy	
Rent	X
Own outright	X
Own with Debt (mortgage or other)	X
Units owned individually (condominium)	X
Owned by group or pool	
Long-term lease	
Other	

4 Structural Features

4.1 Lateral Load-Resisting System

Columns and walls give stiffness to the structure, which controls the lateral drift. The common size of columns is 600 mm X 600 mm and for walls are 150 mm thickness.

4.2 Gravity Load-Bearing Structure

The roofs are designed to transmit gravity loads to the slabs, beams, and columns. The walls are from the non-load bearing wall system. All external walls and partition walls are 9-inch brick walls. Internal partitions are timber framing.

4.3 Type of Structural System

Material	Type of Load-Bearing Structure	#	Subtypes	
Masonry	Stone masonry walls	1	Rubble stone (field stone) in mud/lime mortar or without mortar (usually with timber roof)	
		2	Massive stone masonry (in lime or cement mortar)	
	Earthen walls	3	Mud walls	
		4	Mud walls with horizontal wood elements	
		5	Adobe block or brick walls	
		6	Rammed earth/Pise construction	
	Unreinforced brick masonry walls	7	Unreinforced brick masonry in mud or lime mortar	
		8	Unreinforced brick masonry in mud or lime mortar with vertical posts	
		9	Unreinforced brick masonry in cement or lime mortar (various floor/roof systems)	
	Confined masonry	10	Confined brick/block masonry with concrete posts/tie columns and beams	
	Concrete block masonry walls	11	Unreinforced in lime or cement mortar (various floor/roof systems)	
		12	Reinforced in cement mortar (various floor/roof systems)	
		13	Large concrete block walls with concrete floors and roofs	
Concrete	Moment resisting frame	14	Designed for gravity loads only (predating seismic codes i.e. no seismic features)	X
		15	Designed with seismic features (various ages)	
		16	Frame with unreinforced masonry infill walls	
		17	Flat slab structure	
		18	Precast frame structure	
		19	Frame with concrete shear walls-dual system	
		20	Precast prestressed frame with shear walls	
	Shear wall structure	21	Walls cast in-situ	
		22	Precast wall panel structure	
Steel	Moment resisting frame	23	With brick masonry partitions	
		24	With cast in-situ concrete walls	
		25	With lightweight partitions	
	Braced frame	26	Concentric	
		27	Eccentric	
Timber	Load-bearing timber frame	28	Thatch	
		29	Post and beam frame	
		30	Walls with bamboo/reed mesh and post (wattle and daub)	
		31	Wooden frame (with or without infill)	
		32	Stud wall frame with plywood/gypsum board sheathing	
		33	Wooden panel or log construction	
Various	Seismic protection systems	34	Building protected with base isolation devices or seismic dampers	
	Other	35		

4.4 Type of Foundation

Type	Description	
Shallow Foundation	Wall or column embedded in soil, without footing	
	Rubble stone (fieldstone) isolated footing	
	Rubble stone (fieldstone) strip footing	
	Reinforced concrete isolated footing	X
	Reinforced concrete strip footing	
	Mat foundation	X
	No foundation	
Deep Foundation	Reinforced concrete bearing piles	
	Reinforced concrete skin friction piles	
	Steel bearing piles	
	Wood piles	
	Steel skin friction piles	
	Cast in place concrete piers	
	Caissons	
Other		

4.5 Type of Floor/Roof System

Material	Description of floor/roof system	Floor	Roof
Masonry	Vaulted		
	Composite masonry and concrete joist		
Structural Concrete	Solid slabs (cast in place or precast)	X	
	Cast in place waffle slabs		
	Cast in place flat slabs		
	Precast joist system		
	Precast hollow core slabs		
	Precast beams with concrete topping		
	Post-tensioned slabs		
Steel	Composite steel deck with concrete slab		
Timber	Rammed earth with ballast and concrete or plaster finishing		
	Wood planks or beams with ballast and concrete or plaster finishing		
	Thatched roof supported on wood purlins		X
	Wood single roof		
	Wood planks or beams that support clay tiles		
	Wood planks or beams that support slate, metal asbestos-cement or plastic corrugated sheets or tiles		
	Wood plank, plywood or manufactured wood panels on joists supported by beams or walls		
Other			

Additional Comments: Floor/roof are considered to behave as rigid diaphragms.

4.6 Typical Plan Dimensions

Length: 6 - 6 meters
Width: 6 - 6 meters

4.7 Typical Number of Stories

2

4.8 Typical Story Height

4 meters

Additional Comments: Story height is 3-4 meters.

4.9 Typical Span

6 meters

4.10 Typical Wall Density
2% (1% -5%).

4.11 General Applicability of Answers to Questions in Section 4
This description is based on summarizing data for number of buildings.

5 Evaluation of Seismic Performance and Seismic Vulnerability

5.1 Structural and Architectural Features: Seismic Resistance

Structural/ Architectural Feature	Statement	True	False	N/A
Lateral load path	The structure contains a complete load path for seismic force effects from any horizontal direction that serves to transfer inertial forces form the building to the foundation.		X	
Building configuration	The building is regular with regards to both the plan and the elevation.	X		
Roof construction	The roof diaphragm is considered to be rigid and it is expected that the roof structure will maintain its integrity, i.e.. shape and form, during an earthquake of intensity expected in this area.	X		
Floor construction	The floor diaphragm(s) are considered to be rigid and it is expected that the floor structure(s) will maintain its integrity, during an earthquake of intensity expected in this area.	X		
Foundation performance	There is no evidence of excessive foundation movement (e.g. settlement) that would affect the integrity or performance of the structure in an earthquake.	X		
Wall and frame structures-redundancy	The number of lines of walls or frames in each principal direction is greater than or equal to 2.	X		
Wall proportions	Height-to-thickness ratio of the shear walls at each floor level is: 1) Less than 25 (concrete walls); 2)Less than 30 (reinforced masonry walls); 3) Less than 13 (unreinforced masonry walls).	X		
Foundation- wall connection	Vertical load-bearing elements (columns, walls) are attached to the foundations; concrete columns and walls are doweled into the foundation.	X		
Wall-roof connections	Exterior walls are anchored for out-of-plane seismic effects at each diaphragm level with metal anchors or straps.		X	
Wall openings	The total width of door and window openings in a wall is: 1) for brick masonry construction in cement mortar: less than 1/2 of the distance between the adjacent cross walls; 2) for adobe masonry, stone masonry and brick masonry in mud mortar: less than 1/3 of the distance between the adjacent cross walls; 3) for precast concrete wall structures: less than 3/4 of the length of a perimeter wall.	X		
Quality of building materials	Quality of building materials is considered to be adequate per requirements of national codes and standards (an estimate).	X		
Quality of workmanship	Quality of workmanship (based on visual inspection of few typical buildings) is considered to be good (per local construction standards).	X		
Maintenance	Buildings of this type are generally well maintained and there are no visible signs of deterioration of building elements (concrete, steel, timber).	X		
Other				

5.2 Seismic Features

Structural Element	Seismic Deficiency	Earthquake-Resilient Features	Earthquake Damage Patterns
Wall	Wall is not designed to sustain the seismic forces		
Frame (columns, beams)	Seems sufficient due to the design method		
Roof and floors	Have adequate rigidity		
Other	The structure does not have ability to withstand large drifts		

5.3 Seismic Vulnerability Rating

	Vulnerability					
	High (Very Poor Seismic Performance) A	B	Medium C	D	E	Low (Excellent Seismic Performace) F
Seismic Vulnerability Class			<	0	>	

0 - probable value
< - lower bound
> - upper bound

6 Earthquake Damage Patterns

6.1 Past Earthquakes Reported To Affect This Construction

Year	Earthquake Epicenter	Richter magnitude(M)	Maximum Intensity (Indicate Scale e.g. MMI, MSK)
1996	Penang	6	
1991	Labuan, Sabah	5.8	

7 Building Materials and Construction Process

7.1 Description of Building Materials

Structural Element	Building Material	Characteristic Strength	Mix Proportions/ Dimensions	Comments
Walls	Concrete	24 kN/m³ -30kN/m³ Grade 25-30	1:2:4 (cement: fine aggregate: course aggregate)	
Foundations	Concrete	24 kN/m³ -30kN/m³ Grade 25-30	1:2:4 (cement: fine aggregate: course aggregate)	
Frame	Concrete	24 kN/m³ -30kN/m³ Grade 25-30	1:2:4 (cement: fine aggregate: course aggregate)	
Roof and floors	Concrete	24 kN/m³ -30kN/m³ Grade 25-30	1:2:4 (cement: fine aggregate: course aggregate)	

7.2 Does the builder typically live in this construction type, or is it more typically built by developers or for speculation?

It is more typically built by developers or for speculation.

7.3 Construction Process

Developers normally build structures of this type. Process start with the foundation of the building, then columns and brick walls are built, finally beams and roofs are made at the time to get a monolithic structure. The tools typically used in this type of construction, are hammers, nails, construction wire, etc. and the equipment used include concrete vibrator, concrete mixer and others.
To start the construction of the building one needs to get a construction license. Municipal authorities are in charge to give this license to the builder companies. Each housing project must have four kinds of technical drawings: structural drawings, architectural drawings, water installation drawings and electric installation drawings. Municipal authorities need to approve this technical information in order to get construction license.

7.4 Design/Construction Expertise

Engineers and architects have experience in design and construction process. This is one of the most typical constructions in Malaysia, so there are good capable professionals with experience on this kind of building.

7.5 Building Codes and Standards

	Yes	No
Is this construction type addressed by codes/standards?	X	

Title of the code or standard: BS 8110 (British Standard).
Year the first code/standard addressing this type of construction issued: 1980's
National building code, material codes and seismic codes/standards: The BS 8110 code also includes national building codes, specifications for materials and seismic standards.

7.6 Role of Engineers and Architects

Engineers are in charge of the structural design and the construction process. Architects are in charge of the architectural design.

7.7 Building Permits and Development Control Rules

	Yes	No
Building permits are required	X	
Informal construction		X
Construction authorized per development control rules	X	

7.8 Phasing of Construction

	Yes	No
Construction takes place over time (incrementally)	X	
Building originally designed for its final constructed size		X

Additional Comments: Buildings are originally designed for a specific number of stories. However is commonly found that owners decide to build additional stories some years later of the end of the original construction.

7.9 Building Maintenance

Who typically maintains buildings of this type?	
Builder	X
Owner(s)	X
Renter(s)	X
No one	
Other	

7.10 Process for Building Code Enforcement

Municipal authorities just approve the design of the building. Typically, the owner hires a particular supervisor for construction of the building.

7.11 Typical Problems Associated with this Type of Construction

There are no typical problems associated with this type of construction.

8 Construction Economics

8.1 Unit Construction Cost (estimate)

Unit construction cost is approximately 13.3 US$/m².

8.2 Labor Requirements (estimate)

This type of building needs about 12 months or more to complete the construction. However, the time required does not depend on the architectural characteristics of the building.

9 Insurance

9.1 Insurance Issues

	Yes	No
Earthquake insurance for this construction type is typically available		X
Insurance premium discounts or higher coverages are available for seismically strengthened buildings or new buildings built to incorporate seismically resistant features		X

9.2 If earthquake insurance is available, what does this insurance typically cover/cost?

NA

10 Seismic Strengthening Technologies

10.1 Description of Seismic Strengthening Provisions

Type of intervention	Structural Deficiency	Description of seismic strengthening provision used
Retrofit (Strengthening)	Roof	Timber
	Columns	Shear steel reinforcement

10.2 Has seismic strengthening described in the above table been performed in design practice, and if so, to what extent?

Yes.

10.3 Was the work done as a mitigation effort on an undamaged building, or as repair following earthquake damage?

Yes.

10.4 Was the construction inspected in the same manner as new construction?

Yes.

10.5 Who performed the construction: a contractor, or owner/user? Was an architect or engineer involved?

A contractor performed the construction and also an engineer was involved.

10.6 What has been the performance of retrofitted buildings of this type in subsequent earthquakes?

11 References

British Standard (BS 8110).

Structural Terrace Plan And Brochures of Residential Area.

12 Contributors

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13 Figures

FIGURE 1: Typical Building

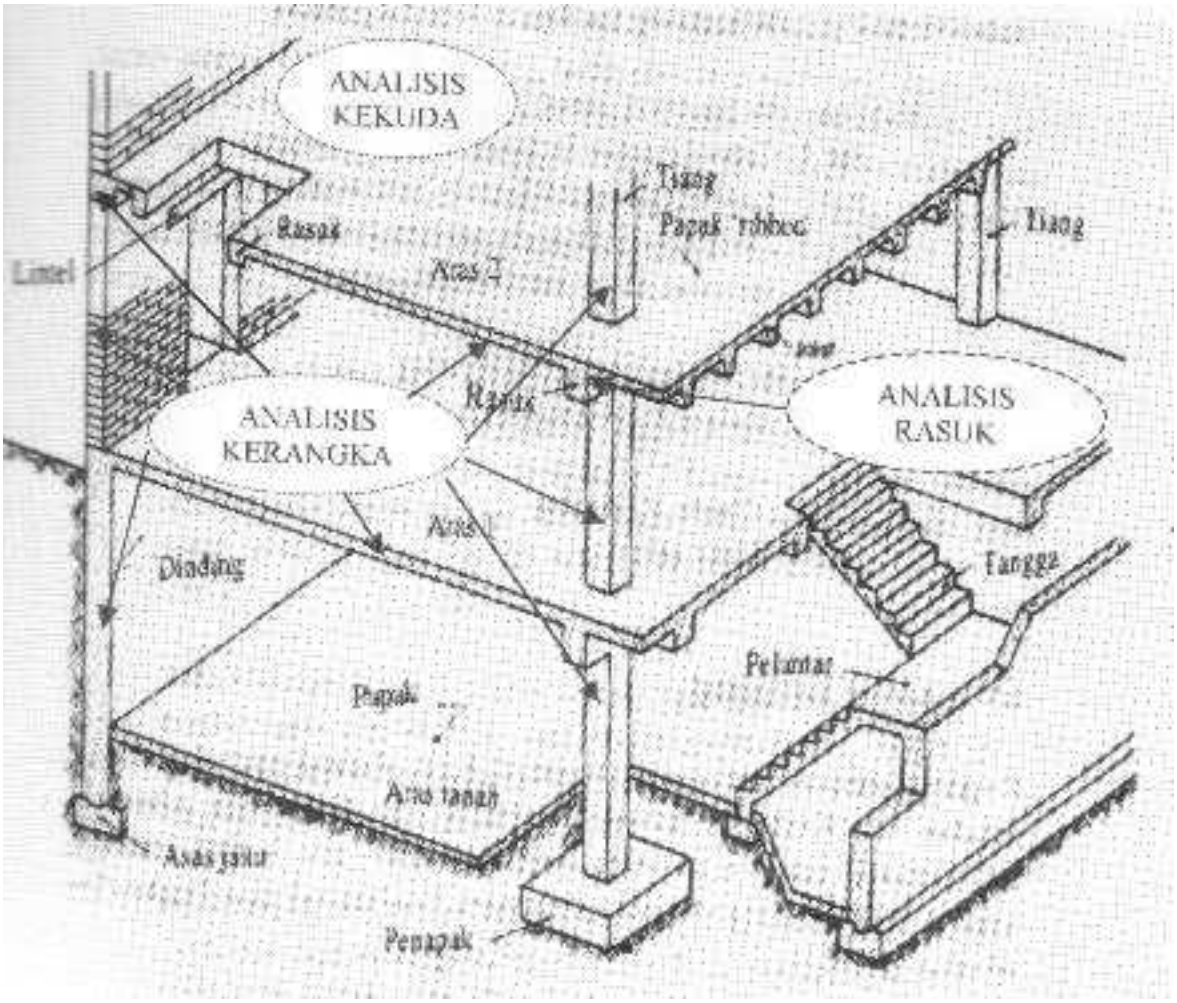

FIGURE 2: Key Load-Bearing Elements

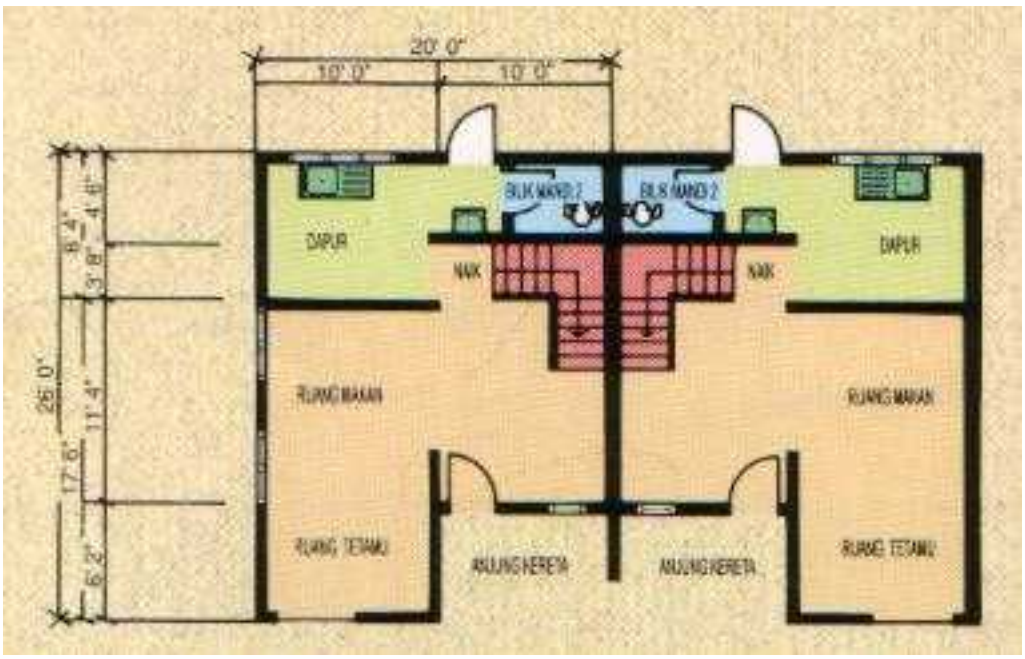

FIGURE 3A: Plan of a Typical Building

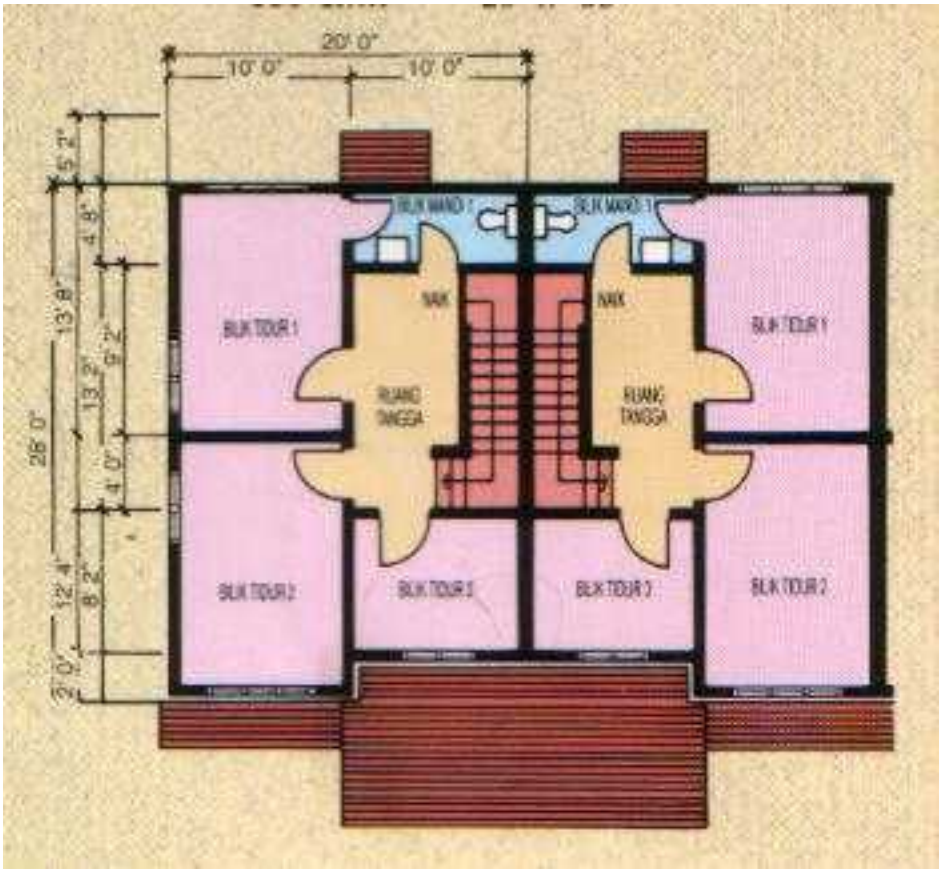

FIGURE 3B: Plan of Typical Building

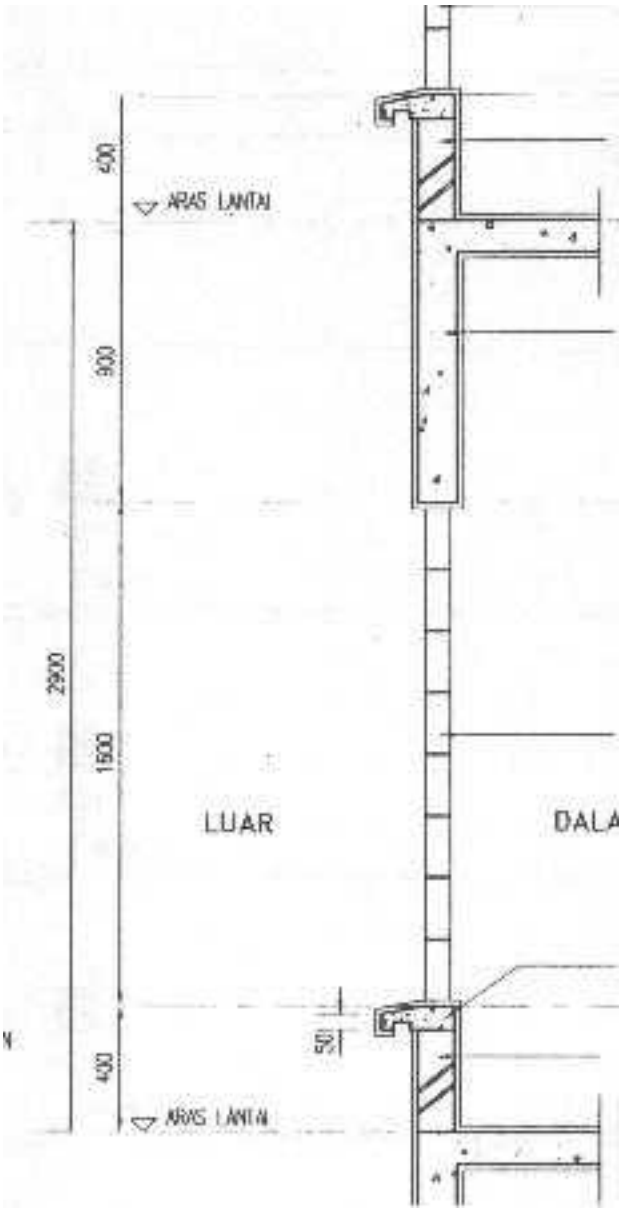

FIGURE 4: Critical Structural Details (e.g. wall section, foundations, roof-wall connections, etc.)

FIGURE 5A: A Photograph Illustrating Typical Earthquake Damage in the Labuan, Sabah (M5.8) of 26 May 1991

FIGURE 5B: Typical Earthquake Damage (Penang (M6.0) earthquake of 10 October 1996)