R.C. SHEAR WALL DESIGN SPREADSHEET TO BS8110

WORKED EXAMPLE

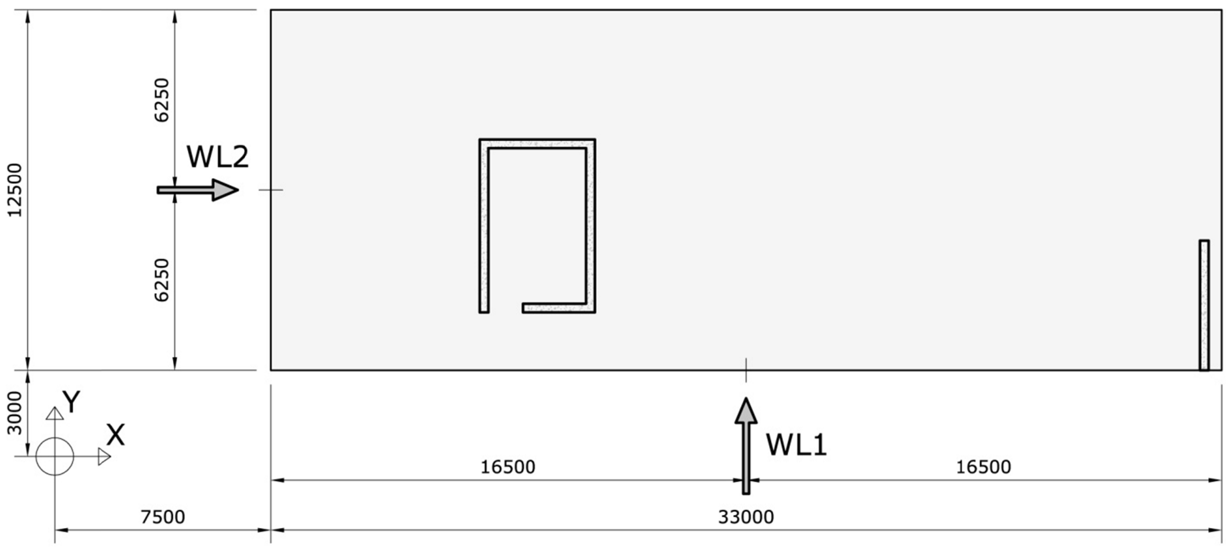
Provided by: www.YourSpreadsheets.co.uk

Design shear walls for an R.C. frame building. Use the following data:

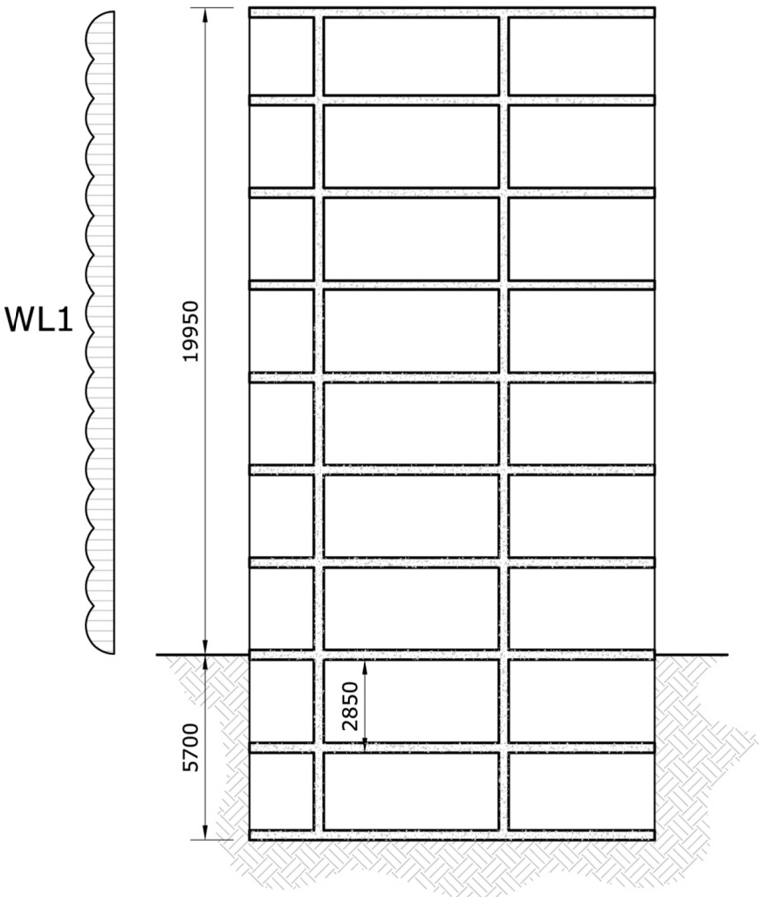
- the building is rectangular in plan: 33m x 12.5m;
- it has one stair core and one extra wall at far right;
- walls are 300mm thick;
- it consists of a two storey basement (substructure) and four storey superstructure;
- each storey is 2.85m high;
- unfactored vertical dead load is 400kN/m per wall;
- unfactored vertical imposed load is 250kN/m per wall;
- unfactored wind pressure is 1.3kN/m2.

It is important to note that:
*1. You have to enter at least **two walls in each direction** for the spreadsheet to calculate push/pull forces. This is because the spreadsheet designs walls for in-plane loads only.*
2. The spreadsheet was developed to design walls under dead and wind load combination. However it can be used to design for other load combinations but then Global Factor of Safety should be calculated based on percentage of dead load to live load, and entered in place of dead load safety factor.
3. The spreadsheet applies wind load in each direction at any one time i.e. +X, -X, +Y, -Y to give the worst case results.

See the below diagrams:



NOTE: When using the spreadsheet it is advised to assume that beginning of the co-ordinate system is in the bottom left hand corner of building being designed. This makes entering wall co-ordinates a lot simpler. However, in this case a 7.5m x 3.0m offset was assumed to cover more complex case.



NOTE: the spreadsheet assumes that wind pressure can only be applied to superstructure.

Start with entering the basic geometry and material properties into the spreadsheet:

STRUCTURE SPECIFICATION:	
Superstructure height 'h1' [*m*] =	19.95
Substructure height 'h2' [*m*] =	5.70
Max vertical bar spacing [mm] =	200
☑ check max allowable area of vertical reinforcement	

ADDITIONAL DATA:		
Concrete 'f_{cu}' [N/mm^2] =		40
Steel 'f_y' [N/mm^2] =		500
$\gamma_{DEAD\ LOAD}$ =	1.4	1.0
$\gamma_{WIND\ LOAD}$ =	1.4	1.4
	max	*min*

The 'maximum vertical bar spacing' limits the vertical spacing to the given figure. The spacing is calculated based on wall thickness as given in BS8110.

Now enter wind loads. Spreadsheet treats the structure as a cantilever with a partial line load (partial because wind is not applied to the substructure). Therefore you have to enter total wind load **per meter height**. And so, in this example:

Wind load WL1:
WL1 is applied to north/south elevation which is 33m long. Therefore wind load per meter height is 1.3kN/m2 x 33m = 42.9kN/m. The load is applied at the centre of the elevation therefore the distance from the beginning of the co-ordinate system is 7.5m (building offset) + 16.5m = 24.0m. Note that the value entered is to be in mm, hence 24000mm.

Wind load WL2:

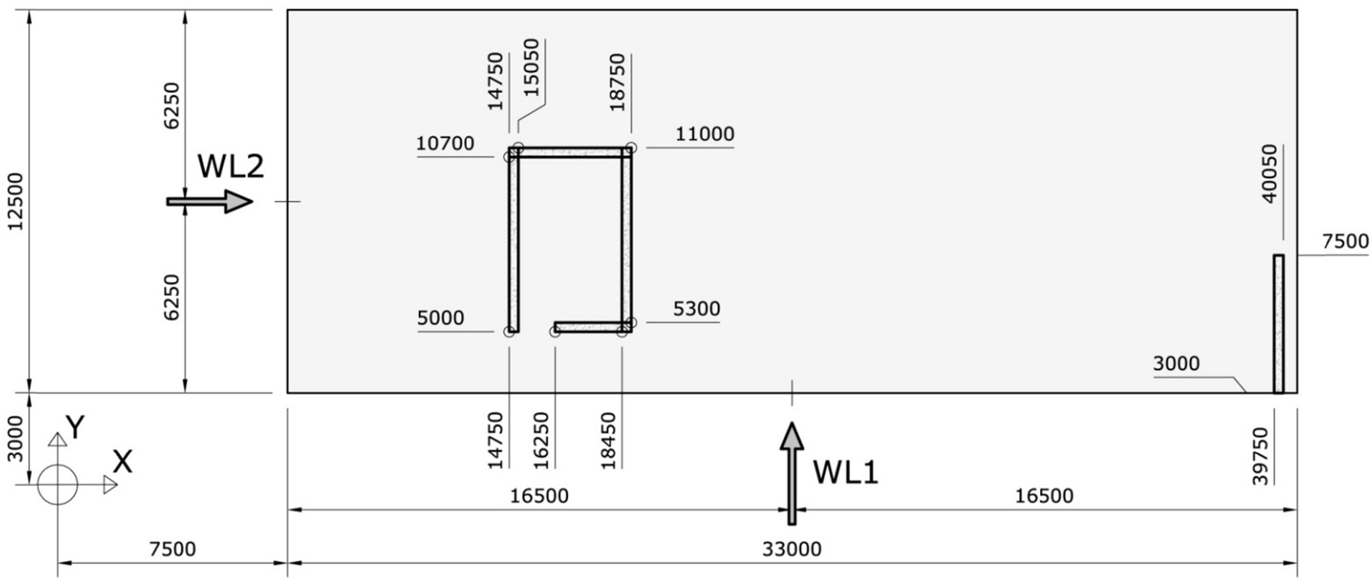
WL2 is applied to east/west elevation which is 12.5m long. Therefore wind load per meter height is 1.3kN/m2 x 12.5m = 16.25kN/m. The load is applied at the centre of the elevation therefore the distance from the beginning of the co-ordinate system is 3.0m (building offset) + 6.25m = 9.25m. Note that the value entered is to be in mm, hence 9250mm.

See below:

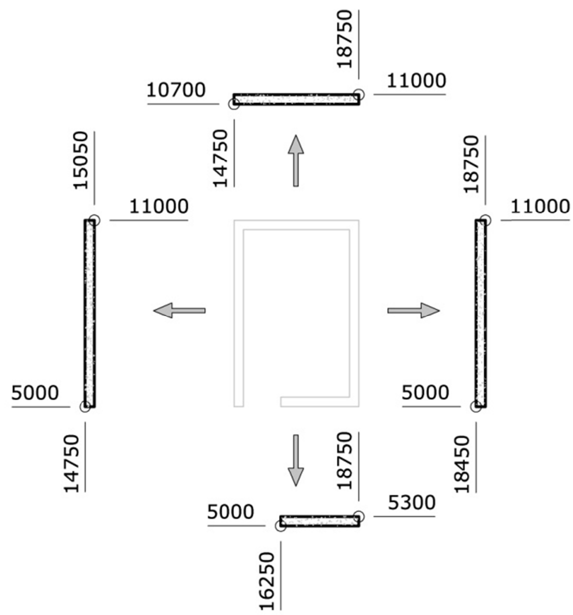
UNFACTORED WIND LOAD:	
North/South 'WL_1' [*kN/m height*] =	42.9
'WL_1' location on X-axis [*mm*] =	24000
West/East 'WL_2' [*kN/m height*] =	16.25
'WL_2' location on Y-axis [*mm*] =	9250

NOTE: Wind Load applied in one direction at any one time.

Now calculate wall co-ordinates by hand or use CAD if there are more than a few walls. Below is a diagram from AutoCAD which gives all wall co-ordinates that will be entered into the spreadsheet:



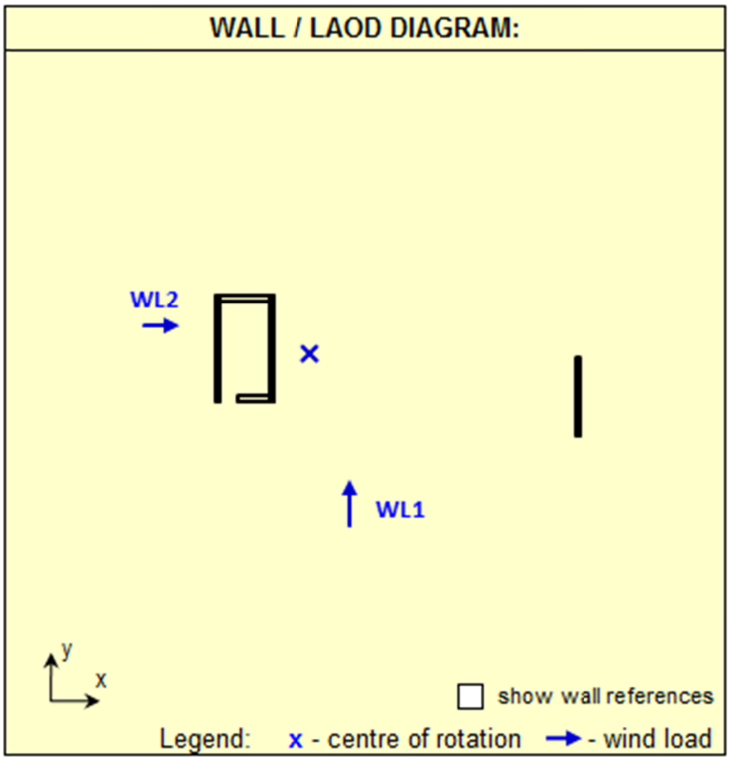
Below is a close-up of the stair core:



Now enter these co-ordinates into the spreadsheet. The spreadsheet gives you wall size on the right hand size to allow quick checks. Make sure you use this facility to eliminate errors when using co-ordinates.

Nº	WALL COORDINATES:				UNFACTORED DEAD LOAD: [*kN/m length*]	WALL SIZE: [*m*]
	Bottom Left [*mm*]:		Top Right [*mm*]:			
	X-axis	*Y-axis*	*X-axis*	*Y-axis*		
1	14750	5000	15050	11000	400	6.00x0.30
2	14750	10700	18750	11000	400	4.00x0.30
3	16250	5000	18750	5300	400	2.50x0.30
4	18450	5000	18750	11000	400	6.00x0.30
5	39750	3000	40050	7500	400	4.50x0.30
6						

The spreadsheet plots walls automatically as you type:



The spreadsheet calculates stiffness per wall and combined with wall location it calculates centre of rotation and torsional moments:

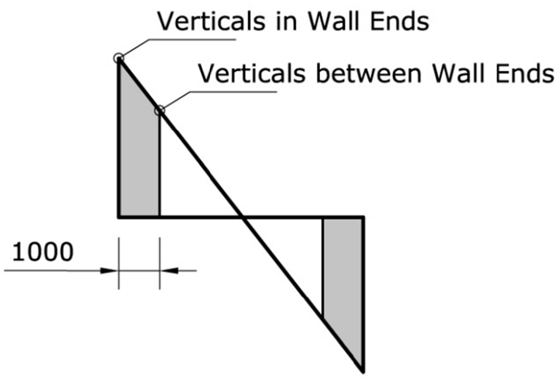
WALL GROUP RESULTS:	
$\sum kx = 157$ $\sum ky = 24$ $\sum kr2 = 12{,}821$	
Centre of rotation (x, y) [*m*] =	(21.36, 7.65)
Moment M_1 [*kNm/m height*] =	158.51
Moment M_2 [*kNm/m height*] =	36.45

The spreadsheet calculates required reinforcement per wall and gives results in a tabulated manner. Note that the spreadsheet also gives you factored tension and compression stresses per wall for easy hand checks.

Nº	WALL REINFORCEMENT OUTPUT:			Stresses [N/mm ^{2}]:		Length of Wall Ends [mm]:
	Horizontals:	Verticals between Wall Ends:	Verticals in Wall Ends:	tension	compr.	
1	H10 @ 200mm EF	H 16 @ 200mm EF [1,200]	H 16 @ 200mm EF [1,432]	-2.08	5.28	1000 (6000)
2	H10 @ 200mm EF	H 16 @ 200mm EF [1,477]	H 20 @ 150mm EF [4,057]	-5.88	9.08	1000 (4000)
3	H10 @ 200mm EF	H 16 @ 200mm EF [1,200]	H 16 @ 175mm EF [2,138]	-3.10	6.30	500 (2500)
4	H10 @ 200mm EF	H 16 @ 200mm EF [1,200]	H 16 @ 200mm EF [1,787]	-2.59	5.79	1000 (6000)
5	H10 @ 200mm EF	H 16 @ 200mm EF [1,200]	H 16 @ 150mm EF [2,644]	-3.83	7.03	1000 (4500)
6						

Enter bar diameter per wall to achieve acceptable bar spacing.

The ‘length of wall ends’ column is used to determine where lower area reinforcement is to be calculated, see below stress diagram.



WALL STRESSES UNDER WIND LOAD

THE END.

Worked example provided by www.YourSpreadsheets.co.uk
Download a free lite version of the spreadsheet to see its full capacity before purchasing.

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