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The shaping for the mixed structures evaluation

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Summary:

Some aspects regarding the possibilities of shaping the mixed structures are presented (structural frames and walls), in a view to use automatic usual evaluation programs, made for bar structures. The paper also contains an example of evaluation that draws several useful conclusions regarding different adopted evaluation models.

KEY WORDS: mixed structures, structural frames and walls, evaluation models, comparative results, efforts, movements.

1. INTRODUCTION:

The mixed structures made of structural ferro-concrete frames and walls are used on a large scale in socio-cultural and administrative buildings.

An important step in designing theses structures is establishing the evaluation model that depends on the available means of solving and that determines the accuracy of the obtained results. Some shaping possibilities are presented in the paper regarding the mixed structures made of structural frames and walls with holes.

A case study referring to a mixed structure, in which three evaluation models have been taken into account, allowed some interesting and useful conclusions and results concerning the effort states from the elements pertaining to the structures and the corresponding movements.

2. CASE STUDY

2.1. General issues

A mixed structure was taken into consideration, made of a frame with two openings and a structural wall with symmetrical large holes. The structure was shaped in three ways, to which three loading plans were taken into consideration, determining the maximum efforts from the structure elements and the entire lateral movements. The structure elements have been pre-dimensioned maintaining the established dimensions in the three shaping version.

In order to determine the efforts and movements the automatic evaluation program SCIA.ESA.PT was used . The purpose of the case study was to determine some comparative data about the efforts and movements for the suggested shaping version. The resulting conclusions are gathered in the final part of the study.

In fig. 1 the analyzed structure is presented (the first model of evaluation):

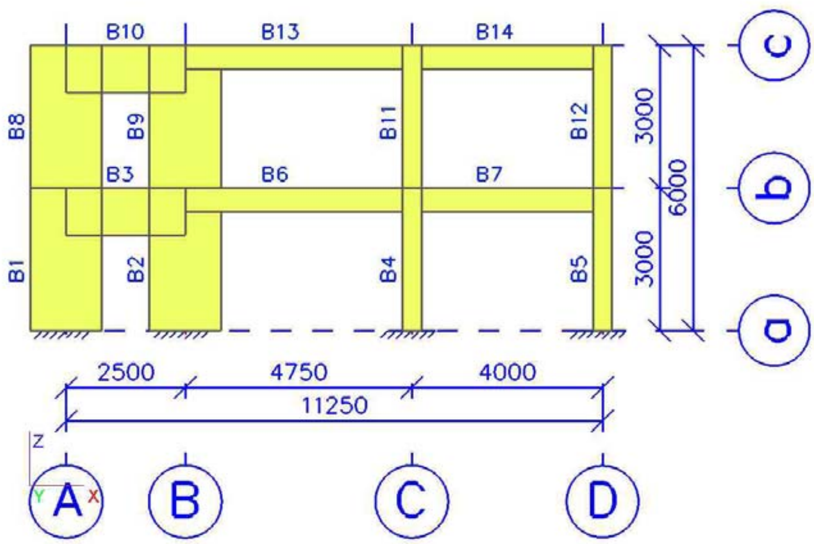

Fig. 1 The first model of evaluation

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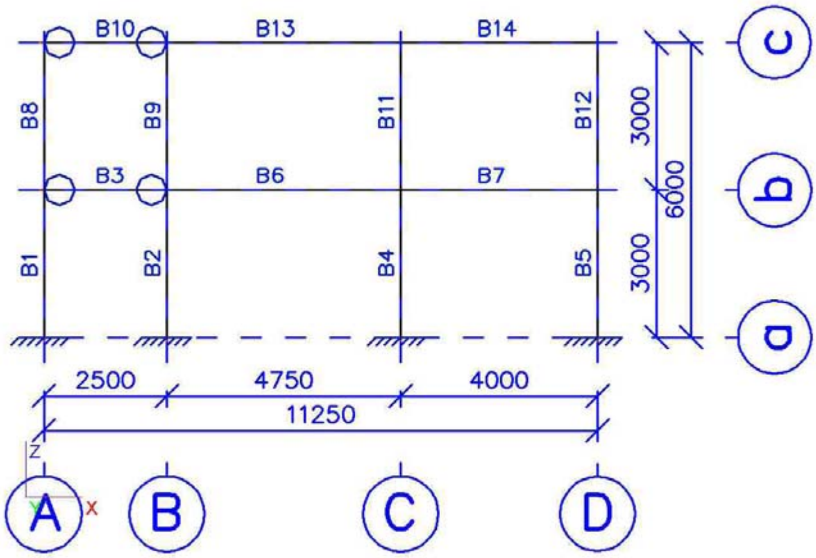

Fig. 2 The second model of evaluation

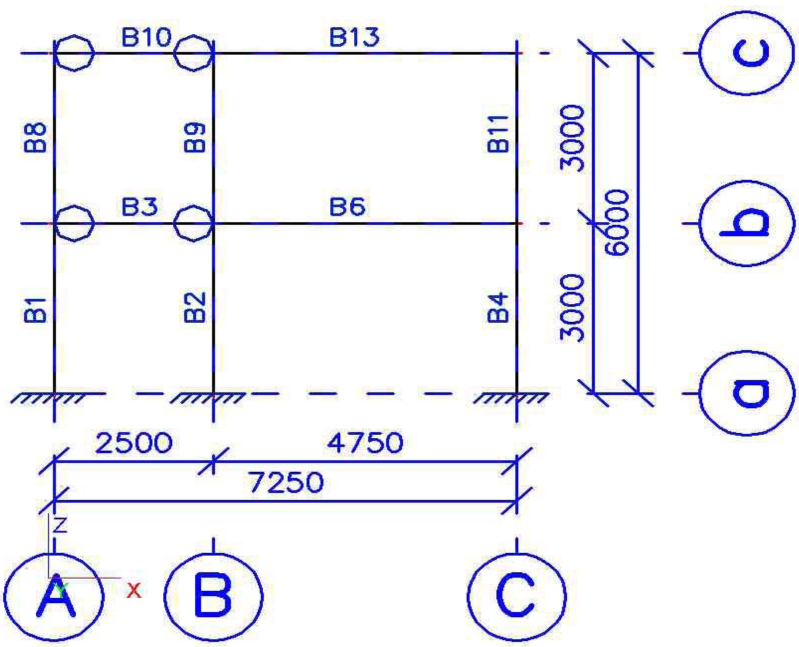

Fig. 3 The third model of evaluation

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2.2. Considered models of evaluation

The first model of evaluation is the real structure (fig.1). The second model of evaluation (fig.2) keeps the real frame, but assimilates the coupling bars of the structural wall with articulated bars at the ends. The third model of evaluation maintains the structural wall plan and replaces the real frame with an equivalent frame with one opening.

2.3. Geometrical features of the structure elements

They are presented in table 1 for the model 1 (for exemplification)

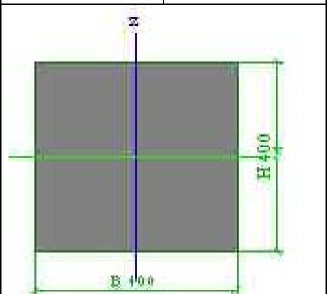
2.4. Loading plans

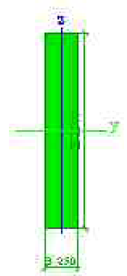
These are presented as follows in table 1, containing:

- Loadings from their own weight
- Loadings from the snow
- Loadings from the wind
- Seismic loadings

In the same table the loading groups and combinations are exhibited, considered for all the three models of evaluation.

Tab.1. Cross-sections

Name	PILLAR FOR FRAME	
Detailed	400; 400	
Material	C12/15	
Buckling y-y,z-z	b, b	
FEM analysis	x	
Picture		
Material	C12/15	
A [m2]	1,6000e-001	
Ay,z [m2]	1,3333e-001	1,3333e-001

Name	WALL VERTICAL	
Detailed	1500; 250	
Material	C12/15	
Buckling y-y, z-z	b, b	
FEM analysis	x	
Picture		
Material	C12/15	
A [m2]	3,7500e-001	
Ay,z [m2]	3,1250e-001	3,1250e-001

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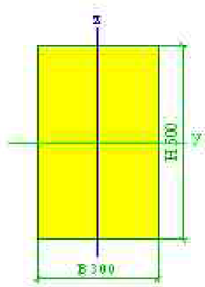
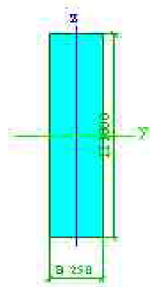
Iy,z [m4]	2,1333e-003	2,1333e-003
It [m4], w [m6]	3,5994e-003	0,0000e+000
alpha [deg]	0,00	
Wel y, z [m3]	1,0667e-002	1,0667e-002
Wpl y,z [m3]	1,6000e-002	1,6000e-002
cYLCS, ZLCS [mm]	200	200
d y,z [mm]	0	0
AL [m2/m]	1,6000e+000	

Iy,z [m4]	7,0313e-002	1,9531e-003
It [m4], w [m6]	6,9277e-003	0,0000e+000
alpha [deg]	0,00	
Wel y, z [m3]	9,3750e-002	1,5625e-002
Wpl y,z [m3]	1,4063e-001	2,3438e-002
cYLCS, ZLCS [mm]	125	750
d y,z [mm]	0	0
AL [m2/m]	3,5000e+000	

Name	**BEAM FOR FRAME**	
Detailed	500; 300	
Material	C12/15	
Fabrication	concret	
Buckling y-y,z-z	b,b	
FEM analysis	x	
Desen		
Material	C12/15	
A [m2]	1,5000e-001	
Ay,z [m2]	1,2500e-001	1,2500e-001
Iy,z [m4]	3,1250e-003	1,1250e-003
It [m4], w [m6]	2,7913e-003	0,0000e+000
alpha [deg]	0,00	
Wel y, z [m3]	1,2500e-002	7,5000e-003
Wpl y,z [m3]	1,8750e-002	1,1250e-002



Name	**WALL ORIZONTAL**	
Detailed	1000; 250	
Material	C12/15	
Fabrication	concret	
Buckling y-y,z-z	b,b	
FEM analysis	x	
Desen		
Material	C12/15	
A [m2]	2,5000e-001	
Ay,z [m2]	2,0833e-001	2,0833e-001
Iy,z [m4]	2,0833e-002	1,3021e-003
It [m4], w [m6]	4,3336e-003	0,0000e+000
alpha [deg]	0,00	
Wel y, z [m3]	4,1667e-002	1,0417e-002
Wpl y,z [m3]	6,2500e-002	1,5625e-002



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cYLCS, ZLCS [mm]	150	250
d y,z [mm]	0	0
AL [m_2/m]	1,6000e+000	

cYLCS, ZLCS [mm]	125	500
d y,z [mm]	0	0
AL [m_2/m]	2,5000e+000	

Tab. 2 - Load cases

NAME	DESCRIPTION	ACTION TYPE	LOAD GROUP	LOAD TYPE	SPEC	DIRECTION	DURATION	MASTER LOAD CASE
LC1	Weight proprie	Permanently	LG1	Weight proprie		-Z		
LC2	Snow	Variable	LG2	Static	Standard		Short	None
LC3	Wind crosswise	Variable	LG3	Static	Standard		Short	None
LC4	Wind longitudinal	Variable	LG4	Static	Standard		Short	None
LC5	Seism	Variable	LG5	Dynamic	Seismicity			None

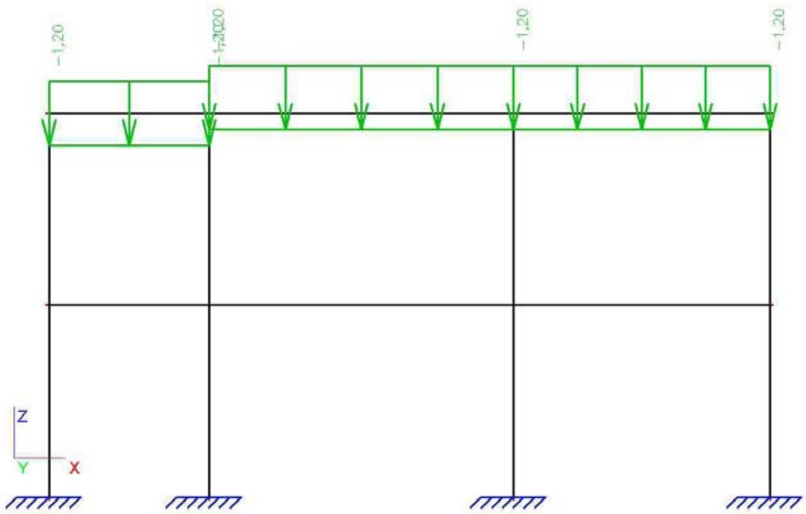

Fig. 4 Loading from snow

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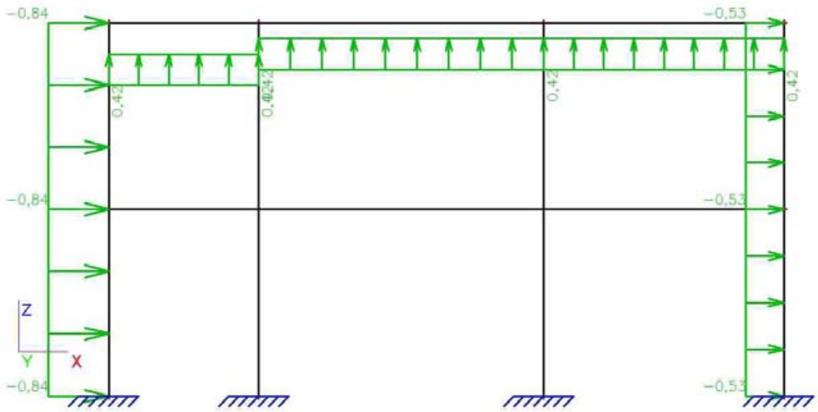

Fig.5 Loading from wind transversely

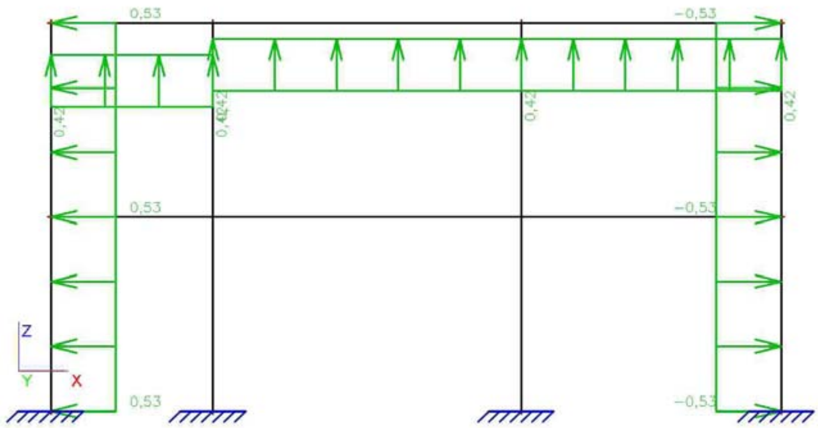

Fig.6 Loading from wind longitudinal

Tab. 3 Loads groupe

Name	Incarcari	Relatii	Coef. 2
LG1	Permanent		Snow load H<1000m a.s.l. Wind
LG2	Variable	Standard	
LG3	Variable	Exclusive	
LG4	Seismic	Together	

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Tab. 4 Combinations

Nume	Description	Type	cases of loading	coef.1
Co1	Usl Str	En-Usl	lc1- own weight	1.00
			lc2-snow	1.00
			lc3-wind transverse	1.00
			lc4-wind longitudinal	1.00
Co2	Seism 1	Liniar-Ultimate	lc1- own weight	1.00
			lc2-snow	1.00
			lc5-seism	1.00
Co3	Seism 2	Liniar-Ultimate	lc1- own weight	1.00
			lc2-snow	1.00
			lc5-seism	1.00

2.5. Obtained results

The efforts and the movements for the three models of evaluation are gathered in table 2.

Tab. 5 Centralizing with efforts with values in the section three cases analyzed

Name Elements	Hypothesis 1								
	Type Of Loading								
	Uls			Seism			Total		
	Nx (kN)	Tz (kN)	My (kNm)	Nx (kN)	Tz (kN)	My (kNm)	Nx (kN)	Tz (kN)	My (kNm)
B2	-129	2,06	-7,84	-86,1	4,92	11,79	-129	17,35	42,82
B6	4,03	11,99	-9,62	8,56	9,94	-4,44	8,56	9,94	-4,44
B13	-3,48	-15,8	-11,8	-0,34	-11,1	-7,97	-3,48	17,35	42,82
B3				4,15	23,21	17,11	4,15	23,21	17,11
B1									
B10									
B9									

Name Elements	Hypothesis 2								
	Type Of Loading								
	Uls			Seism			Total		
	Nx (kN)	Tz (kN)	My (kNm)	Nx (kN)	Tz (kN)	My (kNm)	Nx (kN)	Tz (kN)	My (kNm)
B2	-125,5	-1,2	-3,25	-91	17,25	70,86	-91	17,25	70,86
B6	4,55	11,54	-8,4	10,89	11,16	-0,71	10,89	11,16	-0,071
B13	-3,82	16,14	-12,5	-1,57	-10,9	-7,48	-1,57	-10,9	-7,48

B3									
B1	-95,5	5,98	-18,2						
B10	1,28	0	7,87						
B9				-20,1	-0,47	-8,18	-20,1	-0,47	-8,18

Name Elements	Hypothesis 3								
	Type Of Loading								
	Uls			Seism			Total		
	Nx (kN)	Tz (kN)	My (kNm)	Nx (kN)	Tz (kN)	My (kNm)	Nx (kN)	Tz (kN)	My (kNm)
B2	-127,2	-1,09	-3,85	-92,4	3,6	15,75	-127	14,09	59,01
B6	5,17	11,69	-8,46	6,55	11,35	-1,25	6,55	11,35	-1,25
B13	-4,36	17,7	-14,5	-2,59	-15	-4,28	-4,36	17,7	-14,54
B3									
B1	-95,53	6,28	-19,9				-95,5	6,28	-19,85
B10									
B9				-21,2	-1,21	-9,94			

2.6. Conclusions and comments

From comparing the obtained results for the three shaping version, the following conclusions may be drawn:

2.6.1 The efforts dimension

Compared to the values resulted from the version 1 (the real structure) the following effort variations can be noticed for the special loading version (permanent, quasi-permanent and seism):

A. Axial force

a) The structural wall pillars:

- In shaping version 2, 40% lower axial forces resulted;
- In shaping version 3, the axial forces were relatively the same;

b) In the coupling girders between the frame and the structural wall, the axial forces have low values and their comparison is not significant.

B. Cutter forces from the structural wall pillars have close values in the three shaping versions.

C. The flexion moments

a) The structural wall pillars:

- For the structural wall pillars in the shaping version 2, the moments are approximately 65% higher, while in shaping version 3 they are only about 15% higher.

b)The frame shafts do not have significant values for the flexion moments.

c)In the coupling girders between the frame and the structural wall, the flexion moments have important values in the real structure, while in shaping versions 2, 3 the flexion moments have much lower values.

2.6.2. The maximum lateral movements

For the loading version 3, (permanent loading, quasi-permanent and seism) the maximum lateral movements are close regarding the values to all three shaping versions.

3. CONCLUSIONS

1. The analyzed case study emphasizes the importance of the evaluation model adopted as far as the effort dimensions from the structure elements are concerned.

2. As far as lateral movements are concerned, they are not significantly different in comparison to the chosen evaluation model.

3. Similar studies have been made also for mixed structures with several levels having significant differences both regarding the effort dimension and the movement dimension. These studies are included in the paper [4].

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