Article:

Cavaleri, L, Di Trapani, F, Asteris, PG et al. (1 more author) (2017) Influence of column shear failure on pushover based assessment of masonry infilled reinforced concrete framed structures: A case study. Soil Dynamics and Earthquake Engineering, 100. pp. 98-112. ISSN 0267-7261

https://doi.org/10.1016/j.soildyn.2017.05.032

FIGURES

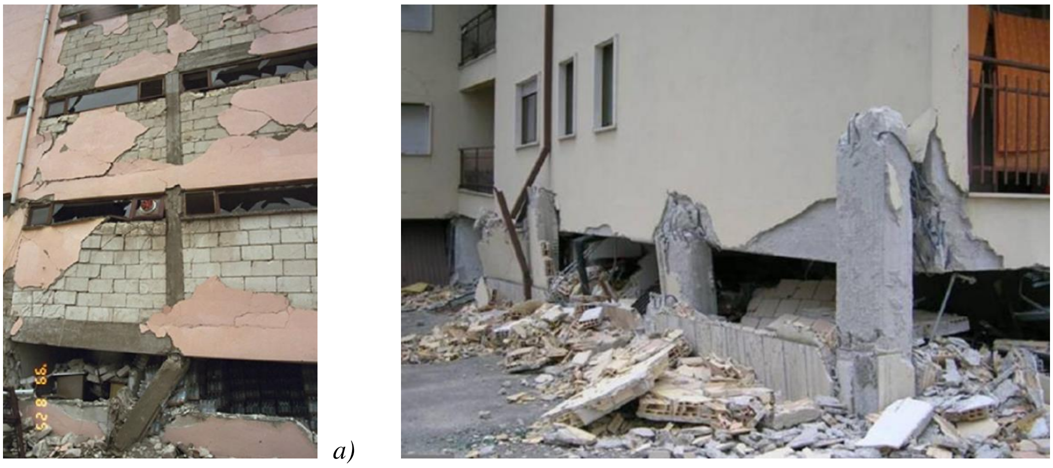


Figure 1. Effect of geometrical irregularities in distribution of infills: *a)* Adapazari-Turkey (1999); *b)* L'Aquila-Italy (2009).

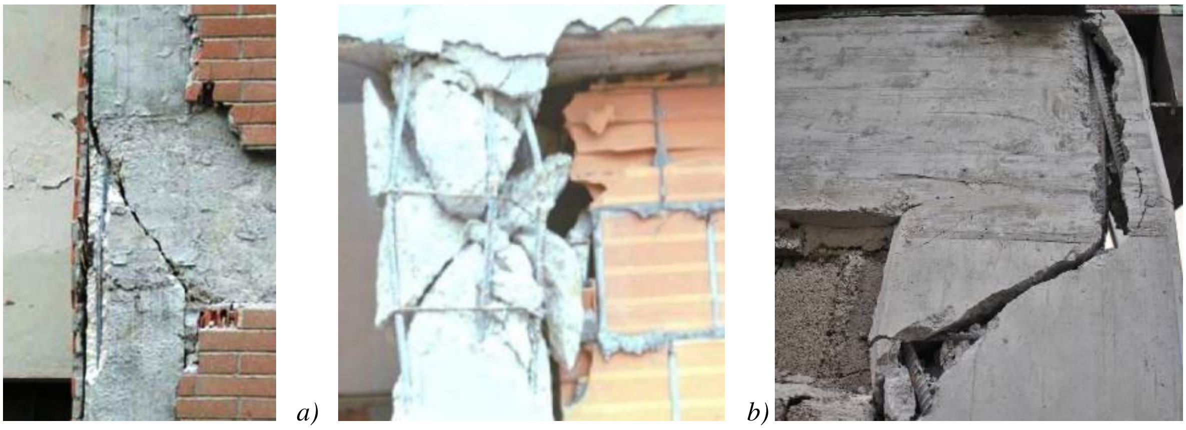


Figure 2. Local failures of RC frames due to the interaction with infills: *a)* Failure of a joint; *b)* Failure of a column end; *c)* Failure of column and joint.

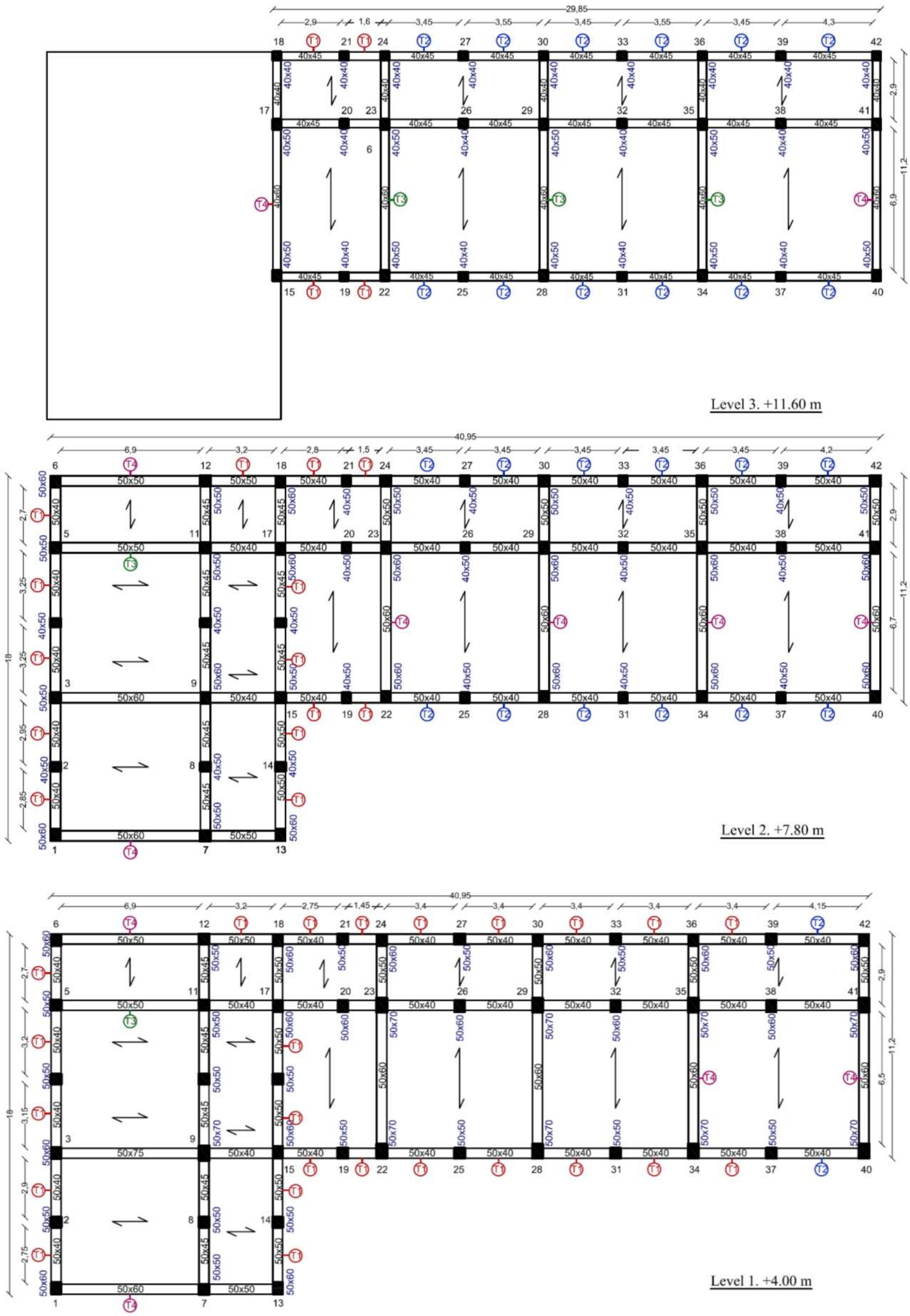


Figure 3. Structural plan of the floors with location of infills and indication of their typology.

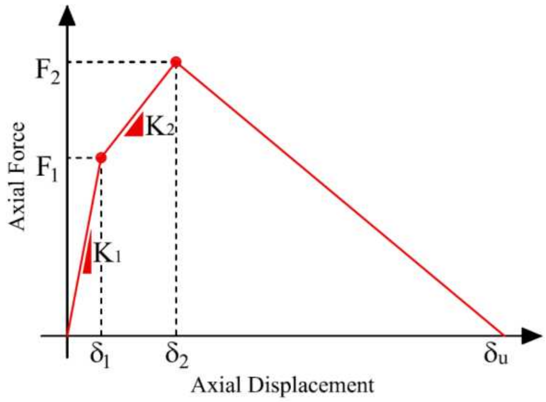


Figure 4. Force-displacement relationship for the equivalent struts.

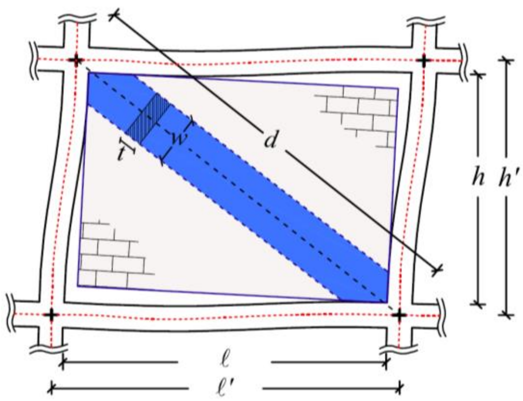


Figure 5. Geometrical parameters for the identification of *w*.

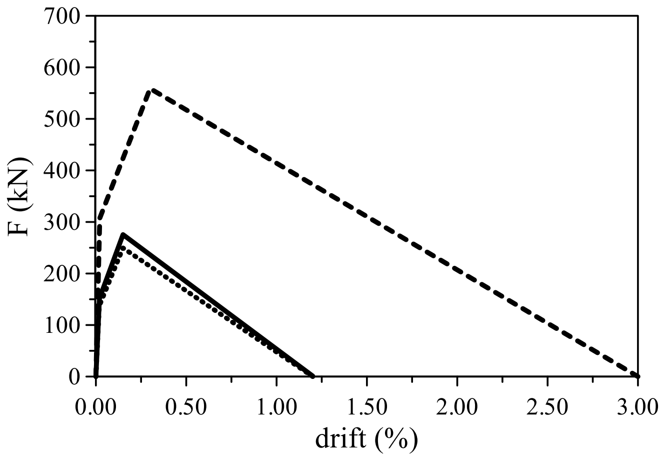


Figure 6. Force – drift relationships adopted for the equivalent struts T_1, T_2, T_3 and T_4.

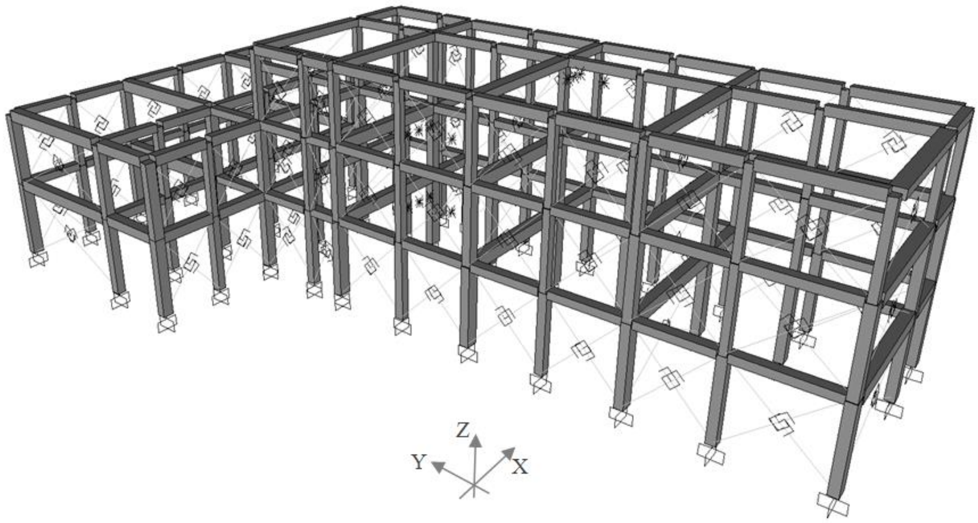


Figure 7. 3D view of the structural model.

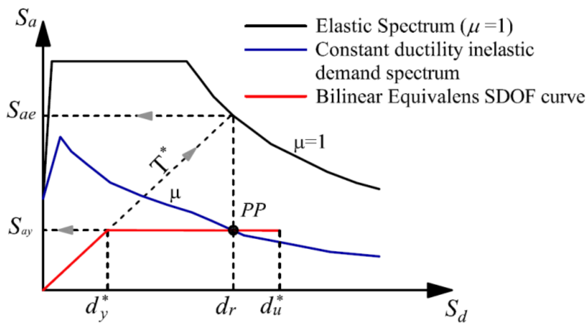


Figure 8. Capacity and demand spectra in acceleration against displacement format.

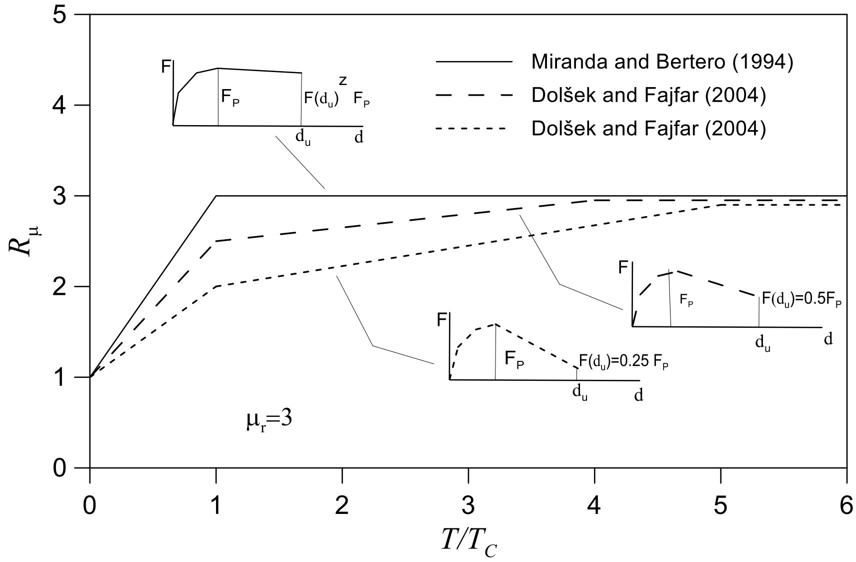


Figure 9. R_μ-μ-T relationships for the evaluation of the inelastic demand spectrum for an assigned value of μ_r and three different peak strength – ultimate strength ratios as proposed by Miranda and Bertero (1994) and Dolsek and Fajfar (2004)

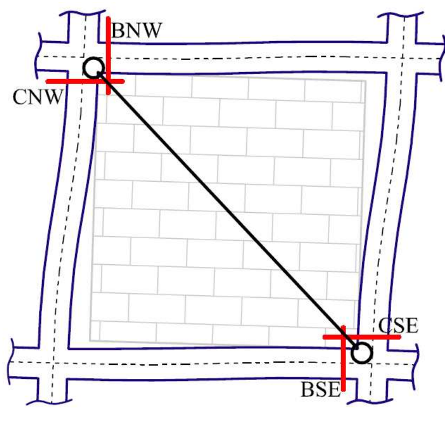


Figure 9-10 . Critical sections subjected to additional shear force due to the presence of the infills.

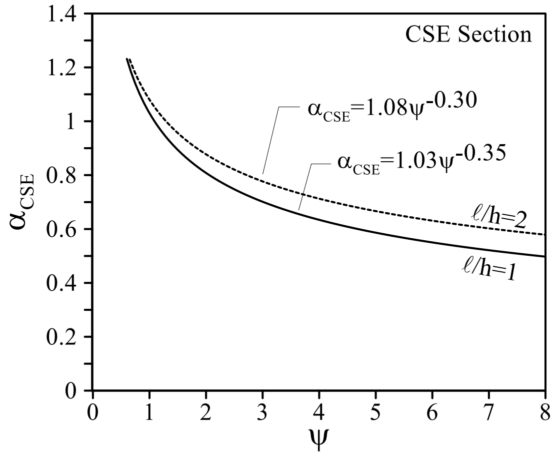


Figure ~~10~~11. Shear distribution coefficients α_{CSE} vs. ψ factor at *ℓ/h=1* and *ℓ/h=2*.

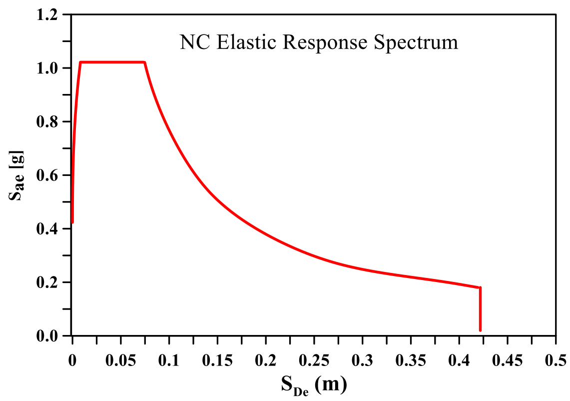


Figure ~~11~~ 12. Near collapse LS elastic response spectrum in ADRS format.

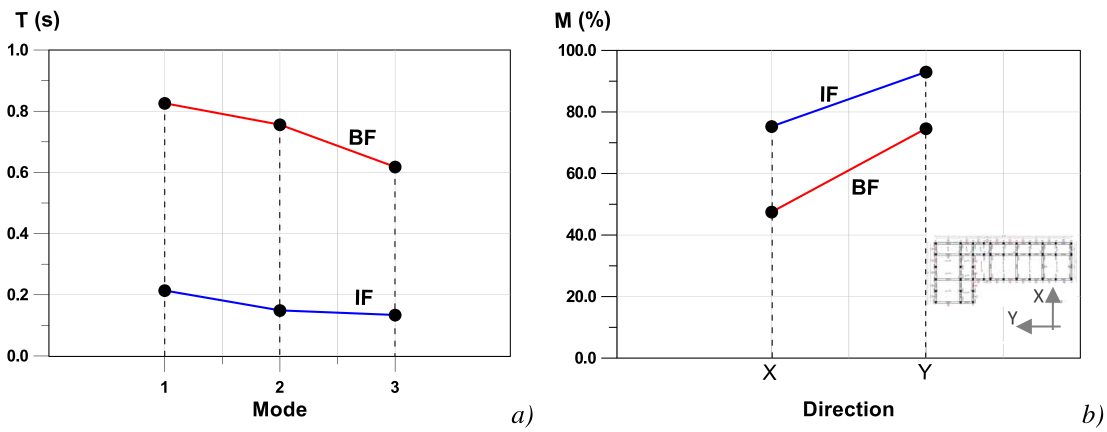


Figure ~~12~~ 13. Comparison of dynamic response of BF and IF models: *a)* Natural periods of the first 3 modes; *b)* Participating mass ratios.

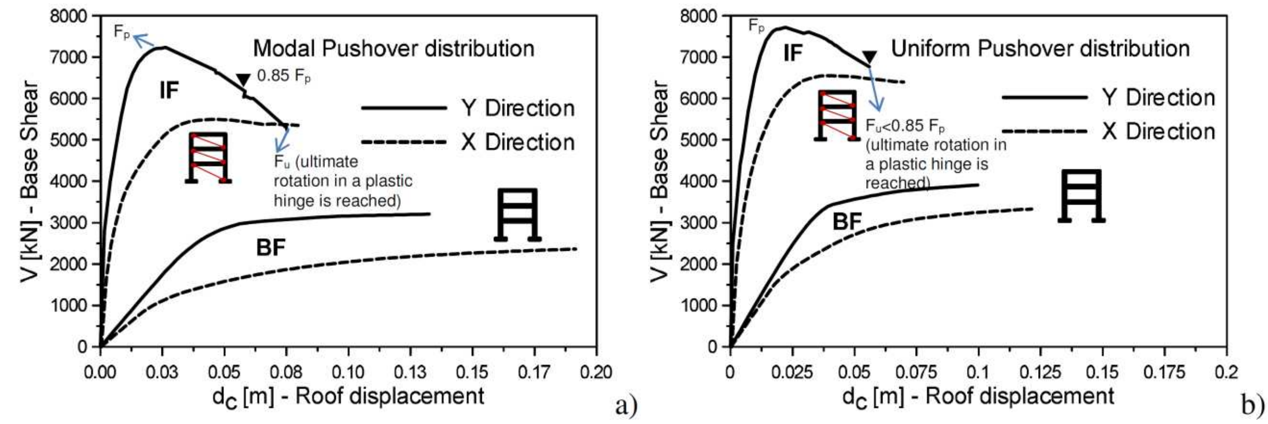


Figure ~~13~~ 14. BF and IF pushover analysis for: a) Modal distribution; b) Uniform distribution.

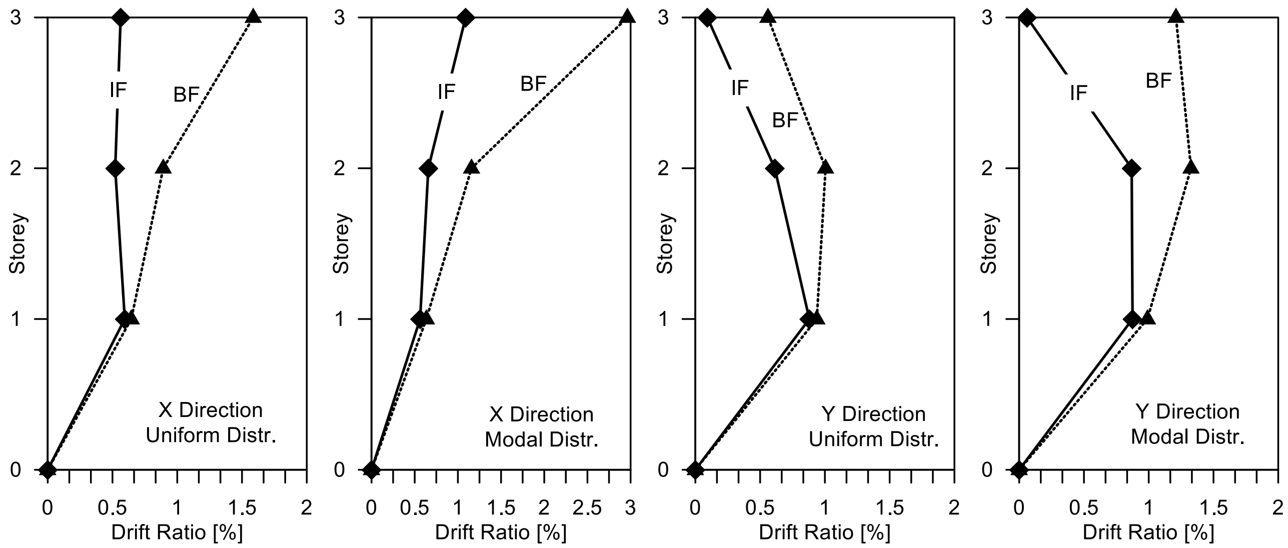


Figure ~~14~~ 15. Distribution of drift demand for IF and BF cases.

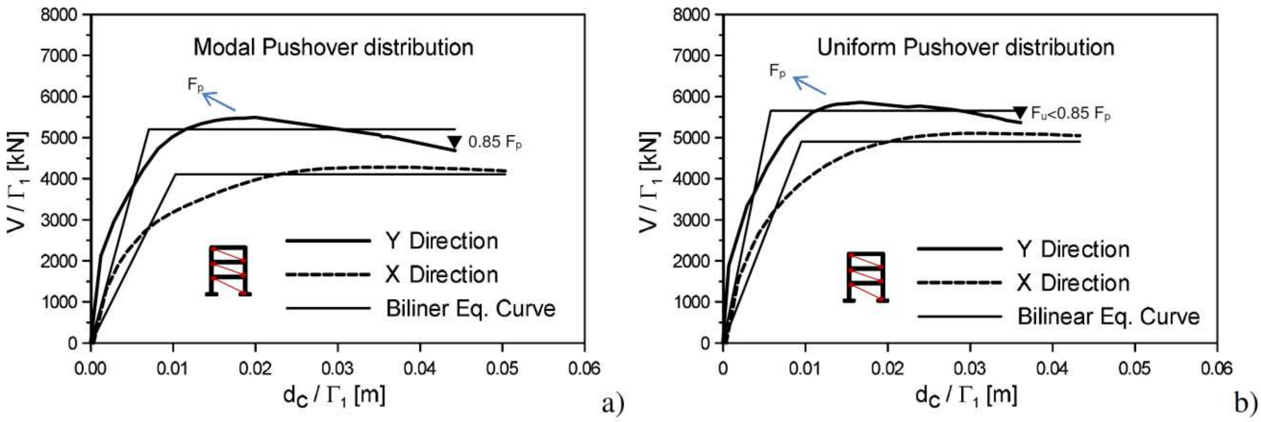


Figure 16. Bilinear equivalent capacity curves.

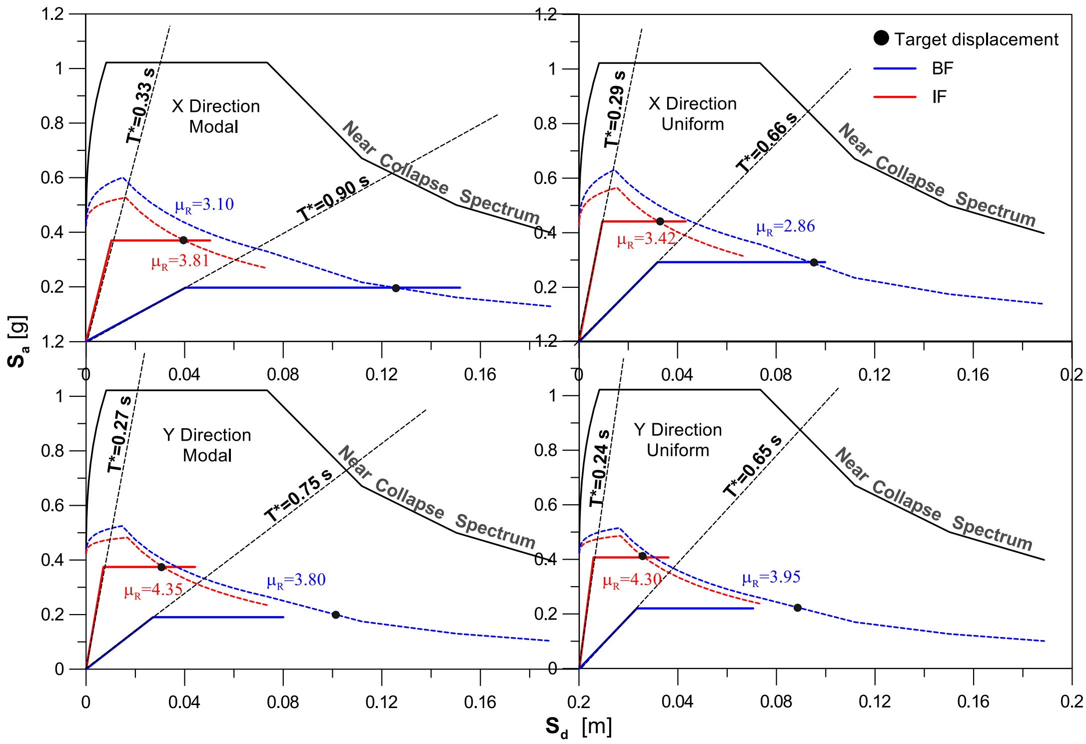


Figure ~~15~~ 17. Assessment of the capacity of BF and IF in ADSR format.

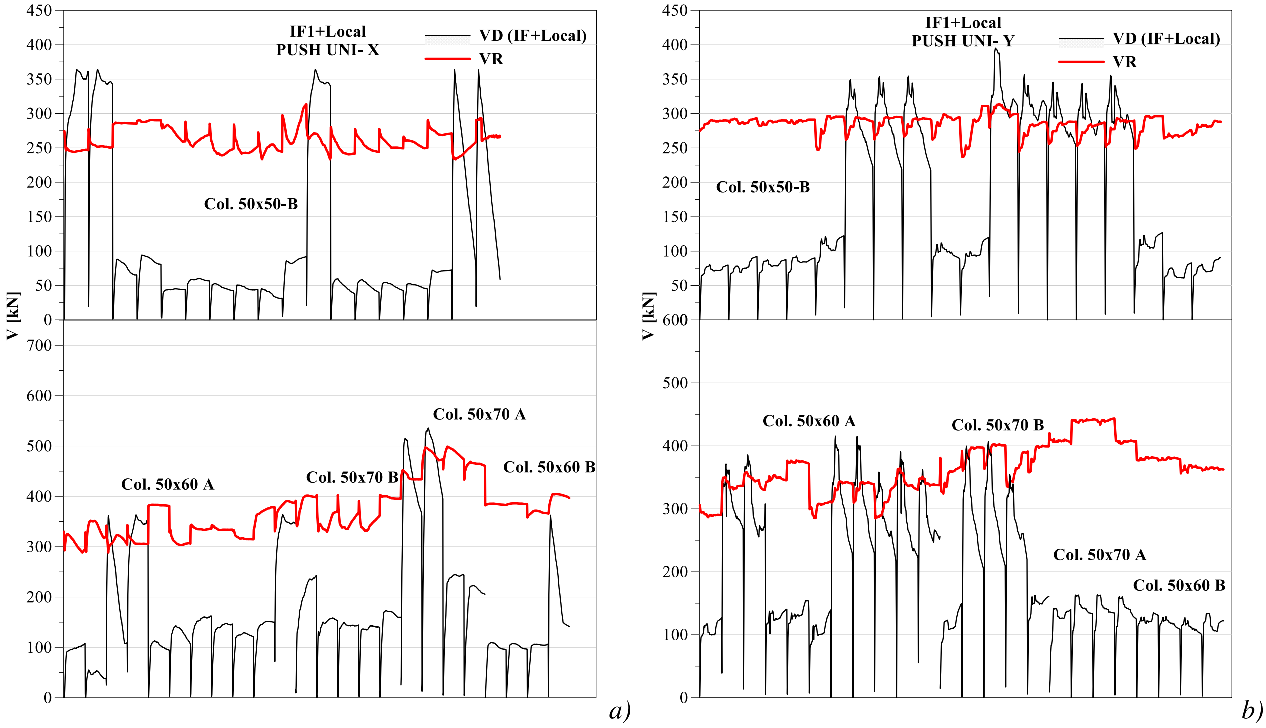


Figure ~~16~~ 18. Comparison between shear demand and capacity of columns according to IF+Local model: *a)* Pushover along X direction; *b)* Pushover along Y direction.

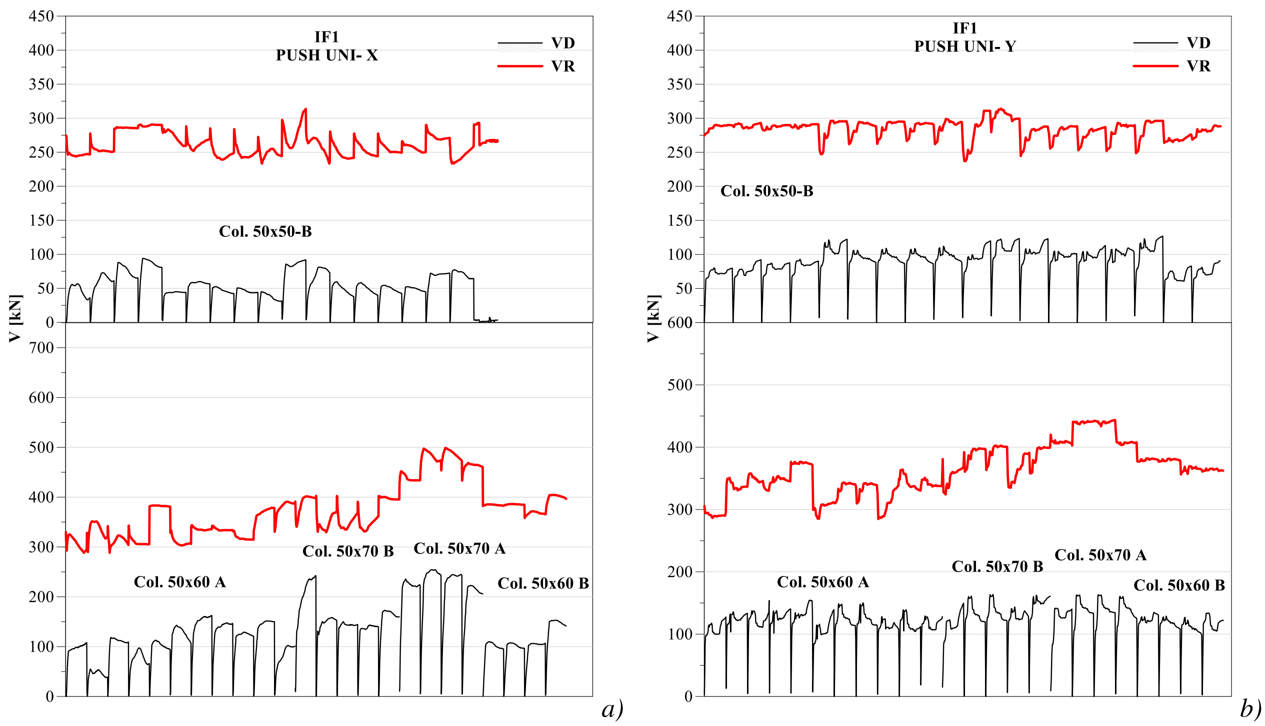


Figure 19. Comparison between shear demand and capacity of columns according to IF model: *a)* Pushover along X direction; *b)* Pushover along Y direction.

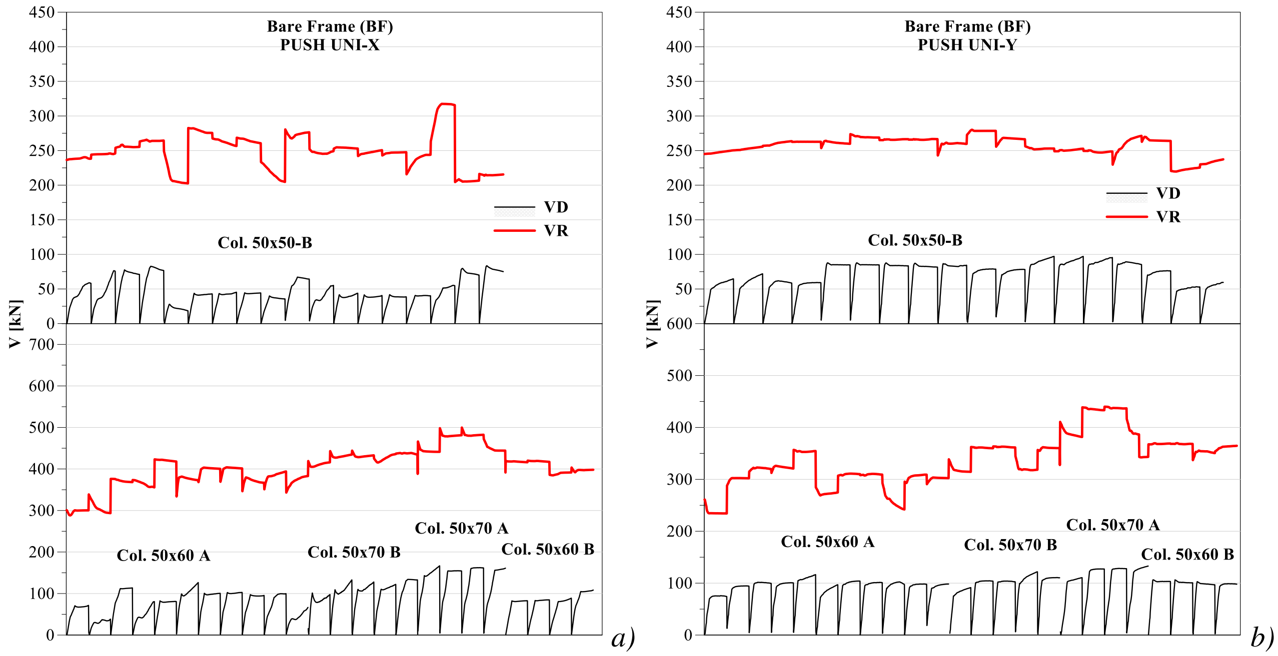


Figure 20. Comparison between shear demand and capacity of columns according to BF model: *a)* Pushover along X direction; *b)* Pushover along Y direction.

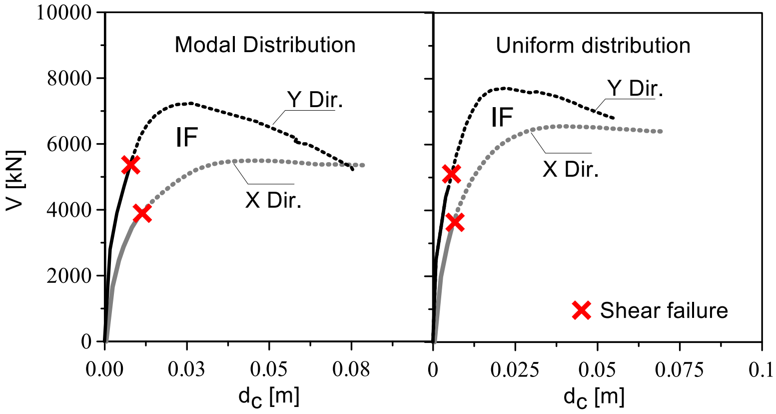


Figure 21. Localization of the first shear failure on the capacity curve.

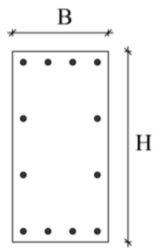
TABLES

Table 1. Typical reinforcement of beam ends (diameters expressed in mm)

Dimensions B X H (cm)	A's (Top)	A_s (Bottom)	Beam connections
First storey			
50x40	6 Φ 14	6 Φ 14	9-15 15-19 19-22 22-25 25-28 28-31 31-34 34-37 37-40 11-17 17-20 20-23 23-26 26-29 29-32 32-35 35-38 38-41
50x40	5 Φ 14	5 Φ 14	1-2 2-3 3-4 4-5 5-6 18-21 21-24 24-27 27-30 30-33 33-36 36-39 39-42
50x45	5 Φ 14	5 Φ 14	7-8 8-9 9-10 10-11 11-12
50x50	7 Φ 16	4 Φ 16	5-11 6-12
50x50	5 Φ 14	5Φ 14	13-14 14-15 15-16 16-17 17-18 23-24 29-30 34-35 35-36 41-42 7-13 12-18
50x60	5 Φ 16	3 Φ 16	22-23 28-29 40-41 1-7
50x75	6 Φ 14	4 Φ 14	3-9.
Second storey			
50x40	6 Φ 14	6 Φ 14	9-15 15-19 19-22 22-25 25-28 28-31 31-34 34-37 37-40 11-17 17-20 20-23 23-26 26-29 29-32 32-35 35-38 38-41
50x40	5 Φ 14	5 Φ 14	1-2 2-3 3-4 4-5 5-6 18-21 21-24 24-27 27-30 30-33 33-36 36-39 39-42
50x45	5 Φ 14	5 Φ 14	7-8 8-9 9-10 10-11 11-12 15-16 16-17 17-18
50x50	5 Φ 14	5Φ 14	13-14 14-15 23-24 29-30 35-36 41-42 7-13 5-11 6-12 12-18
50x60	5 Φ 16	3 Φ 16	22-23 28-29 34-35 40-41 1-7 3-9
Third storey			
40x40	4 Φ 14	4 Φ 14	17-18 23-24 29-30 35-36 41-42
40x45	6 Φ 14	6 Φ 14	17-20 20-23 23-26 26-29 29-32 32-35 35-38 38-41
40x45	4 Φ 14	4 Φ 14	15-19 19-22 22-25 25-28 28-31 31-34 34-37 37-40 18-21 21-24 24-27 30-33 33-36 36-39 39-42
40x60	4 Φ 14	4Φ 14	15-17 23-23 28-29 34-35 40-41

Table 2. Typical reinforcement of columns (diameters in mm)

Dimensions B X H (cm)	Type*	$A_{s,B}$	$A_{s,H}$
	First storey		
50x70	A	6 Φ 20	6 Φ 20
50x70	B	6 Φ 20	4 Φ 20
50x60	A	6 Φ 20	4 Φ 20
50x60	B	5Φ 20	4 Φ 20
50x50	B	4 Φ 18	4 Φ 18
	Second storey		
50x60	A	6 Φ 20	4 Φ 20
50x50	B	4 Φ 18	4 Φ 18
40x50	A	4 Φ 18	4 Φ 18
50x60	C	4 Φ 18	6 Φ 18
	Third storey		
40x50	A	4 Φ 18	4 Φ 18
40x40	A	4 Φ 18	4 Φ 18



*This column indicates different reinforcement typologies for cross sections having same dimensions.

Table 3. Classification of infills typologies

	Typologies of infill			
Geometrical features	T1	T2	T3	T4
Length (m)	2.70 - 3.40	3.40 - 4.30	6.90	6.90
Height (m)	3.40	3.40	3.40	3.40
Openings	Yes	Yes	No	Yes

Table 4. Experimental mechanical parameters of masonry infills.

Infill type	E_m [MPa]	G_m [MPa]	f_{v0m} [MPa]
IF	6450	2540	0.36

Table 5. Parameters identifying equivalent strut constitutive laws.

Infill typology	$\alpha_v = \ell_v / \ell$	*w/d*	F_1 (kN)	F_2 (kN)	δ_1 (mm)	δ_2 (mm)	δ_u (mm)
					D_1 (%)	D_2 (%)	D_u (%)
T1	0.26	0.231	151.5	275.4	0.41	3.17	25.37
					0.020	*0.150*	*1.20*
T2	0.35	0.193	148.65	249.5	0.46	3.63	29.06
					0.019	*0.150*	*1.20*
T3	0.00	0.273	307.4	558.9	0.66	9.15	91.50
					0.022	*0.300*	*3.00*
T4	0.35	0.177	199.41	362.5	0.66	4.57	36.60
					0.022	*0.150*	*1.20*

Table 6. Spectral parameters.

Limit state	**PGA**	F_0	T_c*	**S**	T_B	T_C	T_D
Near Collapse (NC)	0.359	2.411	0.363	1.180	0.177	0.532	3.036

Table 7. Parameters for the equivalent SDOF system bilinear response.

	DIR. X MODAL	**DIR. X UNIF**	**DIR. Y MODAL**	**DIR. Y UNIF**
k^* [kN/m]	399525.72	515533.64	737682.82	976385.62
m^* [kNs^2/m]	1110.59	1110.59	1389.29	1389.29
T^* [s]	0.331	0.291	0.273	0.237
F^*_y [kN]	4106.292	4900.911	5204.514	5656.083
d^*_y [m]	0.010	0.010	0.007	0.006
S_{ay} [g]	0.370	0.441	0.375	0.407
Γ_1	1.28		1.32	

Table ~~7~~8. Shear distribution coefficient for the infills and related parameters.

Infill typology	λ^*	f_{v0m} (MPa)	ξ	α_{CSE}
T1	1.59	0.36	1.0	1.25
T2	1.25	0.36	1.0	1.36
T3	0.92	0.36	1.0	1.51
T4	0.92	0.36	1.0	1.51

Table ~~8~~9. Geometrical properties of ground level columns.

Column Type	b *(mm)*	h *(mm)*	d *(mm)*	A_s / i *(mm^2/m)*	ρ_l -
50x 50 B	500	500	470	0.4	0.0122
50 x 60 A	500	600	570	0.4	0.0147
50 x 60 B	500	600	570	0.4	0.0167
50 x 70 A	500	700	670	0.4	0.0179
50 x 70 B	500	700	670	0.4	0.0144