STRUCTURAL DESIGN OF A SINGLE-STORY RESIDENTIAL BUILDING

Mr. Thanadon Thianphongpan (65109010197)

Mr. Apinat Boonlom (65109010075)

Advisor Assoc. Prof. Acting Sub Lt. Supachai Sinthaworn, D.Eng

Department of Civil Engineering, Faculty of Engineering, Srinakharinwirot University

Motivation

Reinforced Concrete Design and Steel and Timber Design are usually taught one member at a time, so students rarely see how a whole building works together.

This project analyses and designs a real single-storey house in Midas nGen, checks every member in Excel, and estimates the structural material cost.

Design objectives

1. To apply RC Design and Steel and Timber Design to a complete residential building.
2. To analyse and design the structure in Midas nGen and verify it with Excel.
3. To estimate the structural material cost from a quantity takeoff.

Design Specs (Success Criteria)

1. Every member has a demand-to-capacity ratio of 1.0 or less, and Midas nGen agrees with the Excel checks.
2. Governing forces: beam Vu = 32.38 kN and Mu = 31.31 kN·m; column Pu = 17.85 kN.

Design Constraints

Single-storey RC frame with a light steel roof. The architectural layout fixes the grid, spans and column positions, and member sizes must suit ordinary formwork. It must meet the Building Control Act B.E. 2522, Ministerial Regulation B.E. 2566 and MOI Notification B.E. 2567. Dead and live loads only; costs use average market prices.

Key Courses used in the Project

1. Reinforced Concrete Design: columns, beams, slab
2. Design of Steel and Timber Structures: steel roof frame
3. Structural Analysis: Midas nGen frame model
4. Computer Applications: Excel checks
5. Construction Cost Estimating: material BOQ
6. Building Codes: B.E. 2566, B.E. 2567

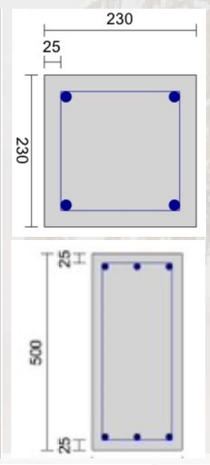
Design Deliverables

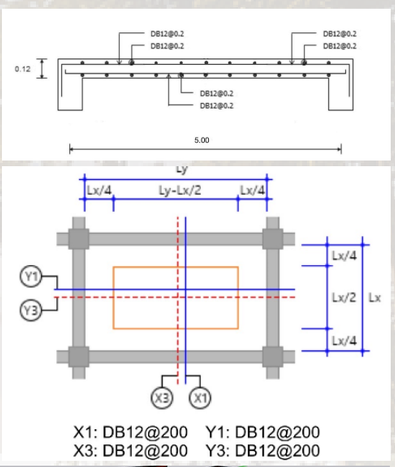
Summary of Structural Member Sizes, Reinforcement Details, and Estimated Cost

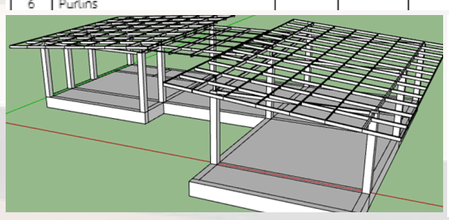
- Columns: 230 × 230 mm, 4-DB16, RB6 ties @ 0.20 m
- Beams: 230 × 500 mm, 3-DB16 top and bottom, 2-RB9 stirrups @ 0.10 m
- Slab: 120 mm thick, DB12 @ 0.20 m both ways
- Wall plate: box 100 × 100 × 4.0 mm
- Rafters: box 100 × 100 × 2.3 mm
- Purlins: box 25 × 25 × 1.6 mm

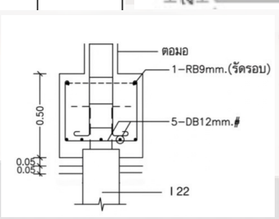
Total structural material cost: about 367,981 Baht

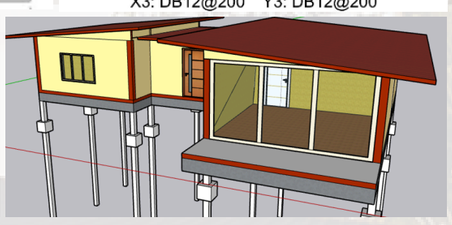
1	Beams				
	- Structural Concrete 240 ksc	10.3	Cu.m.	2400	24,720
	- Deformed Bar DB 16 SD40	890	Kg.	22	19,580
	- Round Bar RB 9 SR24	806	Kg.	22	17,732
	- Formwork	95.4	sq.m.	450	42,930
2	Columns				
	- Structural Concrete 240 ksc	1.72	Cu.m.	2400	4,128
	- Deformed Bar DB 16 SD40	208	Kg.	22	4,576
	- Round Bar RB 6 SR24	52	Kg.	22	1,144
	- Formwork	29.9	sq.m.	450	13,455
3	Slabs				
	- Structural Concrete 240 ksc	12.1	Cu.m.	2400	29,040
	- Deformed Bar DB 12 SD40	920	Kg.	22	20,240
	- Formwork	100.64	sq.m.	450	45,288
4	Tie Beam				
	- Rectangular Tube 100x50x4 mm	73	Pcs.	1,316	96,068
5	Rafters				
	- Rectangular Tube 100x50x2.3 mm	30	Pcs.	720	21,600
6	Purlins				











Research Methodology

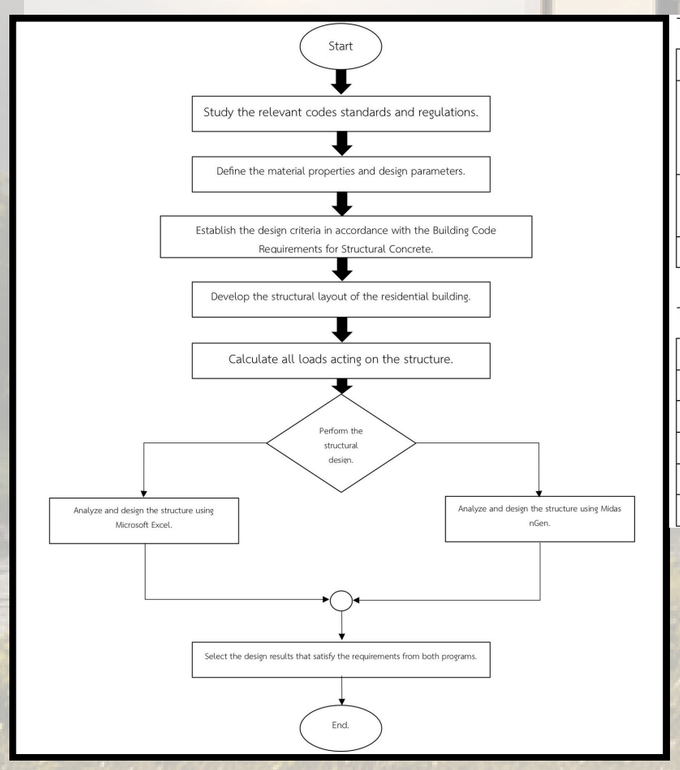


Table 3. 1 Material Properties for Design

Material	Property	Value	Unit
Concrete	f'_c	23	Mpa
	E_c	22540	Mpa
	Unit Weight	23.5	kN/m^3
Reinforcing Steel	f_y	392	Mpa
	E_s	200000	Mpa
Structural Steel	F_y	235	Mpa

Table 3. 2 Design Loads

Type of Load	Value	Unit
Floor Superimposed Dead Load	110	kg/m^2
Floor Live Load	200	kg/m^2
Roof Superimposed Dead Load	5	kg/m^2
Roof Live Load	50	kg/m^2
Wind Load	60	kg/m^2

BOQ / Cost Estimation

BILL OF QUANTITIES

Project: Structural analysis and design of a single-storey residential building

No.	Description	Qty	Unit	Material (THB/unit)	Labour (THB/unit)	Amount (THB)
1. Beams (230 × 500 mm)						
1.1	Concrete 240 ksc	10.30	m³	2,400.00	0.00	24,720.00
1.2	Reinforcement DB16 SD40 (890 kg) + RB9 SR24 (806 kg)	1,696.00	kg	22.00	0.00	37,312.00
1.3	Formwork	95.40	m²	450.00	0.00	42,930.00
2. Columns (230 × 230 mm)						
2.1	Concrete 1.72 m³, DB16 208 kg, RB6 52 kg, formwork 29.9 m²	1.00	lot	23,303.00	0.00	23,303.00
3. Slab (120 mm)						
3.1	Concrete 12.1 m³, DB12 920 kg, formwork 100.64 m²	1.00	lot	94,568.00	0.00	94,568.00
4. Steel roof frame						
4.1	Wall plate, steel box 100 × 100 × 4.0 mm	73.00	lengths	1,316.00	0.00	96,068.00
4.2	Rafters, steel box 100 × 100 × 2.3 mm	30.00	lengths	720.00	0.00	21,600.00
4.3	Purlins, steel box 25 × 25 × 1.6 mm	34.00	lengths	220.00	0.00	7,480.00
	TOTAL (items listed in the report)					**347,981.00**

Engineering Standards

1. ACI 318-19: reinforced concrete columns, beams and slab
2. AISC 360-16 (LRFD): steel roof frame and bearing plates

Conclusions and Recommendations

The final design uses 230 × 230 mm columns, 230 × 500 mm beams, a 120 mm slab and a steel box roof frame. All members meet the strength and serviceability requirements, and the Midas nGen results agree with the Excel checks. The structural material cost is about 367,981 Baht. Future work should add wind and earthquake loads and the foundation design.