

EXERCISE 2

3D ANALYSIS USING DIRECT STIFFNESS APPROACH

RC BUILDING

Relevant codes: IS 456, IS 875(I,II,III), IS 1893(I), IS 13920, SP 16, SP 34

Last date of submission: 21 Sep 2019 (Total marks = 10 report + viva)

Figures 1 to 5 show the general architectural floor plan of a three storeyed RC office building of a start-up company. The floor to floor height is 3.5 m for all storeys. Finished ground floor level is 450 mm above the finished ground level (FGL), which is in turn 800 mm above the natural ground level (NGL). The geotechnical investigation report recommends isolated footings under the columns, to be placed 1.5 m below NGL, with the allowable net bearing pressure equal to 180 kN/m² being recommended by the Geotechnical expert. All external walls are 230 mm thick. In absence of exact details of partitions, an equivalent UDL of 1 kN/m² may be assumed.

For this building, carry out the following in your capacity as a qualified Structural Engineer:

1. Conceive a suitable framing plan of beams and columns with a column to column spacing not exceeding 8 m. Spans of slabs should not exceed 4 m.
2. Assume suitable member sizes and carry out estimation of all loads. **Earthquake and wind load computation and their vertical distribution should be done manually considering entire building.** Perform 3D structural analysis for dead, imposed, earthquake/ wind (critical of the two) loads followed by their combinations using STAAD as per IS 456. The effect of floor slab may be appropriately considered in lateral load analysis in view of the unsymmetrical shape of the building in plan.
3. From STAAD analysis, find out the worst/ governing load combinations for:
 - (a) One corner footing of your choice
 - (b) Column stemming out from the footing above up to first floor
 - (c) Any roof beam from one end of the building to other end

Prepare an ANALYSIS REPORT (typed) in following format.

1. 3D model of the entire building (from STAAD) showing all major dimensions and the members/ nodes chosen by you in step 3 above.
2. Summary of main loadings (dead, imposed, earthquake and wind)-max 3 pages, reference to codes where necessary)
3. Input text file (compact-max two pages, truncate if necessary)
4. Typical Output file (compact-max three pages, truncate, showing typical outputs, if necessary, only of the members you have chosen in next step)

5. Tables of critical/ governing load combinations for foundation, column and beam chosen above in following format.

Table 1: Critical load combinations for foundation design (show the node considered in 3D model of the building)

S. No.	Load combination	Vertical force (kN)	Horizontal force (kN)	Bending moment (kN-m)

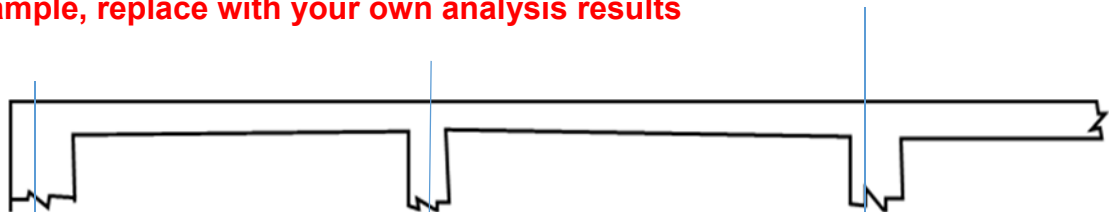
(Add more rows if necessary)

Table 2: Critical load combinations for column design (show the member considered in 3D model of the building)

S. No.	Location (bottom/ top node)	Load combination	Axial force (kN)	Shear force (kN)	Bending moment (kN-m)

(Add more rows if necessary)

Table 3: Critical load combinations for beam design (show the member considered in 3D model of the building) NOTE: Values filled here are for example, replace with your own analysis results



Max negative bending moment (kNm) and corresponding load combination	-350 1.5(D+Ex)	-450 1.2(D+I+Ex)	-350 1.2(D+L+Ex)	-280 1.2(D+I+Ex)	-370 1.5(D+Ex)
Max positive bending moment (kNm) and corresponding load combination	+400 1.5(D+L)		+350 1.5(D+L)		+400 1.5(D+L)
Max shear force and corresponding	230	300	400	350	400

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load combination (kN)			
NOTE: The above forces/ moments may be computed at the point other than the node for economy			

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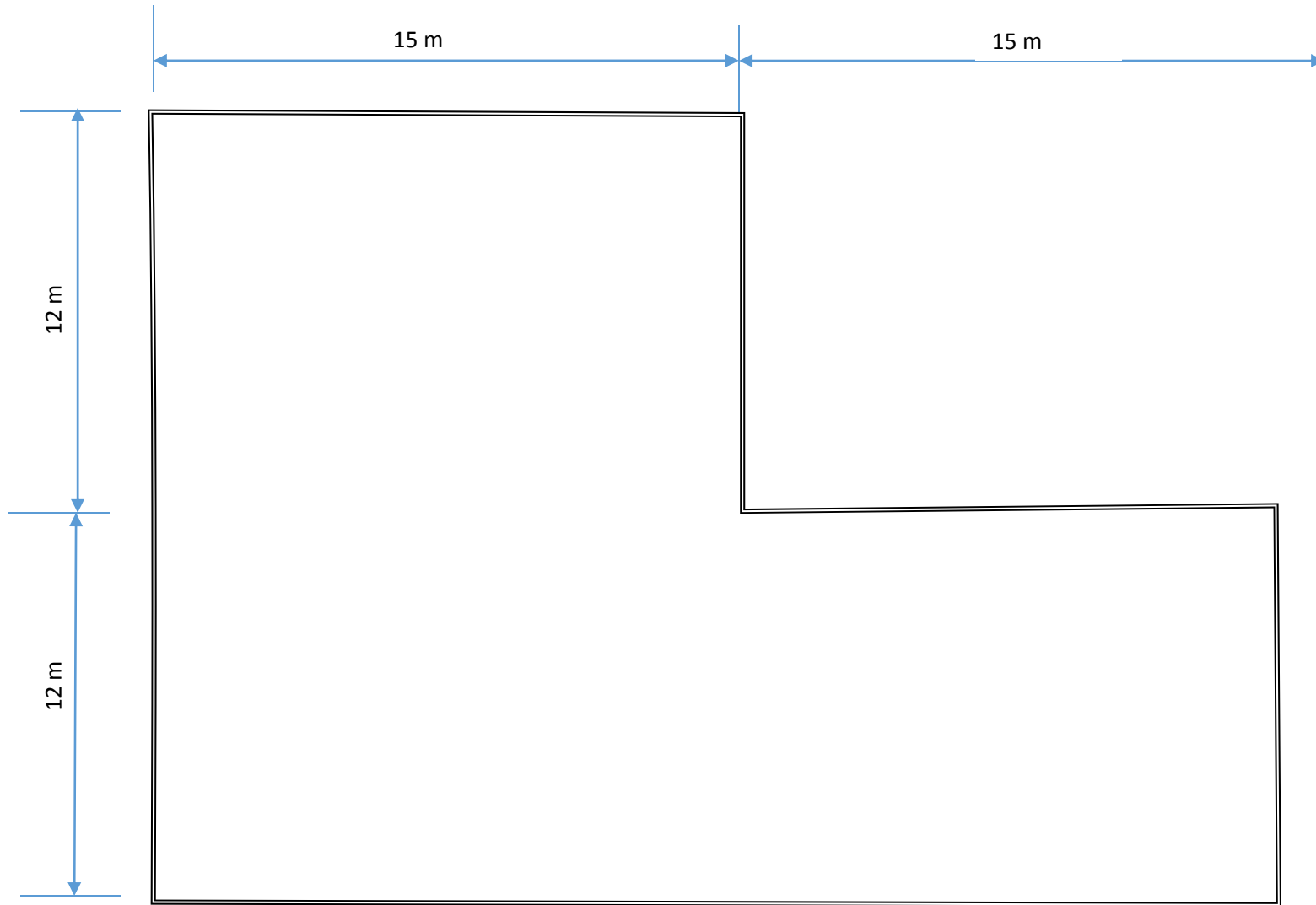


Figure 1 Building plan for Group 1 (minor details may be assumed)

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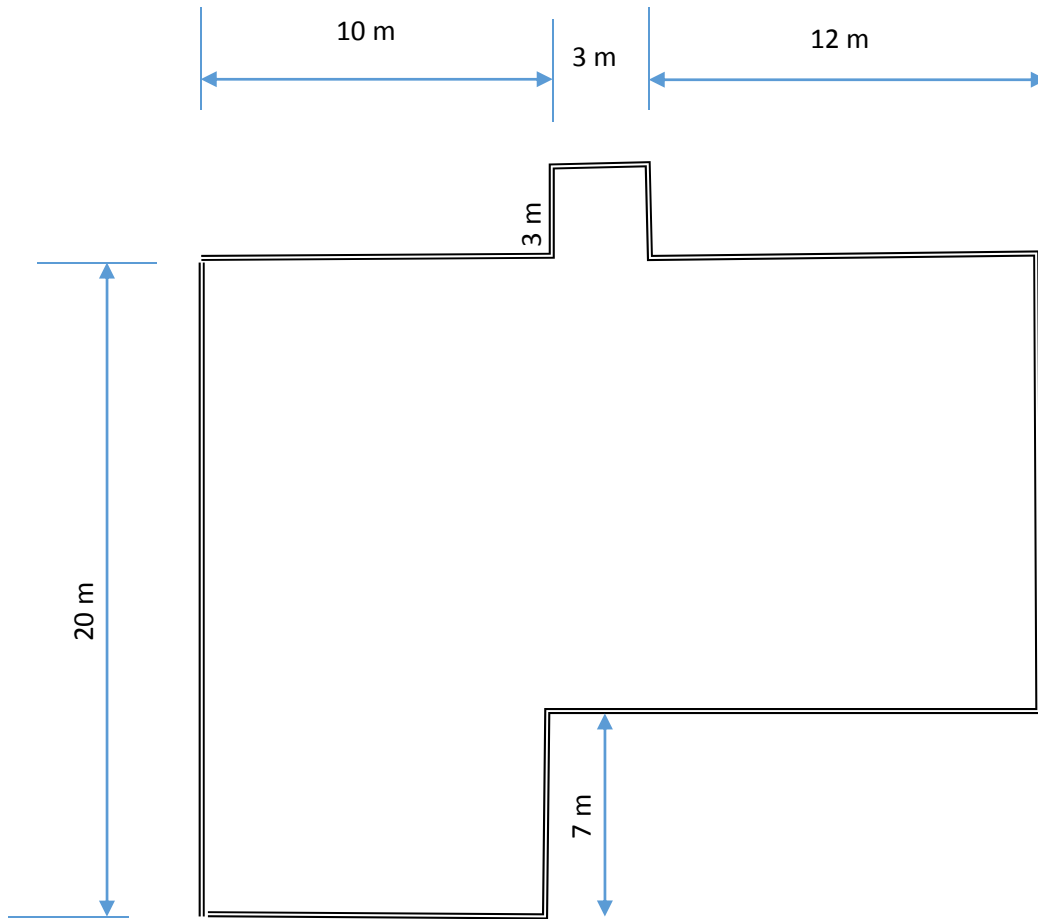


Figure 2 Building plan for Group 2 (minor details may be assumed)

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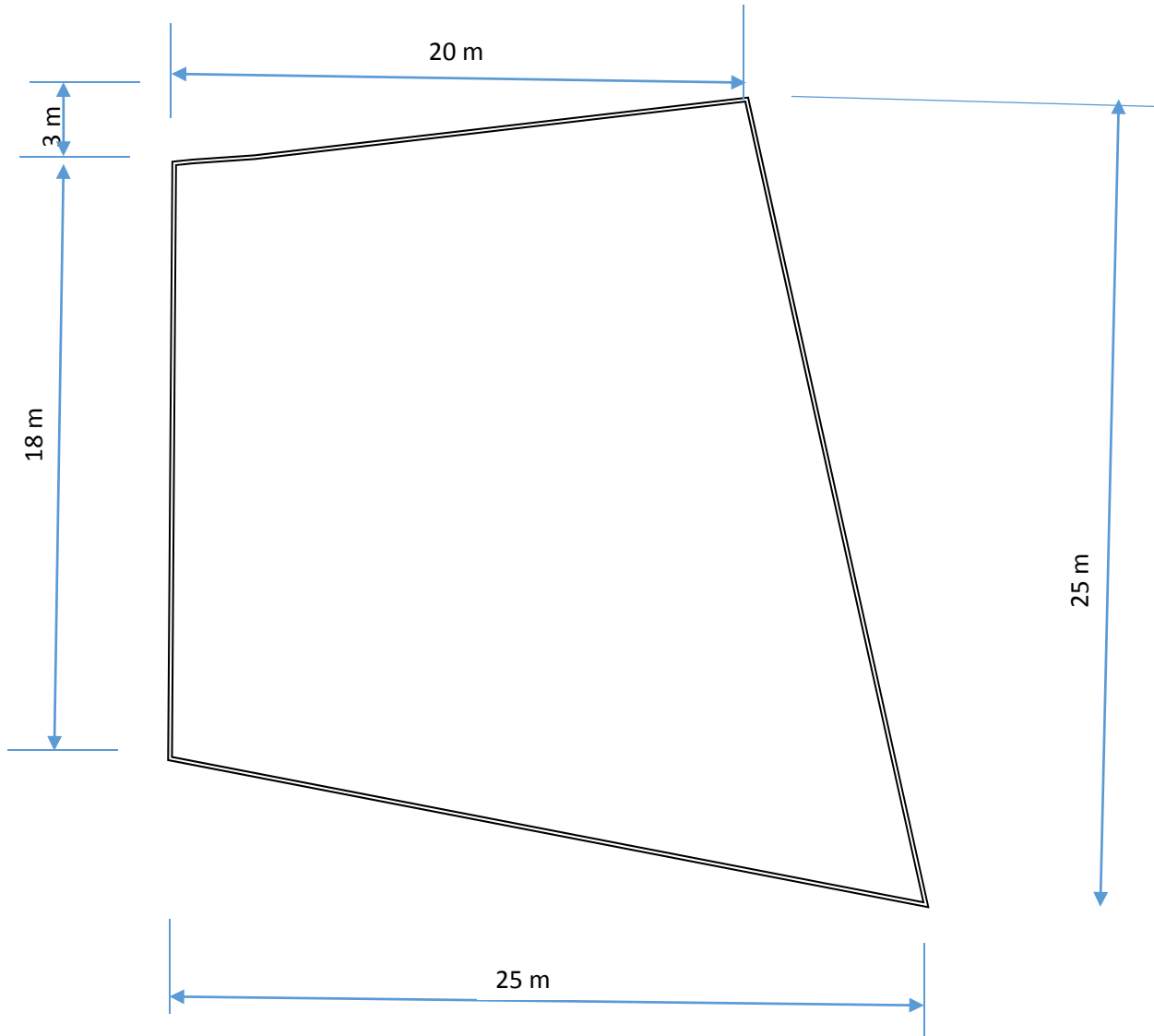


Figure 3 Building plan for Group 3 (minor details may be assumed)

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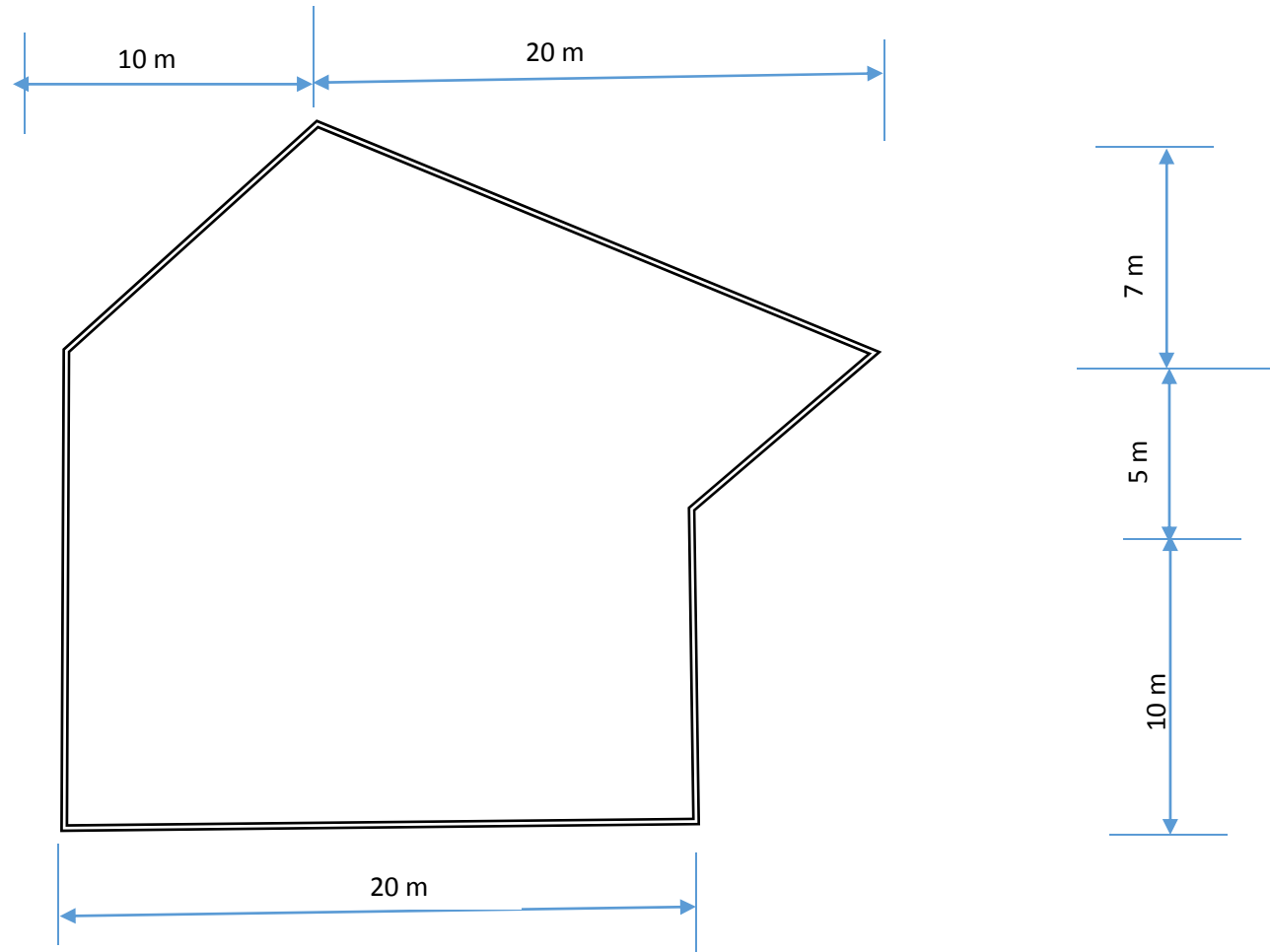


Figure 4 Building plan for Group 4 (minor details may be assumed)

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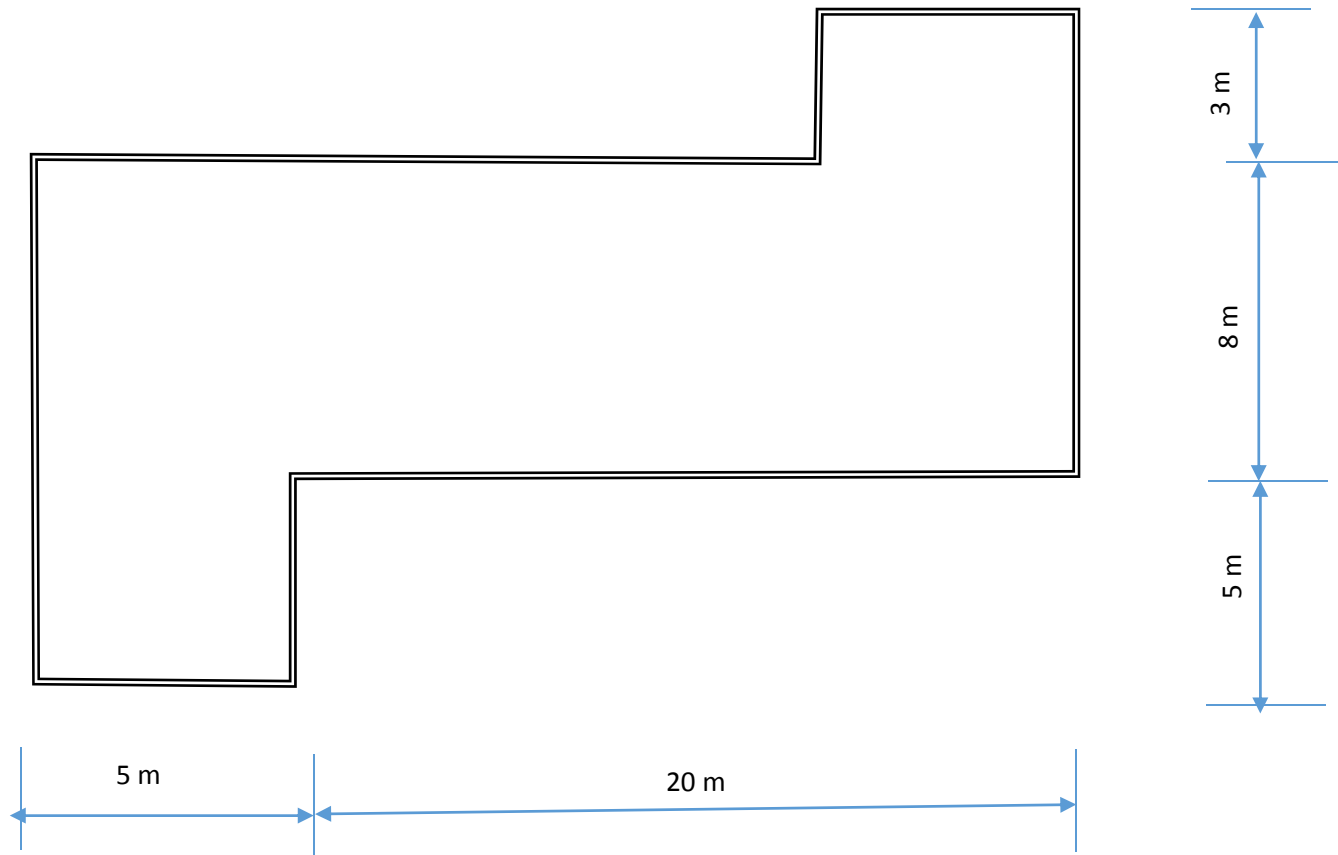


Figure 5 Building plan for Group 5 (minor details may be assumed)