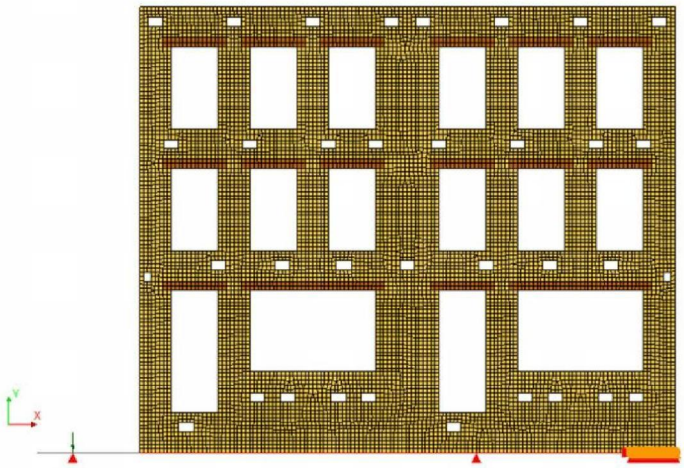


Figure B2. FE model of the scaled façade.

In order to select the most appropriate material model and set of properties to model the masonry material of façades subjected to settlement, a sensitivity study is conducted on this aspect. Two material models are selected and employed: the orthotropic Engineering Masonry Model (EMM) and the isotropic Total Strain Rotating Crack Model (TSRCM). The former accounts for cracking, crushing and shearing failure. In addition, the EMM differentiates the tensile failure in the horizontal, vertical and diagonal direction. The TSRCM computes the two failure mechanisms (i.e. tensile and compressive failures) in the principal directions.

An important aspect that differs between the two models is the evaluation of the head-joint (vertical) cracking. For this type of failure, the TSRCM only relies on the assigned tensile strength. The head-joint failure of the EMM is defined by friction instead. This means that in addition to the defined minimum head-joint strength, also the shearing properties contribute to the strength. Such properties are cohesion and friction angle. The shear resistance along the head-joint failure is a function of the vertical loading acting above the investigated masonry portion. All these factors play a role on the final head-joint strength and to the vertical cracking. A picture that summarizes this concept is depicted in Figure B3. Since the failure mechanism is mainly based on vertical cracking produced by rotation (Figure B4), a sensitivity study on the material properties that enhance this effect is conducted.

The base material properties for the masonry employed in the model are listed in Table B1 and Table B2 for the Engineering Masonry Model and Total Strain Rotating Crack Model respectively. These parameters are based on experimental small scale tests conducted before the test of the façade. Such values are also employed in the numerical model of Giardina. In addition, five model variations of EMM and two of TSRCM are investigated. The calibration against the experiment is validated by varying the tensile strengths, cohesion

and friction angle parameters. The summary of the material parameters of the seven variations are reported in Table B3. Elastic material properties of timber and steel material are shown in Table B4. The ones of the interface between steel and masonry are reported in Table B5. All materials are based on the ones employed by Giardina in her numerical models.

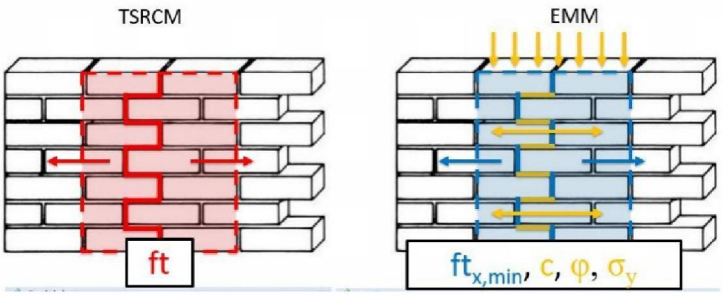


Figure B3. Head-joint failure for the two selected masonry models. TSRCM (left) and EMM (right).

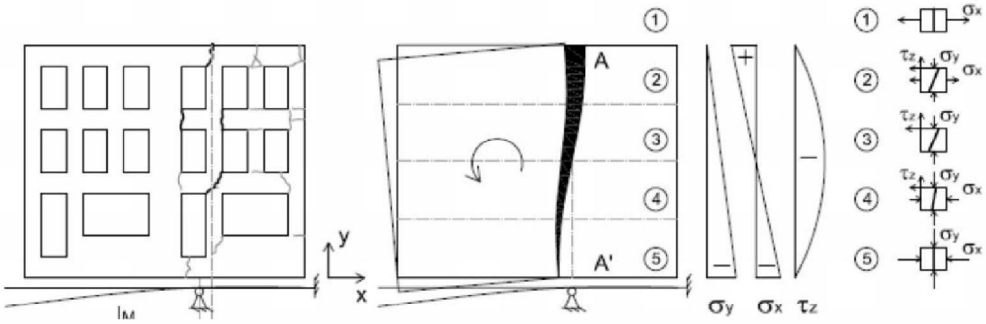


Figure B4. Failure mechanism of the experimental façade [6].

Table B1. Engineering Masonry Model material properties employed in model (EMM1).

Property	Unit	EMM 1
Young's modulus vertical direction E_y	MPa	3000
Young's modulus horizontal direction E_x	MPa	1500
Shear modulus G_{xy}	MPa	1250
Bed joint tensile strength ft_y	MPa	0.10
Minimum head-joint strength ft_x	MPa	0.30
Fracture energy in tension $G_{t,I}$	N/mm	0.010
Angle between stepped crack and bed-joint α	rad	0.5
Compressive strength f_c	MPa	11.4
Fracture energy in compression G_c	N/mm	20
Factor to strain at compressive strength	-	3
Unloading factor	-	Secant
Friction angle ψ	rad	0.26

Cohesion c	MPa	0.03
Fracture energy in shear Gs	N/mm	0.1
Crack bandwidth specification	-	Rots
Mass Density	Kg/m^3	1900

Table B2. Masonry material properties employed in the model. Total Strain Rotating Crack Model 1.

Property	Unit	TSRCM 1
Young's modulus E	MPa	3000
Poisson's ratio υ	-	0.2
Tensile strength f_t	MPa	0.10
Fracture energy in tension $G_{t,I}$	N/mm	0.01
Compressive strength f_c	MPa	11.4
Mass density	Kg/m^3	1900

Table B3. Masonry material variations of EMM and TSRCM.

Property	Tensile strength f_t [MPa]	Fracture energy in tension $G_{t,I}$ [N/mm]	Minimum head-joint strength ft_x [MPa]	Cohesion c [MPa]	Friction angle ψ [rad]
EMM1	0.10	0.01	0.30	0.03	0.26
EMM2	0.10	0.01	0.30	0.15	0.60
EMM3	0.10	0.01	0.15	0.15	0.60
EMM4	0.10	0.01	0.15	0.03	0.26
EMM5	0.10	0.01	0.10	0.03	0.26
TSRCM1	0.10	0.01	-	-	-
TSRCM2	0.15	0.022	-	-	-

Table B4. Timber and Steel elastic material properties employed in the model.

Property	Unit	Timber	Steel
Young's modulus E	MPa	11000	210000
Poisson's ratio υ	-	0.15	0.3
Mass density	Kg/m^3	500	7500

Table B5. Interface material properties employed in the connection masonry-steel in the model. Discrete cracking model.

Property	Unit	Value
Normal stiffness k_n	N/mm^3	0.7
Tangential stiffness k_t	N/mm^3	0.0007
Tensile strength f_t	MPa	0
Mode-I tension softening criterion	-	Brittle

The calibration of the FE model against the experimental façade is carried out by comparing horizontal and vertical displacement at two performance points, failure mechanism, crack pattern and crack width evolution.

The results in terms of applied vertical displacement against vertical and horizontal façade displacement are shown in Figure B5 and Figure B6 respectively. The result view is split according to the different employed constitutive materials. The plots also show the numerical model of Giardina (continuum and discrete). Both horizontal and vertical displacement of the façade, when TSRCMs are employed, are slightly overestimated with respect to the experimental results. The outcomes of vertical displacement are independent from the tensile strength, while a difference is detected for the horizontal displacement once the applied settlement exceeds 5 mm. The overestimation is mainly provided by the different failure mechanism, which involves two main overall vertical cracks that go from the top to the bottom, splitting the façade in three parts. The experiment mainly involves a rigid rotation of the left part of the façade, with a complete vertical crack that runs top-bottom approximately above the mid support. Some additional horizontal flexural cracks are reported at base and top of the masonry piers at the right side of the façade. The cracking produced by the numerical models at 10 mm of applied displacement is depicted in Figure B7.

Figure B5 (right) also shows the comparison of the EMM models against the experiment. The difference between the model with experimental cohesion (c=0.03 MPa) and the cohesion selected as recommendation for the EMM (1.5 times the bed-joint tensile strength, [15]). The latter option is the one closer to the experiment, while the former slightly overestimates the vertical displacement. Similar outcome is obtained for the horizontal displacement results (Figure B6) where the models with higher cohesion better approximate the experiment. Differently from the TSRCM, the EMM models show a bit more flexural cracking at the base and at the top of the pier at the left side of the building, especially when a higher cohesion is employed. Vertical cracking is often shifted to the right side of the building in the variations that employ low cohesion value and minimum head joint strength lower than 0.3 MPa. Above this limit instead, the crack pattern results more in line with the experiment, although the FE recorded displacements are a bit off. The models with high

cohesion (EMM2 and EMM3) show vertical cracking concentrated to the right side of the building in direction of the support (Figure B8).

When looking at evolution of crack width in the experiment and in the model (Figure B9). The crack width of the TSRCMs, which is interpreted from the largest vertical crack, is quite conservative with respect to the experimental one. At a deflection ratio of 1.25 x 10^{-3}, the crack width computed in the model with tensile strength equal to 0.1 MPa is almost double respect to the experimental one. The model with higher tensile strength is too conservative as well. Using this model approach for façades that involve mainly vertical cracking, would largely overestimate the crack width (and thus the damage state) of a façade. Such a model is in fact unable to distinguish between head-joint and bed-joint failure. When looking at the evolution of the crack width of the façade modelled with EMM (Figure B9), the values of maximum crack width are much closer to the experimental ones. From the model with cohesion equal to 0.15 MPa, the one with minimum head-joint tensile strength equal to the cohesion (EMM3, dashed green line) is the one that better approximates the experimental curve, especially up to crack width of 3 mm. After this point (reached at about 2.25 x 10^{-3}), when very severe damage occurs, the crack width results are a bit underestimated with respect to the experimental one. For crack values between 0.5 and 1.6 mm, the model slightly overestimates the maximum achieved crack. Although the model EMM1 ($f_{tx,min}$=0.3 MPa and c=0.03 MPa) shows good agreement with respect to the overall crack pattern, the maximum crack width appears to be on the non-conservative side when cracking is between 0.5 and 2.5 mm.

In conclusion, the masonry façade modelled with the Engineering Masonry Model with a cohesion value equal to the minimum head-joint tensile strength and equal to 1.5 times the bed-joint tensile strength exhibit the closest results to the experimental façade of Giardina [6] in terms of displacement, crack pattern and crack width.

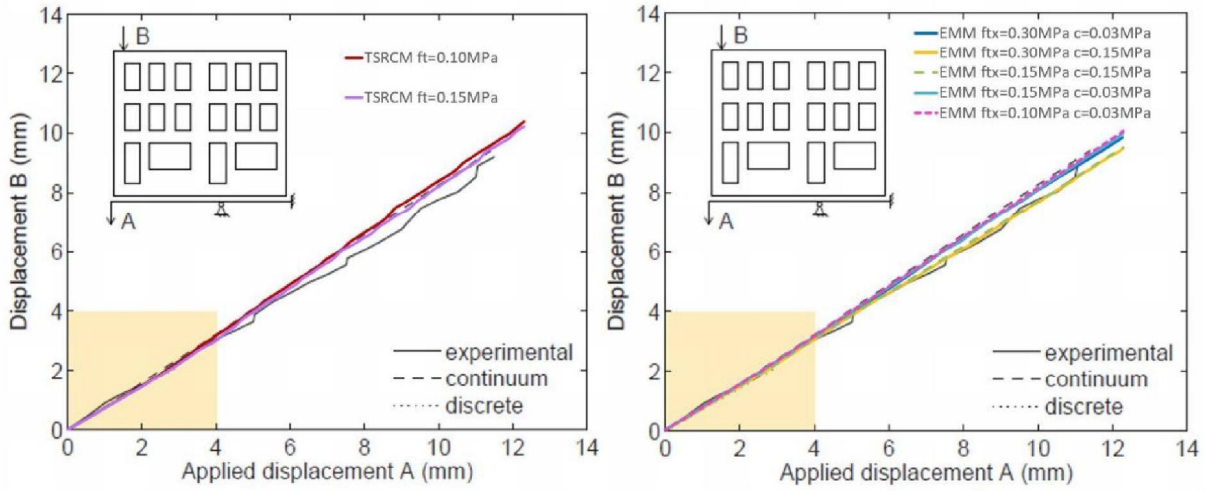


Figure B5. Applied against façade vertical displacement. Experimental vs Giardina's FE model (continuum and discrete) vs TSRCMs (left) and EMMs (right) [6].

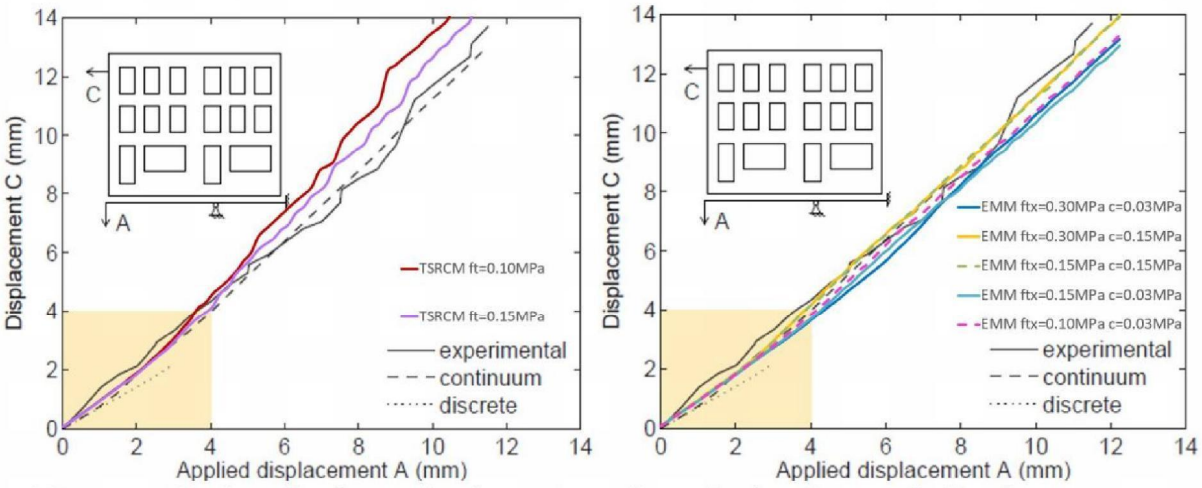


Figure B6. Applied vertical against façade horizontal displacement. Experimental vs Giardina's FE model (continuum and discrete) vs TSRCMs (left) and EMMs (right) [6].

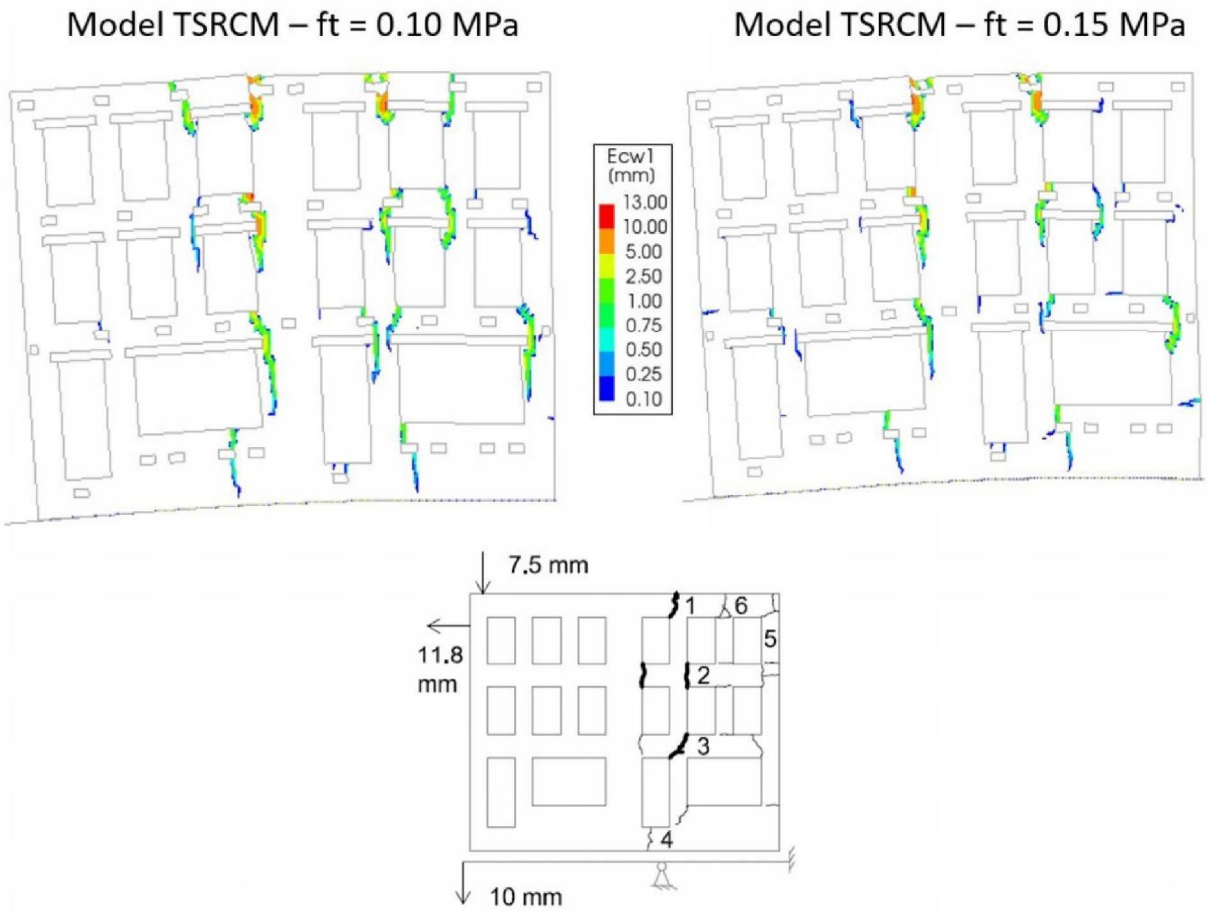


Figure B7. Failure mechanism of the models employing the TSRCM and the experimental façade [6]. Principal crack width is reported at applied settlement of 10 mm.

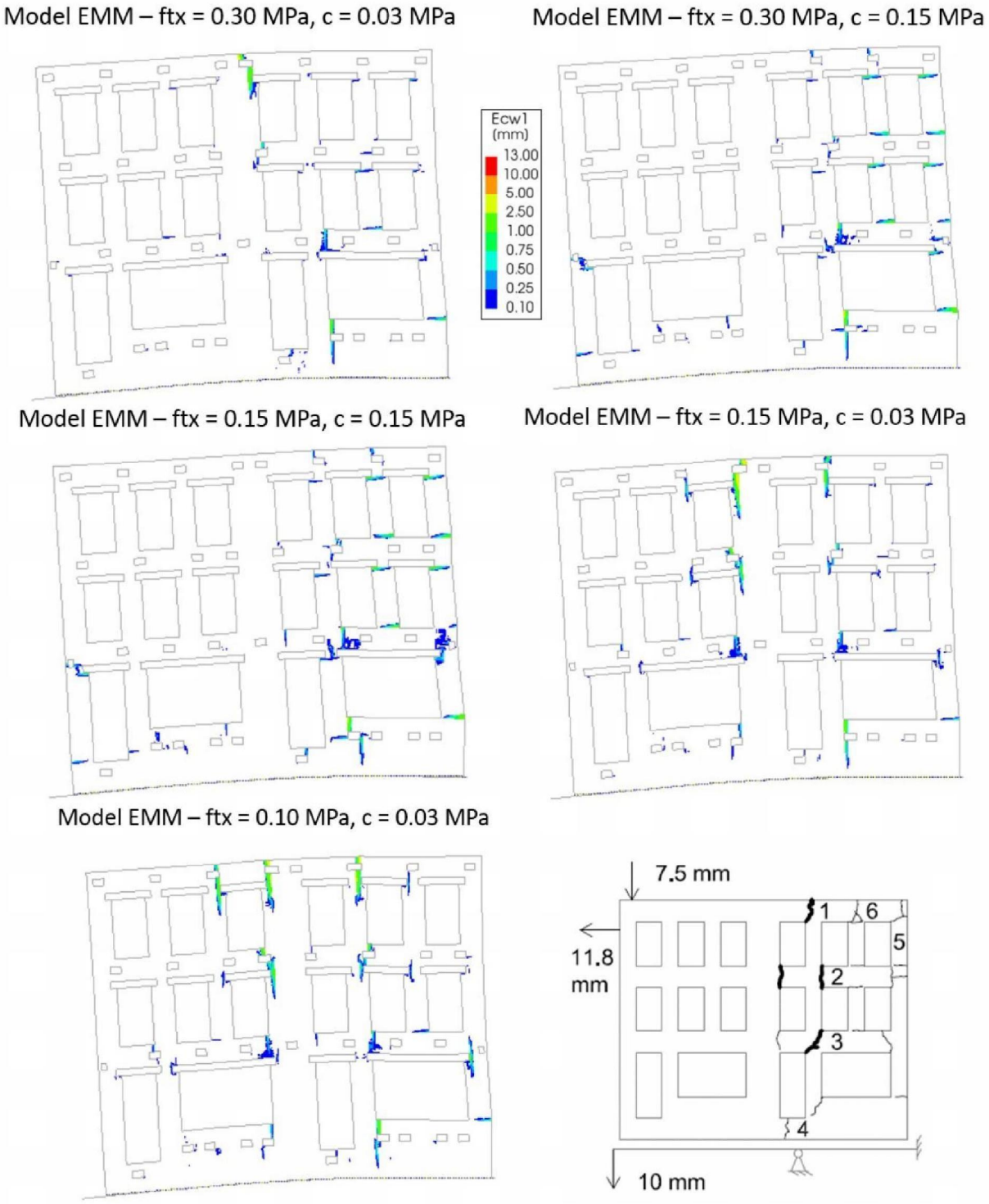


Figure B8. Failure mechanism of the models employing the EMM and the experimental façade [6]. Principal crack width is reported at applied settlement of 10 mm.

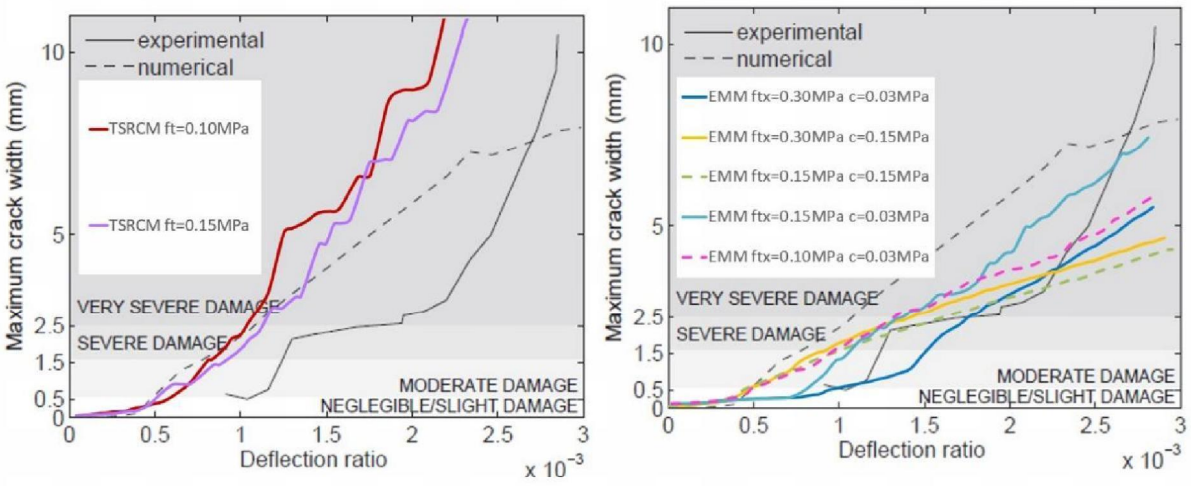


Figure B9. Deflection ratio against max crack width. Experimental vs Giardina's FE model vs TSRCMs (left) and EMMs (right) [6].

Appendix C: Foundation type

The North-East part of the Netherlands is characterized by relatively good soil in respect to the west side of the country. In fact, sandy soil at shallow depth is largely present in the Groningen area (Figure C1). Such type of soil allows for the use of shallow foundations, especially for low-rise buildings. In the past this method was also implemented on (sea) clay soil. In the Groningen area, a quite high percentage of buildings is thus built on shallow foundations (or "fundering op staal" in Dutch), about 85% (Figure C2).

The shallow foundations of masonry structures can be divided in different typologies: a masonry foundation, a concrete foundation or a concrete strip foundation (Figure C3). With the masonry foundation used in older structures and the strip foundations in newer structures.

The minimum depth for these foundations is 60 cm in order to avoid problems related to freezing. Two different foundation typologies are employed in the numerical study of the main report, the masonry foundation and the strip foundation depicted in Figure C3-d. The former is mainly employed for buildings before 1945 while the latter is modelled underneath more recent façades.

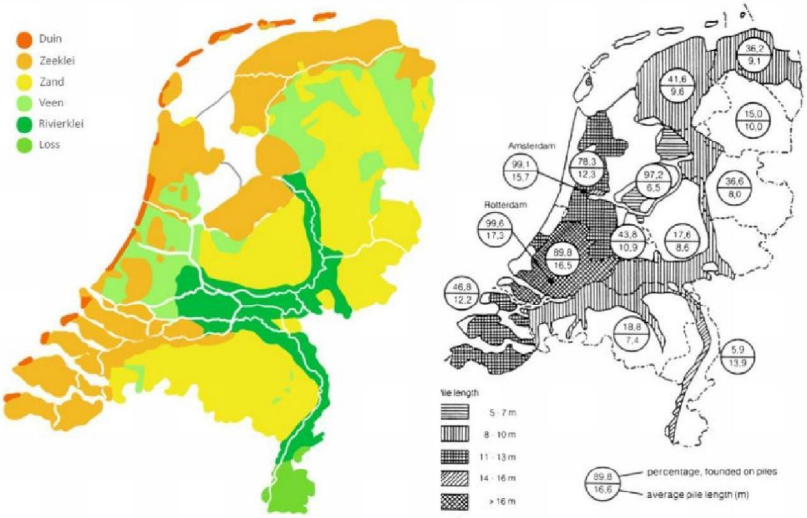
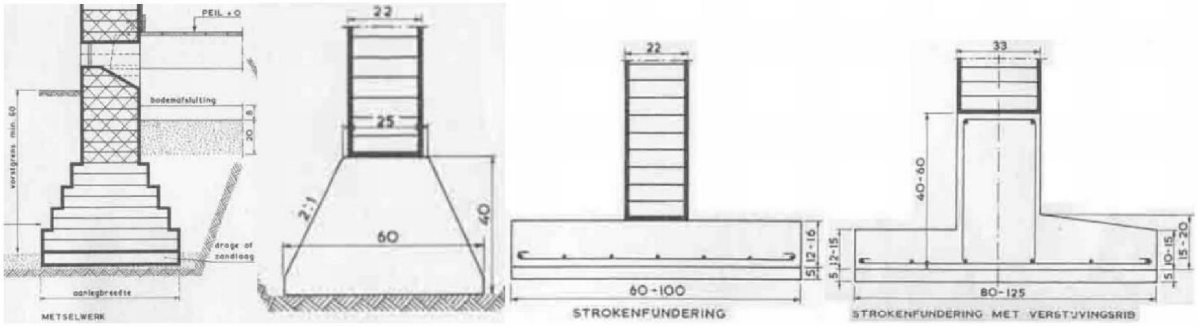


Figure C1. Left - Soil type Netherlands [18].
Figure C2. Right - Percentage of structure founded on piles. Clearly shown: the high amount of shallow foundations in the North of the country.



(a) (b) (c) (d)

Figure C3. Shallow foundation typologies. Masonry foundation (a), concrete foundation (b) and strip foundations (c, d) [19].

The modelling of the different foundations employed in the models is schematized in Figure C4. The masonry shallow foundation is modelled as a beam of 60x60 cm. Reinforced concrete strip foundations are modelled as T beam. The base dimension differs according to the length of the façade. A width of 57 or 159 cm is used. The former is mainly employed for longitudinal façades, while the latter is mainly present underneath massive transversal walls. The dimensions of the foundations are taken from original drawings. The steel reinforcement is modelled with line reinforcement with an equivalent thickness. The amount of bars and their diameter is also taken from original drawings. The materials of the foundations are modelled as non-linear. Material properties are defined in Appendix A.

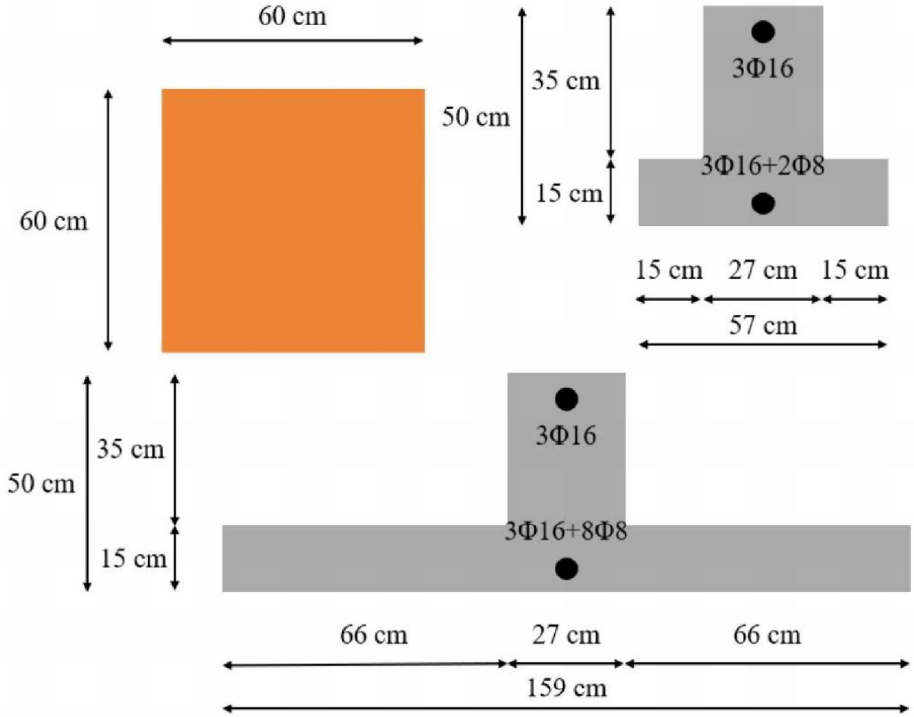
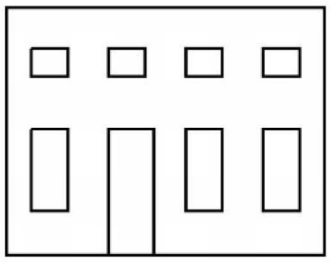
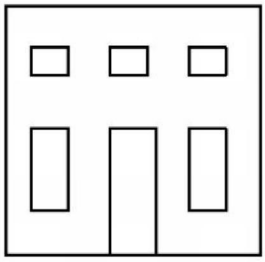
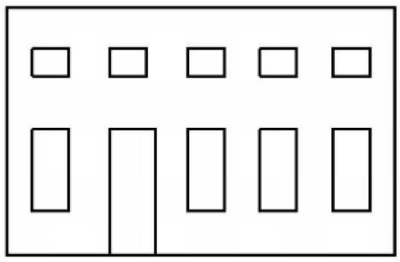
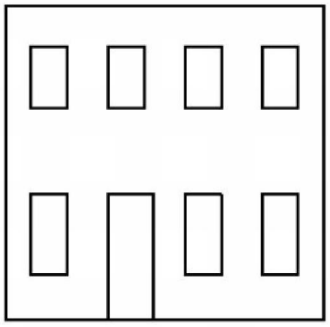
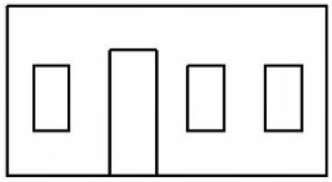
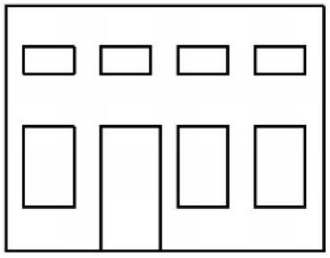
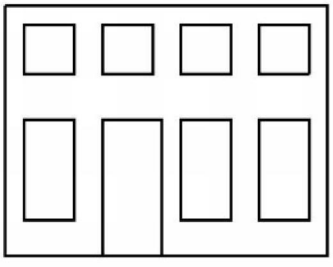
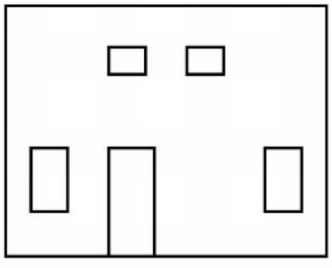
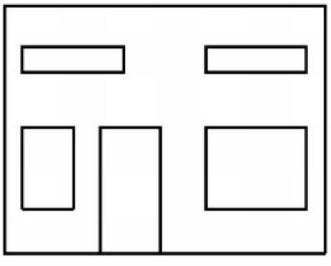


Figure C4. Schematization of different foundations employed in models. In orange, masonry and in grey, concrete.

Appendix D: FEM Results

The results of the FE analyses are here summarized and presented. The results are subdivided for façade typology.

Façade 1

		
Façade 1 – A 7.00 x 5.50 m L/H = 1.27 Opening % = 23.5%	Façade 1 – B 5.50 x 5.50 m L/H = 1.00 Opening % = 23.5%	Façade 1 – C 8.48 x 5.50 m L/H = 1.54 Opening % = 23.5%
		
Façade 1 – D 7.00 x 7.00 m L/H = 1.00 Opening % = 23.5%	Façade 1 – E 7.00 x 3.80 m L/H = 1.84 Opening % = 23.5%	Façade 1 – F 7.00 x 5.50 m L/H = 1.27 Opening % = 31.7%
		
Façade 1 – G 7.00 x 5.50 m L/H = 1.27 Opening % = 41.6%	Façade 1 – H 7.00 x 5.50 m L/H = 1.27 Opening % = 14.5%	Façade 1 – I 7.00 x 5.50 m L/H = 1.27 Opening % = 31.7% (Large)

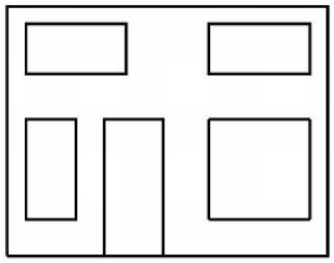
		
Façade 1 – J 7.00 x 5.50 m L/H = 1.27 Opening % = 41.6% (Large)		

Figure D1. Ten geometry variations of Façade 1.

Table D1. Percentage of models that reach a specific damage level. Geometric variation of Façade 1.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F1-A	96.7%	85.8%	67.5%	55.8%	49.2%	49.2%
F1-B	85.0%	63.3%	46.7%	30.8%	25.0%	25.0%
F1-C	99.2%	95.8%	85.0%	73.3%	62.5%	62.5%
F1-D	95.0%	84.2%	63.3%	53.3%	43.3%	43.3%
F1-E	96.7%	84.2%	70.8%	58.3%	58.3%	58.3%
F1-F	99.2%	95.8%	83.3%	71.7%	70.8%	70.8%
F1-G	100.0%	98.3%	91.7%	83.3%	81.7%	81.7%
F1-H	92.5%	75.0%	55.8%	42.5%	36.7%	36.7%
F1-I	98.3%	95.8%	85.0%	82.5%	82.5%	82.5%
F1-J	100.0%	98.3%	92.5%	90.8%	90.8%	90.8%

Table D2. Percentage of models that reach a specific damage level. Soil and interface variations of Façade 1.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	98.3%	91.3%	77.8%	68.5%	64.3%	64.3%
Soil B	94.3%	84.1%	70.6%	60.1%	55.9%	55.9%

Interface	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Low kn	90.0%	74.5%	57.8%	45.0%	42.8%	42.8%
Original kn	99.0%	93.0%	78.3%	69.8%	65.0%	65.0%
High kn	99.8%	95.5%	86.5%	78.0%	72.5%	72.5%

Table D3. Percentage of models that reach a specific damage level. Material variations of Façade 1.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	99.6%	98.8%	97.9%	94.2%	90.0%	90.0%
Sl Weak	98.8%	96.7%	90.8%	79.2%	76.7%	76.7%
Standard	97.1%	90.0%	77.9%	66.3%	62.5%	62.5%
Sl Strong	95.4%	82.9%	62.5%	49.6%	46.3%	46.3%
Strong	90.4%	70.0%	41.7%	32.1%	25.0%	25.0%

Table D4. Percentage of models that reach a specific damage level. Settlement variations of Façade 1.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	98.7%	93.2%	83.3%	75.0%	71.2%	71.2%
Symmetric	93.8%	82.2%	65.0%	53.5%	49.0%	49.0%

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	99.7%	96.3%	87.3%	81.0%	77.3%	77.3%
Asym L/5	97.7%	90.0%	79.3%	69.0%	65.0%	65.0%
Sym L/2	99.7%	95.7%	86.0%	77.0%	71.7%	71.7%
Sym L/4	88.0%	68.7%	44.0%	30.0%	26.3%	26.3%

Table D5. Percentage of models that reach a specific damage level. L/H variations. Façade 1.

L/H	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
L/H=1.00	90.4%	74.1%	55.2%	42.3%	34.3%	34.3%
L/H=1.27	96.7%	85.8%	67.5%	55.8%	49.2%	49.2%
L/H=1.54	99.2%	95.8%	85.0%	73.3%	62.5%	62.5%
L/H=1.84	96.7%	84.2%	70.8%	58.3%	58.3%	58.3%

Table D6. Percentage of models that reach a specific damage level. Size effect variations. Façade 1.

Size Effect	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
L=H=5.5	85.0%	63.3%	46.7%	30.8%	25.0%	25.0%
L=H=7.0	95.0%	84.2%	63.3%	53.3%	43.3%	43.3%

Table D7. Percentage of models that reach a specific damage level. Opening % variations. Façade 1.

Opening %	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
14.5%	92.5%	75.0%	55.8%	42.5%	36.7%	36.7%
23.5%	96.7%	85.8%	67.5%	55.8%	49.2%	49.2%
31.7%	99.2%	95.8%	83.3%	71.7%	70.8%	70.8%
41.6%	100.0%	98.3%	91.7%	83.3%	81.7%	81.7%

Table D8. Percentage of models that reach a specific damage level. Opening % and large opening variations. Façade 1.

Large Open	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
31.7% - N	99.2%	95.8%	83.3%	71.7%	70.8%	70.8%
41.6% - N	100.0%	98.3%	91.7%	83.3%	81.7%	81.7%
31.7% - Y	98.3%	95.8%	85.0%	82.5%	82.5%	82.5%
41.6% - Y	100.0%	98.3%	92.5%	90.8%	90.8%	90.8%

Table D9. Percentage of models that reach a specific damage level. Façade 1.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F1	96.3%	87.7%	74.2%	64.3%	60.1%	60.1%

Table D10. Measured value of β^{-1}. Geometry variations of Façade 1.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F1-A	10138	6361	4334	3143	2390	1941
F1-B	7681	4125	2705	1950	1487	1215
F1-C	11441	7351	5122	3774	2913	2389
F1-D	8670	5527	3794	2764	2102	1690
F1-E	12166	7427	5201	3944	3154	2706
F1-F	8904	5598	3996	3052	2436	2044
F1-G	8320	5313	3811	2933	2375	2049
F1-H	10885	6486	4462	3320	2612	2187
F1-I	9069	5519	3958	3041	2432	2009
F1-J	7987	5098	3691	2833	2251	1839

Table D11. Measured value of β^{-1}. Soil and interface variations of Façade 1.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	9901	6185	4341	3261	2566	2125
Soil B	9151	5576	3874	2890	2265	1889

Interface	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Low kn	8359	4829	3283	2412	1864	1551
Original kn	9930	6279	4379	3249	2522	2076
High kn	10290	6534	4660	3566	2860	2393

Table D12. Measured value of β^{-1}. Material of Façade 1.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	7656	5290	3952	3018	2356	1963
Sl Weak	8741	5834	4195	3179	2511	2105
Standard	9671	6198	4386	3314	2630	2200
Sl Strong	10478	6246	4252	3161	2489	2068
Strong	11084	5835	3752	2705	2091	1698

Table D13. Measured value of β^{-1}. Settlement variations of Façade 1.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	9449	5895	4061	2990	2310	1900
Symmetric	9603	5866	4154	3161	2521	2114

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	9418	5892	4069	3016	2349	1959
Asym L/5	9480	5898	4053	2964	2271	1841
Sym L/2	10429	6709	4828	3703	2969	2521
Sym L/4	8806	5040	3491	2629	2080	1712

Table D14. Measured value of β^{-1}. L/H ratio variations of Façade 1.

L/H	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
L/H=1.00	8210	4846	3263	2367	1802	1459
L/H=1.27	10138	6361	4334	3143	2390	1941
L/H=1.54	11441	7351	5122	3774	2913	2389
L/H=1.84	12166	7427	5201	3944	3154	2706

Table D15. Measured value of β^{-1}. Size effect variations of Façade 1.

Size Effect	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
L=H=5.5	7681	4125	2705	1950	1487	1215
L=H=7.0	8670	5527	3794	2764	2102	1690

Table D16. Measured value of β^{-1}. Opening % variations of Façade 1.

Opening %	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
14.5%	10885	6486	4462	3320	2612	2187
23.5%	10138	6361	4334	3143	2390	1941
31.7%	8904	5598	3996	3052	2436	2044
41.6%	8320	5313	3811	2933	2375	2049

Table D17. Measured value of β^{-1}. Opening % and large opening variations of Façade 1.

Large Open	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
31.7% - N	8904	5598	3996	3052	2436	2044
41.6% - N	8320	5313	3811	2933	2375	2049
31.7% - Y	9069	5519	3958	3041	2432	2009
41.6% - Y	7987	5098	3691	2833	2251	1839

Table D18. Measured value of β^{-1} of Façade 1.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F1	9526	5880	4107	3076	2415	2007

Table D19. Applied value of β^{-1}. Geometry variations of Façade 1.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F1-A	940	421	228	141	97	82
F1-B	477	180	92	55	36	30
F1-C	1417	701	413	274	199	171
F1-D	765	348	185	103	64	46
F1-E	1137	504	303	215	181	178
F1-F	1155	538	324	228	189	181
F1-G	1328	699	451	341	297	287
F1-H	765	302	152	89	57	46
F1-I	1178	615	415	314	262	231
F1-J	1322	744	518	395	325	279

Table D20. Applied value of β^{-1}. Soil and interface variations of Façade 1.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	1322	626	379	263	206	183
Soil B	776	385	238	168	136	123

Interface	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Low kn	93	53	36	28	25	23
Original kn	729	384	241	175	148	139
High kn	2323	1079	647	443	339	298

Table D21. Applied value of β^{-1}. Material variations of Façade 1.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	1418	890	637	490	411	376
Sl Weak	1196	625	383	266	211	189
Standard	1034	465	261	171	127	112
Sl Strong	871	329	165	100	71	60
Strong	725	218	94	51	34	29

Table D22. Applied value of β^{-1}. Settlement variations of Façade 1.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	1137	576	353	247	194	176
Symmetric	961	435	263	185	147	131

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	1549	820	513	360	283	255
Asym L/5	724	332	193	133	106	96
Sym L/2	1581	741	454	321	255	228
Sym L/4	339	128	72	48	38	33

Table D23. Applied value of β^{-1}. L/H ratio variations of Façade 1.

L/H	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
L/H=1.00	623	266	139	79	51	38
L/H=1.27	940	421	228	141	97	82
L/H=1.54	1417	701	413	274	199	171
L/H=1.84	1137	504	303	215	181	178

Table D24. Applied value of β^{-1}. Size effect variations of Façade 1.

Size Effect	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
L=H=5.5	477	180	92	55	36	30
L=H=7.0	765	348	185	103	64	46

Table D25. Applied value of β^{-1}. Opening % variations of Façade 1.

Opening %	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
14.5%	765	302	152	89	57	46
23.5%	940	421	228	141	97	82
31.7%	1155	538	324	228	189	181
41.6%	1328	699	451	341	297	287

Table D26. Applied value of β^{-1}. Opening % and large opening variations of Façade 1.

Large Open	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
31.7% - N	1155	538	324	228	189	181
41.6% - N	1328	699	451	341	297	287
31.7% - Y	1178	615	415	314	262	231
41.6% - Y	1322	744	518	395	325	279

Table D27. Applied value of β^{-1} of Façade 1.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F1	1048	505	308	215	171	153

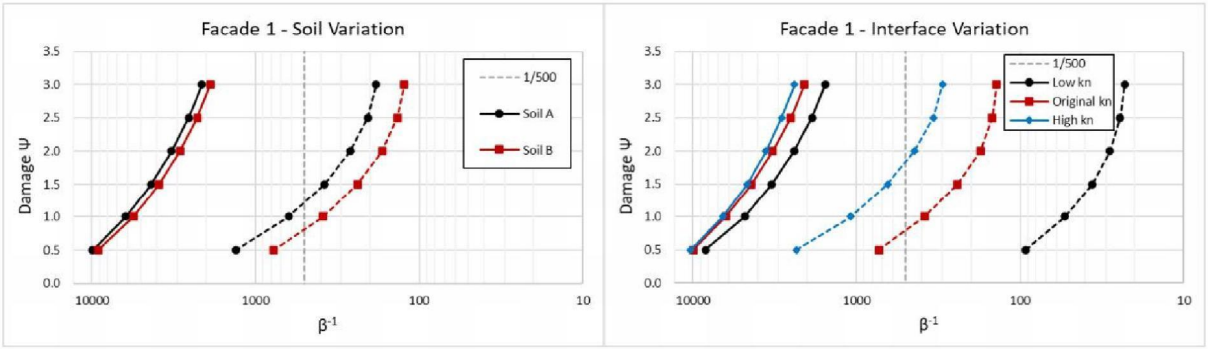


Figure D2. Angular distortion (^-1) against damage of Façade 1. Soil variation (left) and interface variation (right). Dashed lines refers to applied β^{-1}.

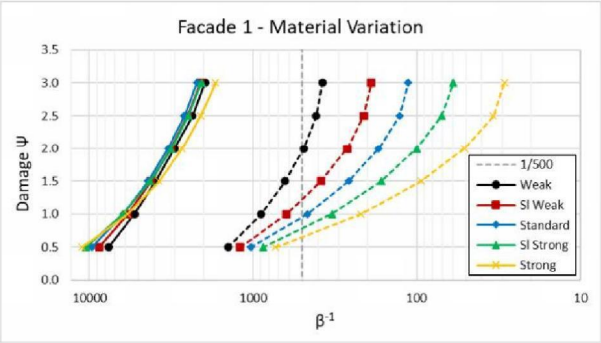


Figure D3. Angular distortion (^-1) against damage of Façade 1. Material variation. Dashed lines refers to applied β^{-1}.

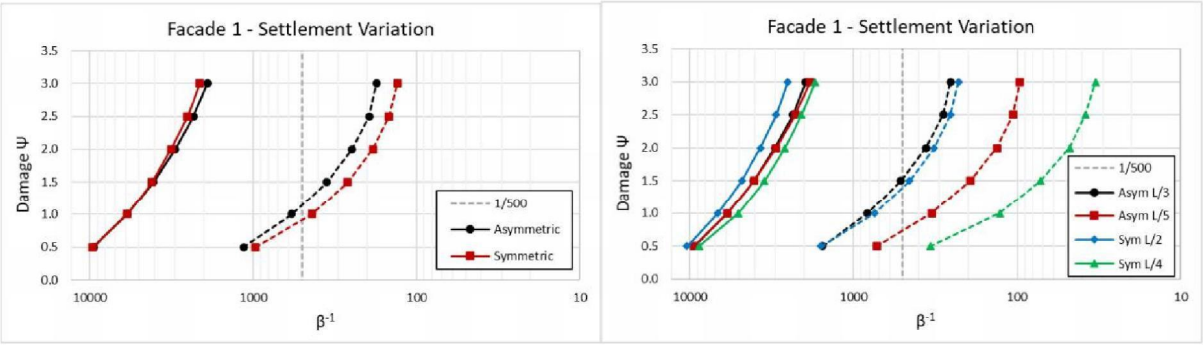


Figure D4. Angular distortion (^-1) against damage of Façade 1. Settlement variation. Dashed lines refers to applied β^{-1}.

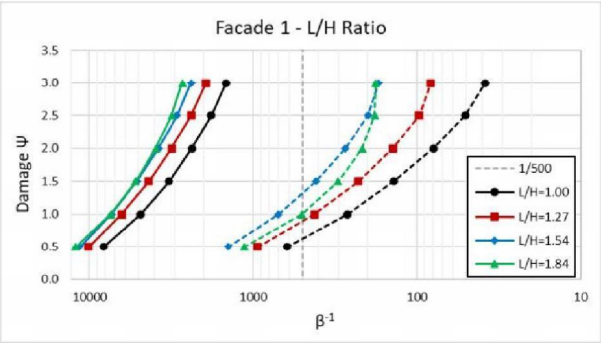


Figure D5. Angular distortion (^-1) against damage of Façade 1. L/H ratio variation. Dashed lines refers to applied β^{-1}.

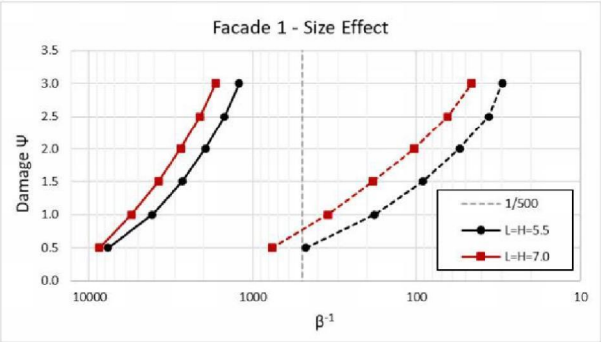


Figure D6. Angular distortion (^-1) against damage of Façade 1. Size effect variation. Dashed lines refers to applied β^{-1}.

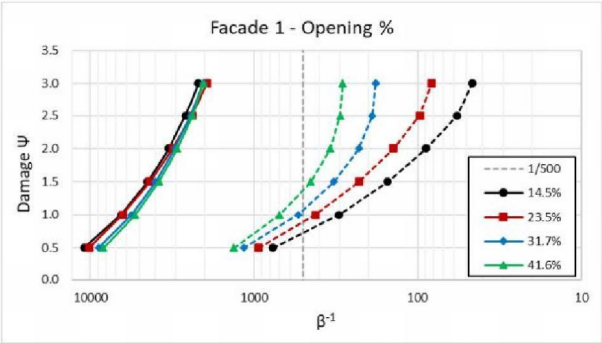


Figure D7. Angular distortion (^-1) against damage of Façade 1. Opening % variation. Dashed lines refers to applied β^{-1}.

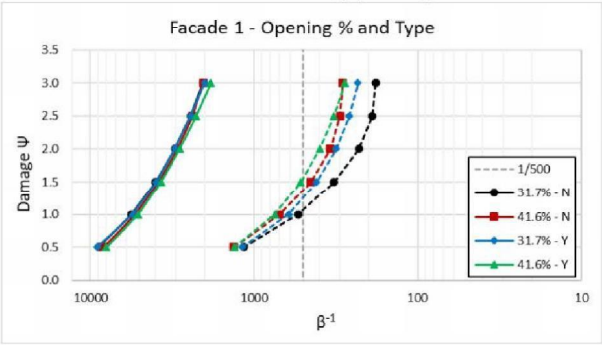


Figure D8. Angular distortion (^-1) against damage of Façade 1. Opening % and type of openings variation. Dashed lines refers to applied β^{-1}.

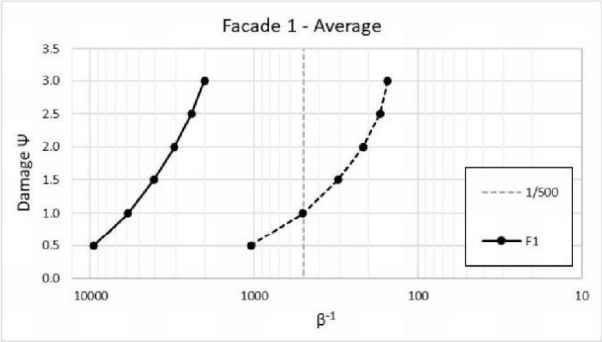
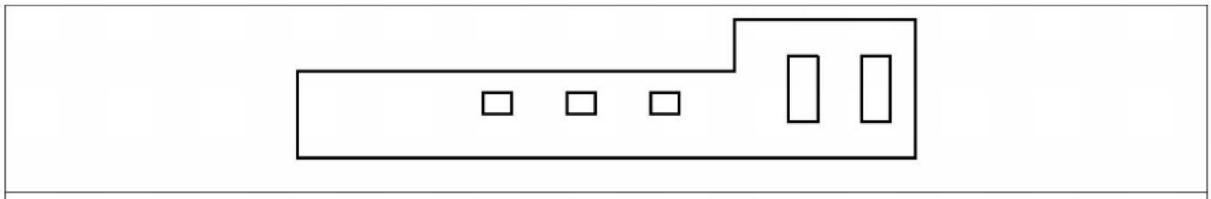


Figure D9. Angular distortion (^-1) against damage of Façade 4. Average results. Dashed lines refers to applied β^{-1}.

Façade 2



Façade 2 – A
12.0 x 2.4 m + 5.0 x 3.6 m
L/H = 5.00
Opening % = 9.0%

Figure D10. Geometry variation of Façade 2.

Table D28. Percentage of models that reach a specific damage level. Façade 2.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F2	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table D29. Measured value of β^{-1}. Soil and interface variations of Façade 2.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	5414	4328	3544	2957	2519	2183
Soil B	4405	3767	3295	2933	2636	2412

Interface	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Low kn	6265	5083	4208	3483	2970	2533
Original kn	5728	4467	3588	2941	2483	2118
High kn	6391	4511	3448	2770	2316	1975

Table D30. Measured value of β^{-1}. Material of Façade 2.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	5505	4837	4125	3448	2854	2363
Sl Weak						
Standard	5728	4467	3588	2941	2483	2118
Sl Strong						
Strong	5505	4250	3380	2770	2316	1995

Table D31. Measured value of β^{-1}. Settlement variations of Façade 2.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	4513	3816	3283	2867	2537	2278
Symmetric	5305	4278	3556	3023	2619	2317

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	4493	3811	3279	2879	2553	2297
Asym L/5	4534	3821	3287	2856	2521	2259
Sym L/2	5211	4176	3468	2926	2534	2229
Sym L/4	5399	4380	3645	3120	2703	2405

Table D32. Measured value of β^{-1} of Façade 2.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F2	5245	4255	3543	3003	2590	2271

Table D33. Applied value of β^{-1}. Soil and interface variations of Façade 2.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	2292	1937	1679	1473	1330	1191
Soil B	1291	1113	1006	970	963	885

Interface	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Low kn	955	839	783	783	783	783
Original kn	3380	2798	2386	2055	1824	1635
High kn	5671	4003	3060	2483	2076	1770

Table D34. Applied value of β^{-1}. Material variations of Façade 2

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	3771	3414	2970	2558	2182	1842
Sl Weak						
Standard	3380	2798	2386	2055	1824	1635
Sl Strong						
Strong	2941	2434	2076	1806	1587	1422

Table D35. Applied value of β^{-1}. Settlement variations of Façade 2.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	1706	1495	1348	1265	1209	1094
Symmetric	1877	1556	1337	1178	1084	981

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	2241	1974	1783	1677	1591	1467
Asym L/5	1171	1015	913	853	828	721
Sym L/2	2649	2217	1911	1691	1575	1430
Sym L/4	1105	895	762	664	594	532

Table D36. Applied value of β^{-1} of Façade 2.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F2	2306	1908	1636	1450	1317	1177

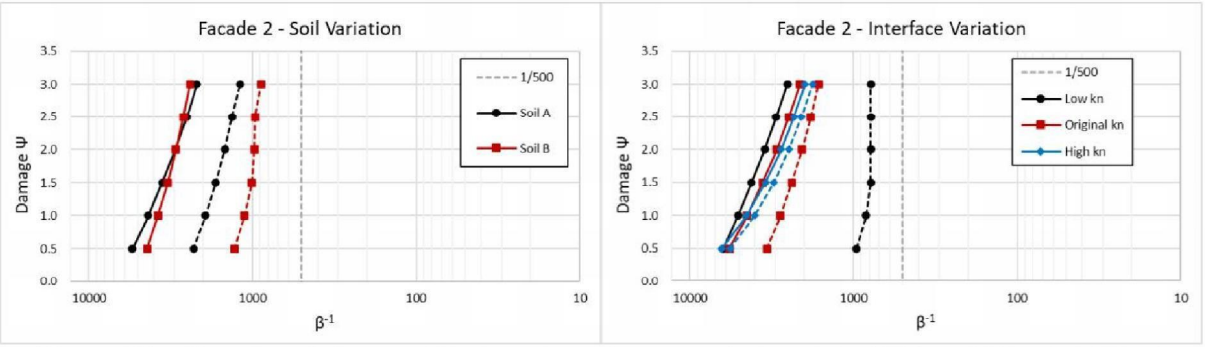


Figure D11. Angular distortion (^-1) against damage of Façade 2. Soil variation (left) and interface variation (right). Dashed lines refers to applied β^{-1}.

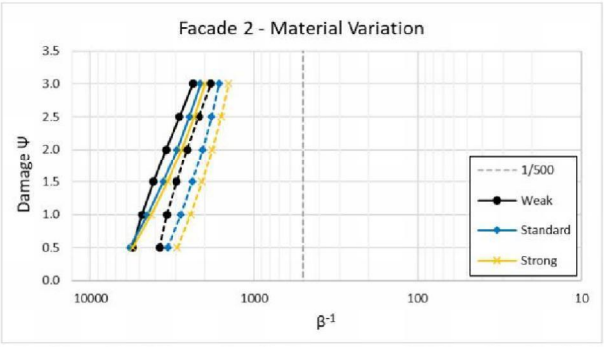


Figure D12. Angular distortion (^-1) against damage of Façade 2. Material variation. Dashed lines refers to applied β^{-1}.

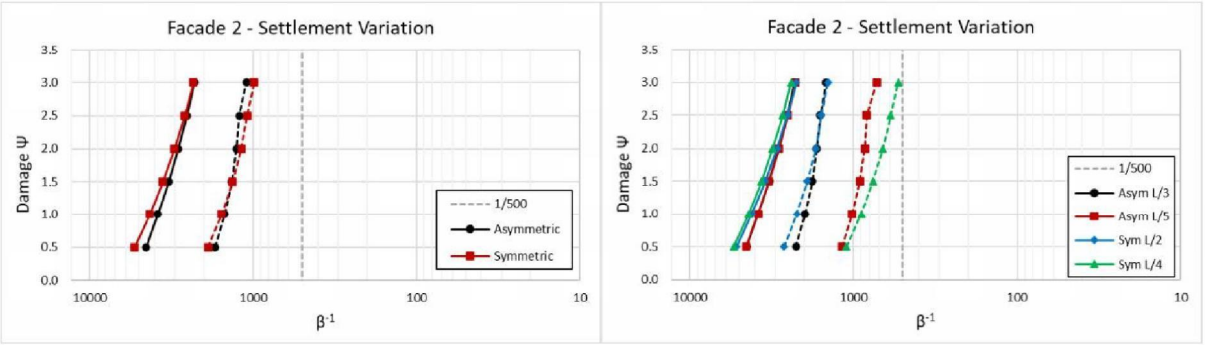


Figure D13. Angular distortion (^-1) against damage of Façade 2. Settlement variation. Dashed lines refers to applied β^{-1}.

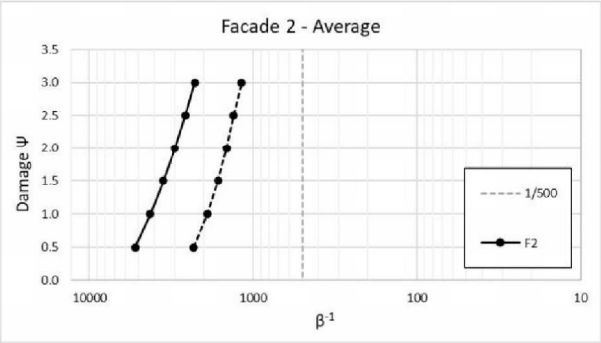
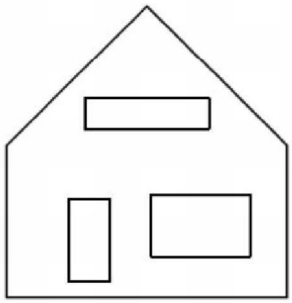
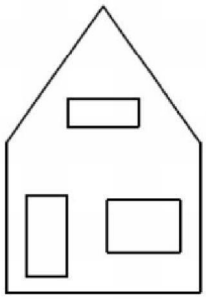
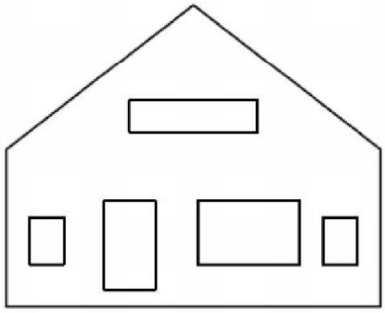
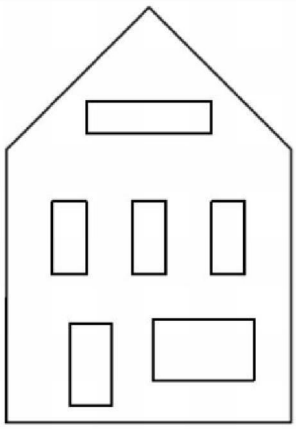
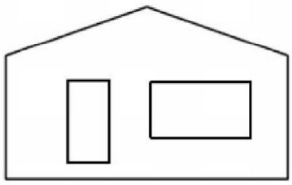
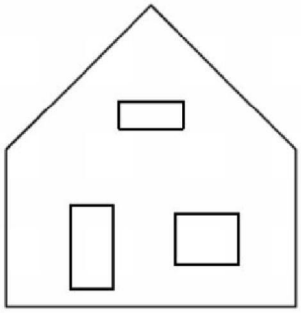
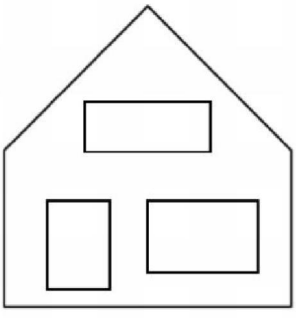


Figure D14. Angular distortion (^-1) against damage of Façade 2. Average results. Dashed lines refers to applied β^{-1}.

Façade 3

		
Façade 3 – A 6.80 x 7.10 m L/H = 0.96 Opening % = 21.4% (Large)	Façade 3 – B 4.80 x 7.10 m L/H = 0.68 Opening % = 21.4% (Large)	Façade 3 – C 8.80 x 7.10 m L/H = 1.24 Opening % = 21.4% (Large)
		
Façade 3 – D 6.80 x 10.0 m L/H = 0.68 Opening % = 21.4% (Large)	Façade 3 – E 6.80 x 4.20 m L/H = 1.62 Opening % = 21.4% (Large)	Façade 3 – F 6.80 x 7.10 m L/H = 0.96 Opening % = 13.0%
		
Façade 3 – G		

6.80 x 7.10 m L/H = 0.96 Opening % = 30.4% (Large)		

Figure D15. Seven geometry variations of Façade 3.

Table D37. Percentage of models that reach a specific damage level. Geometric variation of Façade 3.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F3-A	98.6%	70.0%	64.3%	60.0%	51.4%	51.4%
F3-B	76.9%	54.7%	51.3%	50.4%	49.6%	47.9%
F3-C	100.0%	97.0%	80.3%	77.3%	74.2%	71.2%
F3-D	95.9%	84.9%	83.6%	80.8%	61.6%	58.9%
F3-E	97.5%	80.0%	66.7%	65.8%	65.0%	65.0%
F3-F	94.9%	55.9%	15.3%	15.3%	15.3%	15.3%
F3-G	100.0%	93.7%	93.7%	93.7%	91.6%	88.4%

Table D38. Percentage of models that reach a specific damage level. Soil and interface variations of Façade 3.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	94.8%	76.4%	63.2%	62.0%	57.6%	57.2%
Soil B	90.6%	69.5%	59.0%	56.6%	51.6%	49.6%

Interface	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Low kn	86.1%	59.5%	49.1%	47.4%	41.6%	40.5%
Original kn	94.9%	77.7%	65.1%	64.0%	59.4%	58.3%
High kn	97.5%	82.3%	69.6%	67.1%	63.3%	62.0%

Table D39. Percentage of models that reach a specific damage level. Material variations of Façade 3.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	100.0%	100.0%	100.0%	100.0%	100.0%	98.3%
Sl Weak	98.6%	95.7%	91.3%	91.3%	88.4%	87.0%
Standard	95.6%	83.5%	76.9%	76.9%	74.7%	73.6%
Sl Strong	92.3%	66.4%	49.0%	46.2%	41.3%	40.6%
Strong	85.3%	50.3%	32.2%	28.7%	19.6%	18.2%

Table D40. Percentage of models that reach a specific damage level. Settlement variations of Façade 3.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	96.0%	81.7%	67.9%	66.3%	61.9%	61.1%
Symmetric	89.4%	64.2%	54.3%	52.4%	47.2%	45.7%

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	96.8%	86.5%	75.4%	73.0%	68.3%	68.3%
Asym L/5	95.2%	77.0%	60.3%	59.5%	55.6%	54.0%
Sym L/2	96.9%	83.6%	74.2%	71.9%	67.2%	66.4%
Sym L/4	81.7%	44.4%	34.1%	32.5%	27.0%	24.6%

Table D41. Percentage of models that reach a specific damage level. L/H ratio variations of Façade 3.

L/H	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
L/H=0.68	84.2%	66.3%	63.7%	62.1%	54.2%	52.1%
L/H=0.96	98.6%	70.0%	64.3%	60.0%	51.4%	51.4%
L/H=1.24	100.0%	97.0%	80.3%	77.3%	74.2%	71.2%
L/H=1.62	97.5%	80.0%	66.7%	65.8%	65.0%	65.0%

Table D42. Percentage of models that reach a specific damage level. Size effect variations of Façade 3.

Size Effect	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
4.8 x 7.1	76.9%	54.7%	51.3%	50.4%	49.6%	47.9%
6.8 x 10.0	95.9%	84.9%	83.6%	80.8%	61.6%	58.9%

Table D43. Percentage of models that reach a specific damage level. Opening % variations of Façade 3.

Opening %	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
13.0%	94.9%	55.9%	15.3%	15.3%	15.3%	15.3%
21.4%	98.6%	70.0%	64.3%	60.0%	51.4%	51.4%
30.4%	100.0%	93.7%	93.7%	93.7%	91.6%	88.4%

Table D44. Percentage of virgin models that reach a specific damage level. Façade 3.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F3	92.7%	72.9%	61.1%	59.3%	54.5%	53.4%

Table D45. Percentage of pre-damaged models that reach a specific pre-damage level. Façade 3.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F3	22.7%	7.3%	7.3%	7.3%	4.2%	1.2%

Table D46. Measured value of β^{-1}. Geometry variations of Façade 3.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F3-A	10885	5249	3609	2752	2222	1864
F3-B	3973	2414	1715	1280	992	794
F3-C	20923	15092	5694	4137	3276	2717
F3-D	9393	5961	4383	3435	2760	2330
F3-E	8623	5616	4038	3113	2514	2118
F3-F	11853	4926	2791	2009	1569	1285
F3-G	*	8878	5993	4480	3422	2561

Table D47. Measured value of β^{-1}. Soil and interface variations of Façade 3.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	9385	5484	3618	2753	2194	1826
Soil B	10533	6572	3511	2633	2102	1753

Interface	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Low kn	9532	6404	2871	2148	1720	1437
Original kn	11333	6080	3952	2949	2334	1925
High kn	8926	5580	3893	3004	2410	2024

Table D48. Measured value of β^{-1}. Material of Façade 3.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	19452	14798	4821	3289	2476	1993
Sl Weak	9035	5115	3899	3133	2590	2187
Standard	8613	5275	3792	2932	2378	2009
Sl Strong	8653	4939	3383	2587	2060	1720
Strong	8608	4380	2911	2181	1736	1441

Table D49. Measured value of β^{-1}. Settlement variations of Façade 3.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	9613	6001	3677	2785	2222	1845
Symmetric	10316	6068	3452	2600	2073	1734

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	9211	5941	3593	2743	2196	1833
Asym L/5	10014	6061	3762	2827	2248	1857
Sym L/2	9653	6377	3843	2953	2394	2021
Sym L/4	10989	5754	3054	2242	1748	1442

Table D50. Measured value of β^{-1}. L/H ratio variations of Façade 3.

L/H	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
L/H=0.68	6055	3777	2740	2108	1671	1384
L/H=0.96	10885	5249	3609	2752	2222	1864
L/H=1.24	20923	15092	5694	4137	3276	2717
L/H=1.62	8623	5616	4038	3113	2514	2118

Table D51. Measured value of β^{-1}. Size effect variations of Façade 3.

Size Effect	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
4.8 x 7.1	3973	2414	1715	1280	992	794
6.8 x 10.0	9393	5961	4383	3435	2760	2330

Table D52. Measured value of β^{-1}. Opening % variations of Façade 3.

Opening %	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
13.0%	11853	4926	2791	2009	1569	1285
21.4%	10885	5249	3609	2752	2222	1864
30.4%		8878	5993	4480	3422	2561

Table D53. Measured value of β^{-1} of Façade 3.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F3	9966	6035	3564	2692	2147	1789

Table D54. Applied value of β^{-1}. Geometry variations of Façade 3.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F3-A	845	319	184	129	103	92
F3-B	514	287	182	124	84	63
F3-C	2933	920	372	217	157	131
F3-D	996	513	313	212	155	119
F3-E	943	481	326	252	215	204
F3-F	712	84	28	24	23	22
F3-G	*	1286	979	783	617	422

Table D55. Applied value of β^{-1}. Soil and interface variations of Façade 3.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	1038	445	269	191	148	127
Soil B	1104	416	217	146	114	99

Interface	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Low kn	516	118	37	26	23	22
Original kn	974	407	230	160	128	115
High kn	1788	797	481	334	251	210

Table D56. Applied value of β^{-1}. Material variations of Façade 3.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	3600	1511	812	559	425	367
Sl Weak	1023	463	305	231	194	178
Standard	793	387	247	182	149	131
Sl Strong	719	267	146	97	72	59
Strong	564	150	67	37	24	16

Table D57. Applied value of β^{-1}. Settlement variations of Façade 3.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	1280	518	291	202	159	139
Symmetric	865	343	194	135	102	87

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	1675	702	412	296	238	209
Asym L/5	884	333	171	108	81	68
Sym L/2	1306	541	315	222	172	148
Sym L/4	418	141	71	47	30	25

Table D58. Applied value of β^{-1}. L/H ratio variations of Façade 3.

L/H	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
L/H=0.68	699	374	232	158	111	85
L/H=0.96	845	319	184	129	103	92
L/H=1.24	2933	920	372	217	157	131
L/H=1.62	943	481	326	252	215	204

Table D59. Applied value of β^{-1}. Size effect variations of Façade 3.

Size Effect	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
4.8 x 7.1	514	287	182	124	84	63
6.8 x 10.0	996	513	313	212	155	119

Table D60. Applied value of β^{-1}. Opening % variations of Façade 3.

Opening %	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
13.0%	712	84	28	24	23	22
21.4%	845	319	184	129	103	92
30.4%		1286	979	783	617	422

Table D61. Applied value of β^{-1} of Façade 3.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F3	1072	430	242	168	131	113

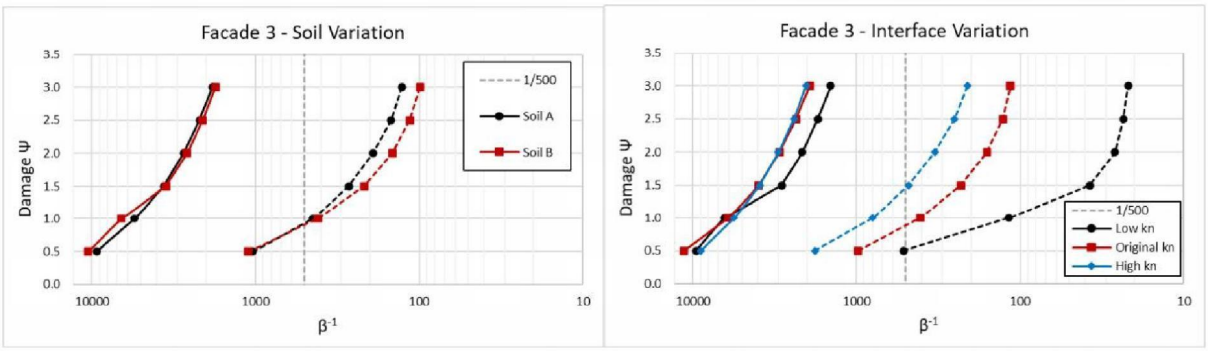


Figure D16. Angular distortion (^-1) against damage of Façade 3. Soil variation (left) and interface variation (right). Dashed lines refers to applied β^{-1}.

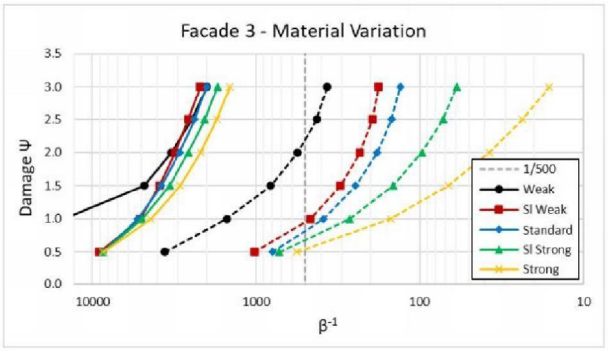


Figure D17. Angular distortion (^-1) against damage of Façade 3. Material variation. Dashed lines refers to applied β^{-1}.

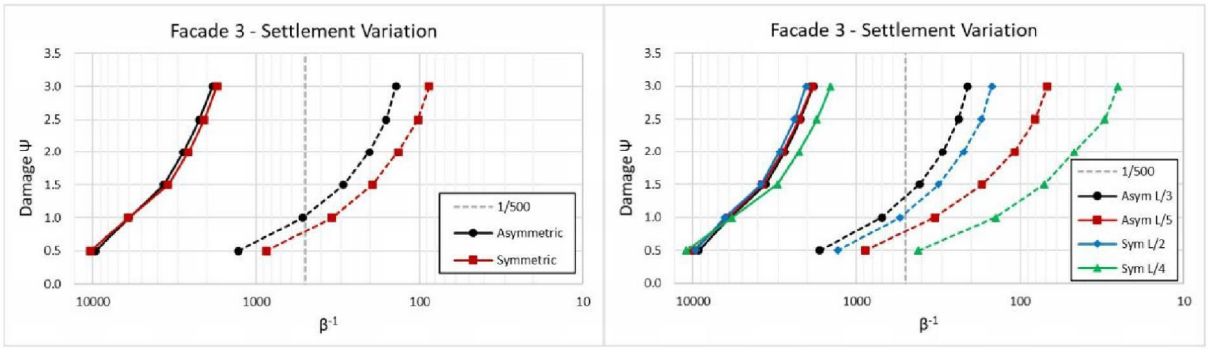


Figure D18. Angular distortion (^-1) against damage of Façade 3. Settlement variation. Dashed lines refers to applied β^{-1}.

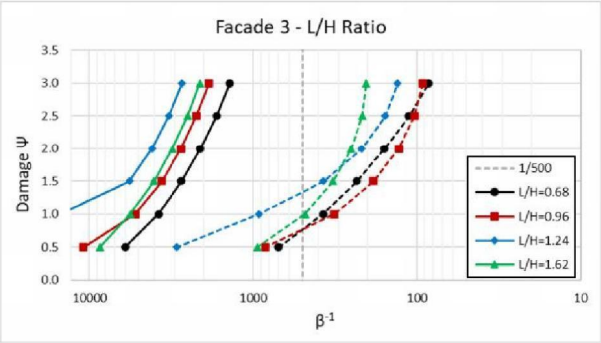


Figure D19. Angular distortion (^-1) against damage of Façade 3. L/H ratio variation. Dashed lines refers to applied β^{-1}.

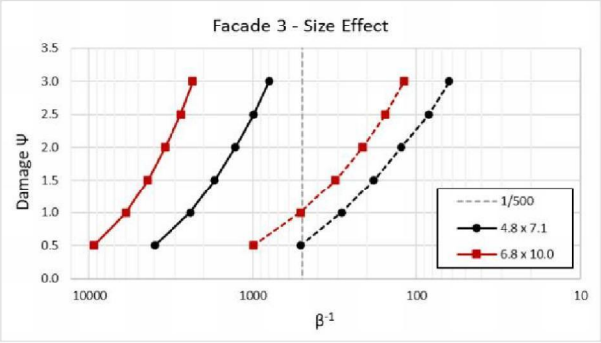


Figure D20. Angular distortion against damage of Façade 3. Size effect variation. Dashed lines refers to applied β.

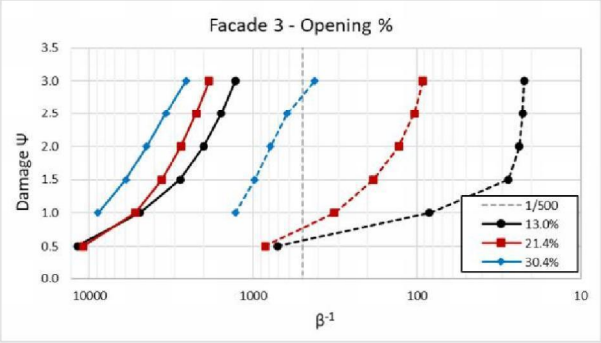


Figure D21. Angular distortion (^-1) against damage of Façade 3. Opening % variation. Dashed lines refers to applied β^{-1}.

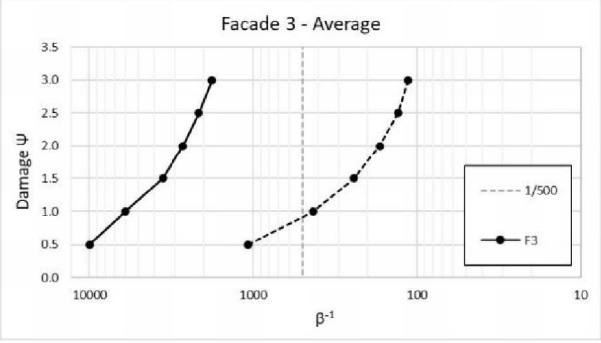


Figure D22. Angular distortion (^-1) against damage of Façade 3. Average results. Dashed lines refers to applied β^{-1}.

Façade 4

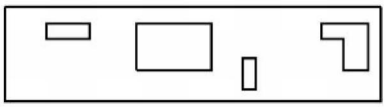
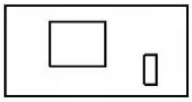
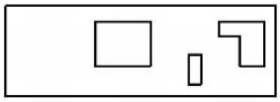
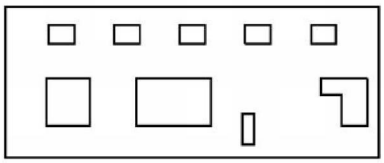
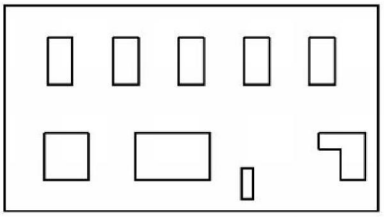
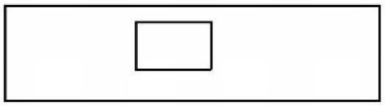
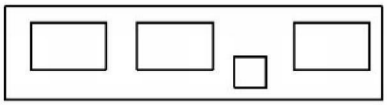
		
Façade 4 – A 12.00 x 3.00 m L/H = 4.00 Opening % = 17.4% (Large)	Façade 4 – B 6.00 x 3.00 m L/H = 2.00 Opening % = 17.4% (Large)	Façade 4 – C 9.00 x 3.00 m L/H = 3.00 Opening % = 17.4% (Large)
		
Façade 4 – D 12.00 x 4.80 m L/H = 2.50 Opening % = 17.4% (Large)	Façade 4 – E 12.00 x 6.60 m L/H = 1.82 Opening % = 17.4% (Large)	Façade 4 – F 12.00 x 3.00 m L/H = 4.00 Opening % = 10.0% (Large)
		
Façade 4 – G 12.00 x 3.00 m L/H = 4.00 Opening % = 32.8% (Large)		

Figure D23. Seven geometry variations of Façade 4.

Table D62. Percentage of models that reach a specific damage level. Geometric variation of Façade 4.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F4-A	*	*	100.0%	100.0%	100.0%	100.0%
F4-B	75.4%	72.0%	72.0%	72.0%	69.5%	69.5%
F4-C	100.0%	99.2%	98.3%	98.3%	96.7%	96.7%
F4-D	100.0%	100.0%	98.6%	97.2%	97.2%	97.2%
F4-E	100.0%	100.0%	87.2%	83.0%	78.7%	78.7%
F4-F	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
F4-G	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table D63. Percentage of models that reach a specific damage level. Soil and interface variations of Façade 4.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	95.3%	94.6%	93.8%	93.1%	92.0%	92.0%
Soil B	94.1%	93.0%	90.8%	90.5%	89.0%	89.0%

Interface	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Low kn	90.4%	89.9%	87.1%	86.0%	83.7%	83.7%
Original kn	96.3%	94.7%	93.6%	93.1%	92.0%	92.0%
High kn	97.3%	96.7%	96.2%	96.2%	95.6%	95.6%

Table D64. Percentage of models that reach a specific damage level. Material variations of Façade 4.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Sl Weak	97.4%	97.4%	97.4%	97.4%	97.4%	97.4%
Standard	94.8%	93.9%	93.9%	93.9%	93.9%	93.9%
Sl Strong	93.7%	93.7%	92.3%	90.8%	90.8%	90.8%
Strong	91.5%	88.7%	84.5%	83.8%	78.9%	78.9%

Table D65. Percentage of models that reach a specific damage level. Settlement variations of Façade 4.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	96.8%	96.1%	96.1%	96.1%	94.6%	94.6%
Symmetric	92.6%	91.5%	88.5%	87.4%	86.3%	86.3%

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	97.9%	97.2%	97.2%	97.2%	96.5%	96.5%
Asym L/5	95.6%	94.9%	94.9%	94.9%	92.7%	92.7%
Sym L/2	97.8%	97.1%	97.1%	97.1%	95.6%	95.6%
Sym L/4	87.2%	85.7%	79.7%	77.4%	76.7%	76.7%

Table D66. Percentage of models that reach a specific damage level. L/H ratio variations of Façade 4.

L/H	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
L/H=1.82	100.0%	100.0%	87.2%	83.0%	78.7%	78.7%
L/H=2.00	75.4%	72.0%	72.0%	72.0%	69.5%	69.5%
L/H=2.50	100.0%	100.0%	98.6%	97.2%	97.2%	97.2%
L/H=3.00	100.0%	99.2%	98.3%	98.3%	96.7%	96.7%
L/H=4.00	*	*	100.0%	100.0%	100.0%	100.0%

Table D67. Percentage of models that reach a specific damage level. Opening % variations of Façade 4.

Opening %	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
10.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
17.4%	*	*	100.0%	100.0%	100.0%	100.0%
32.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table D68. Percentage of virgin models that reach a specific damage level. Façade 4.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F4	94.7%	93.8%	92.3%	91.8%	90.5%	90.5%

Table D69. Percentage of pre-damaged models that reach a specific pre-damage level. Façade 4.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F4	20.8%	17.3%	8.3%	2.1%	0.0%	0.0%

Table D70. Measured value of β^{-1}. Geometry variations of Façade 4.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F4-A	*	*	7040	5125	4203	3451
F4-B	6622	5313	4471	3777	3211	2806
F4-C	13288	8280	5829	4427	3547	2995
F4-D	13630	8025	5609	4266	3476	3111
F4-E	12839	7304	5030	3811	3067	2763
F4-F	10027	8517	7031	5708	4594	3699
F4-G	12683	8481	5864	4246	3235	2569

Table D71. Measured value of β^{-1}. Soil and interface variations of Façade 4.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	11424	7843	5862	4562	3657	3055
Soil B	10708	7363	5551	4376	3566	3038

Interface	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Low kn	10130	7203	5534	4422	3658	3201
Original kn	11721	7903	5910	4612	3693	3065
High kn	11309	7688	5668	4370	3484	2878

Table D72. Measured value of β^{-1}. Material of Façade 4.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	12823	9261	6875	5184	3966	3192
Sl Weak	12451	8635	6322	4840	3859	3192
Standard	11481	7751	5847	4623	3777	3207
Sl Strong	10271	6991	5335	4267	3513	3014
Strong	9878	6689	5034	3981	3260	2797

Table D73. Measured value of β^{-1}. Settlement variations of Façade 4.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	11282	8046	6126	4814	3888	3273
Symmetric	10846	7148	5276	4113	3326	2813

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	12474	8748	6538	5048	4002	3309
Asym L/5	10047	7320	5698	4573	3770	3236
Sym L/2	11868	7970	5945	4674	3820	3269
Sym L/4	9793	6301	4587	3536	2818	2343

Table D74. Measured value of β^{-1}. L/H ratio variations of Façade 4.

L/H	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
L/H=1.82	12839	7304	5030	3811	3067	2763
L/H=2.00	6622	5313	4471	3777	3211	2806
L/H=2.50	13630	8025	5609	4266	3476	3111
L/H=3.00	13288	8280	5829	4427	3547	2995
L/H=4.00	*	*	7040	5125	4203	3451

Table D75. Measured value of β^{-1}. Opening % variations of Façade 4.

Opening %	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
10.0%	10027	8517	7031	5708	4594	3699
17.4%	*	*	7040	5125	4203	3451
32.8%	12683	8481	5864	4246	3235	2569

Table D.76. Measured value of β^{-1} of Façade 4.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F4	11068	7604	5708	4470	3612	3047

Table D77. Applied value of β^{-1}. Geometry variations of Façade 4.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F4-A	*	*	1675	1425	1195	979
F4-B	535	416	351	309	286	271
F4-C	2415	1438	1021	820	715	646
F4-D	3183	1671	1092	832	776	772
F4-E	2750	1062	554	352	276	268
F4-F	2582	2157	1802	1503	1264	1069
F4-G	5890	3847	2585	1831	1393	1126

Table D78. Applied value of β^{-1}. Soil and interface variations of Façade 4.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	3181	2027	1451	1117	930	813
Soil B	2089	1357	996	792	676	598

Interface	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Low kn	306	229	194	176	167	160
Original kn	2275	1500	1133	931	815	734
High kn	5278	3318	2321	1739	1411	1207

Table D79. Applied value of β^{-1}. Material variations of Façade 4.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	3429	2447	1853	1453	1188	1007
Sl Weak	3980	2700	1849	1341	1061	886
Standard	2809	1817	1356	1099	947	842
Sl Strong	2181	1326	964	769	669	609
Strong	1821	1030	717	561	485	439

Table D80. Applied value of β^{-1}. Settlement variations of Façade 4.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	2844	1901	1383	1077	905	791
Symmetric	2424	1480	1061	830	699	618

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	4055	2724	1950	1489	1231	1062
Asym L/5	1589	1048	797	650	566	509
Sym L/2	3579	2240	1632	1293	1097	978
Sym L/4	1235	697	472	354	288	247

Table D81. Applied value of β^{-1}. L/H ratio variations of Façade 4.

L/H	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
L/H=1.82	2750	1062	554	352	276	268
L/H=2.00	535	416	351	309	286	271
L/H=2.50	3183	1671	1092	832	776	772
L/H=3.00	2415	1438	1021	820	715	646
L/H=4.00	*	*	1675	1425	1195	979

Table D82. Applied value of β^{-1}. Opening % variations of Façade 4.

Opening %	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
10.0%	2582	2157	1802	1503	1264	1069
17.4%	*	*	1675	1425	1195	979
32.8%	5890	3847	2585	1831	1393	1126

Table D83. Applied value of β^{-1} of Façade 4.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F4	2638	1694	1225	956	803	706

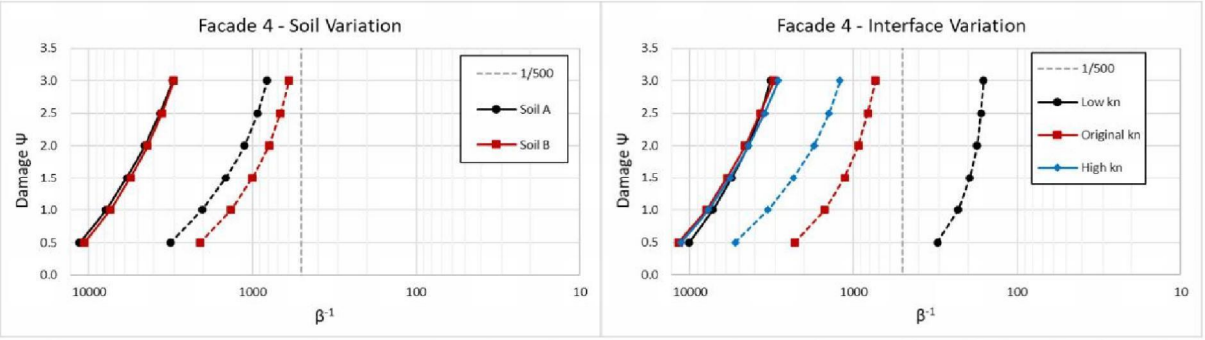


Figure D24. Angular distortion (^-1) against damage of Façade 4. Soil variation (left) and interface variation (right). Dashed lines refers to applied β^{-1}.

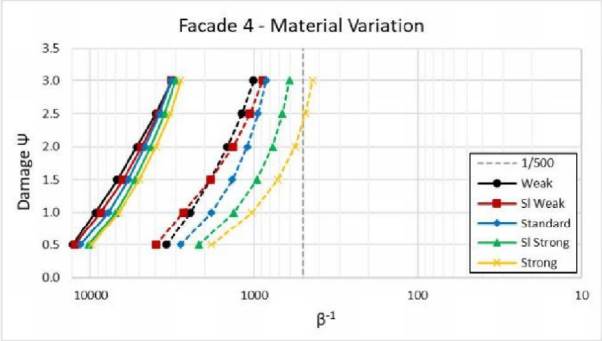


Figure D25. Angular distortion (^-1) against damage of Façade 4. Material variation. Dashed lines refers to applied β^{-1}.

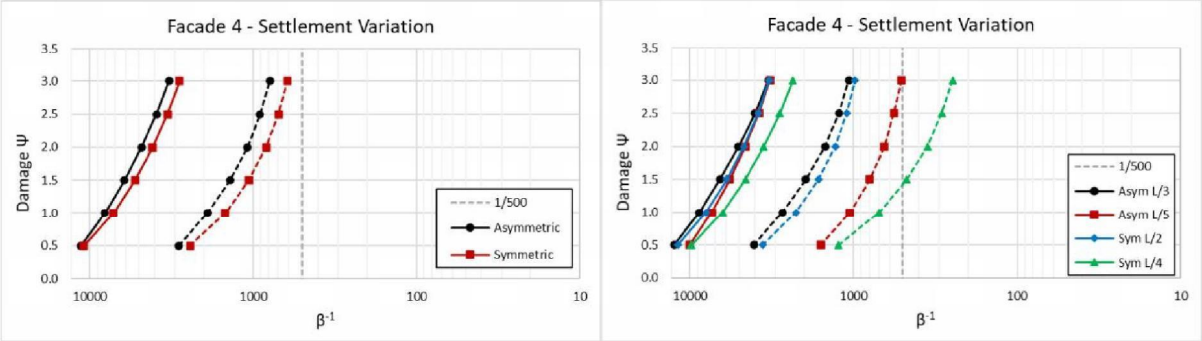


Figure D26. Angular distortion (^-1) against damage of Façade 4. Settlement variation. Dashed lines refers to applied β^{-1}.

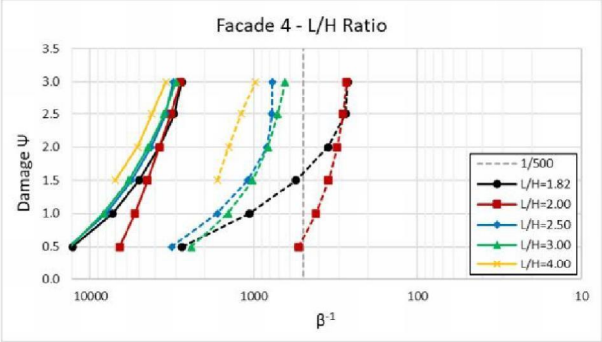


Figure D27. Angular distortion (^-1) against damage of Façade 4. L/H ratio variation. Dashed lines refers to applied β^{-1}.

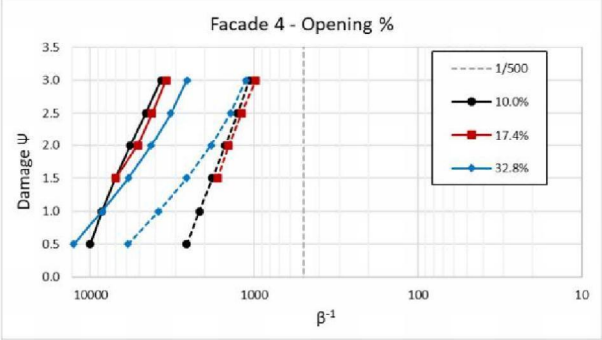


Figure D28. Angular distortion (^-1) against damage of Façade 4. Opening % variation. Dashed lines refers to applied β^{-1}.

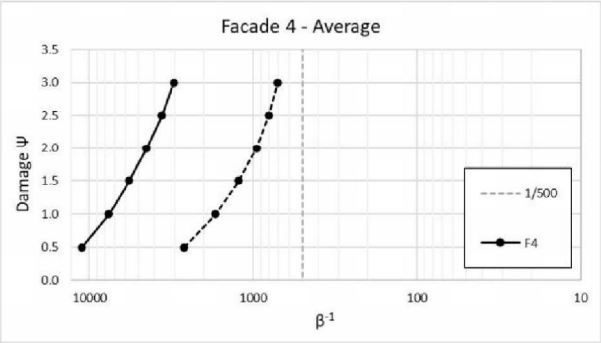
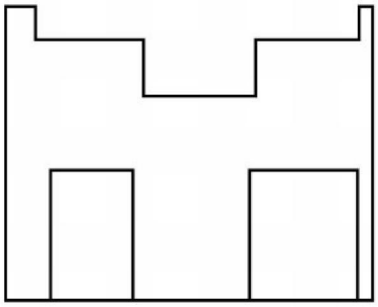


Figure D29. Angular distortion (^-1) against damage of Façade 4. Average results. Dashed lines refers to applied β^{-1}.

Façade 5



Façade 5 – A
6.75 x 5.40 m
L/H = 1.25
Opening % = 39.0%

Figure D30. Geometry variation of Façade 5. Timber roof not depicted.

Table D84. Percentage of models that reach a specific damage level. Soil variations of Façade 5.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	100.0%	83.3%	58.3%	58.3%	41.7%	33.3%
Soil B	91.7%	75.0%	58.3%	58.3%	33.3%	25.0%

Table D85. Percentage of models that reach a specific damage level. Material variations of Façade 5.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	100.0%	100.0%	100.0%	100.0%	100.0%	75.0%
Sl Weak						
Standard	100.0%	75.0%	75.0%	75.0%	12.5%	12.5%
Sl Strong						
Strong	87.5%	62.5%	0.0%	0.0%	0.0%	0.0%

Table D86. Percentage of models that reach a specific damage level. Settlement variations of Façade 5.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	100.0%	91.7%	66.7%	66.7%	33.3%	33.3%
Symmetric	91.7%	66.7%	50.0%	50.0%	41.7%	25.0%

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	100.0%	100.0%	66.7%	66.7%	33.3%	33.3%
Asym L/5	100.0%	83.3%	66.7%	66.7%	33.3%	33.3%
Sym L/2	100.0%	100.0%	66.7%	66.7%	50.0%	50.0%
Sym L/4	83.3%	33.3%	33.3%	33.3%	33.3%	0.0%

Table D87. Percentage of models that reach a specific damage level. Façade 5.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F5	95.8%	79.2%	58.3%	58.3%	37.5%	29.2%

Table D88. Measured value of β^{-1}. Soil variations of Façade 5.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	7119	4617	3349	2647	2174	1862
Soil B	7041	4608	3307	2578	2074	1702

Table D89. Measured value of β^{-1}. Material of Façade 5.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	8007	6647	5479	4502	3719	3109
Sl Weak						
Standard	6683	3839	2903	2325	1929	1680
Sl Strong						
Strong	6551	3351	1603	1011	724	557

Table D90. Measured value of β^{-1}. Settlement variations of Façade 5.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	7586	5306	3696	2848	2276	1863
Symmetric	6574	3919	2960	2377	1972	1701

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	7637	5049	3289	2557	2069	1705
Asym L/5	7536	5563	4103	3140	2483	2020
Sym L/2	7008	5030	3887	3153	2644	2328
Sym L/4	6140	2808	2034	1601	1301	1074

Table D91. Measured value of β^{-1} of Façade 5.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F5	7080	4612	3328	2613	2124	1782

Table D92. Applied value of β^{-1}. Soil variations of Façade 5.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	962	516	382	304	219	91
Soil B	419	249	183	132	80	55

Table D93. Applied value of β^{-1}. Material variations of Façade 5.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	1166	962	787	626	431	207
Sl Weak						
Standard	564	156	58	27	17	12
Sl Strong						
Strong	341	31	3	1	0	0

Table D94. Applied value of β^{-1}. Settlement variations of Façade 5.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	806	436	302	213	151	110
Symmetric	575	330	264	223	147	36

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	1180	642	451	321	227	166
Asym L/5	432	229	153	106	74	54
Sym L/2	1007	561	440	369	295	72
Sym L/4	143	98	87	76	0	0

Table D95. Applied value of β^{-1} of Façade 5.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F5	690	383	283	218	149	73

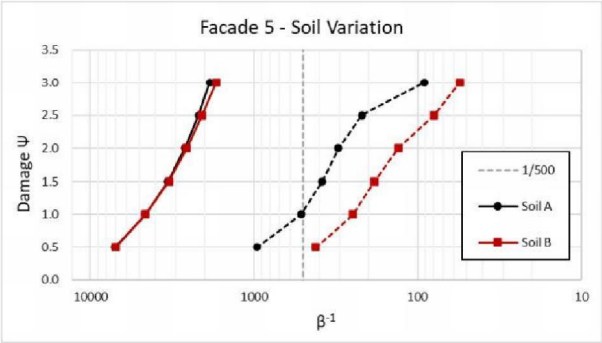


Figure D31. Angular distortion (^-1) against damage of Façade 5. Soil variation. Dashed lines refers to applied β^{-1}.

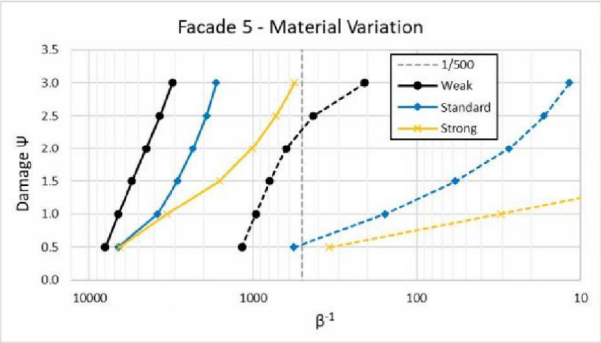


Figure D32. Angular distortion (^-1) against damage of Façade 5. Material variation. Dashed lines refers to applied β^{-1}.

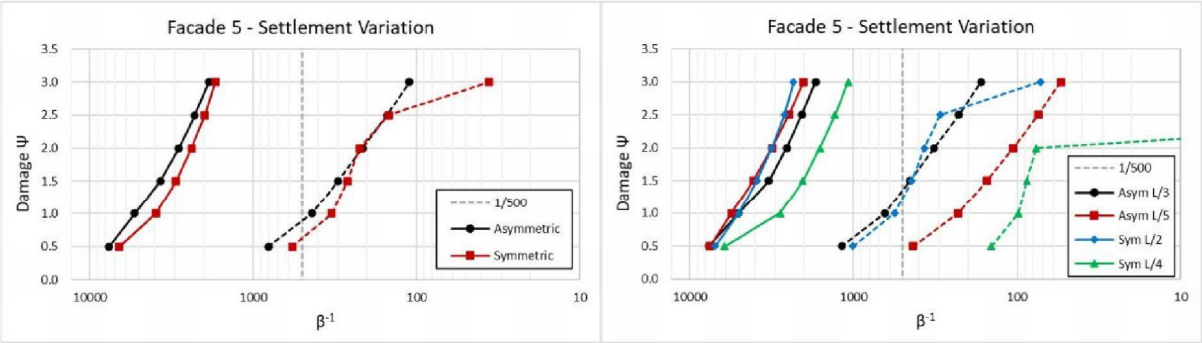


Figure D33. Angular distortion (^-1) against damage of Façade 5. Settlement variation. Dashed lines refers to applied β^{-1}.

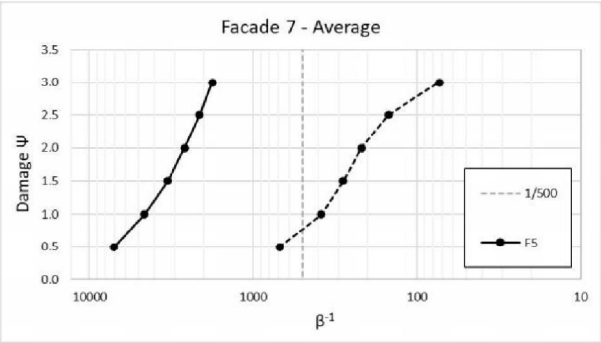
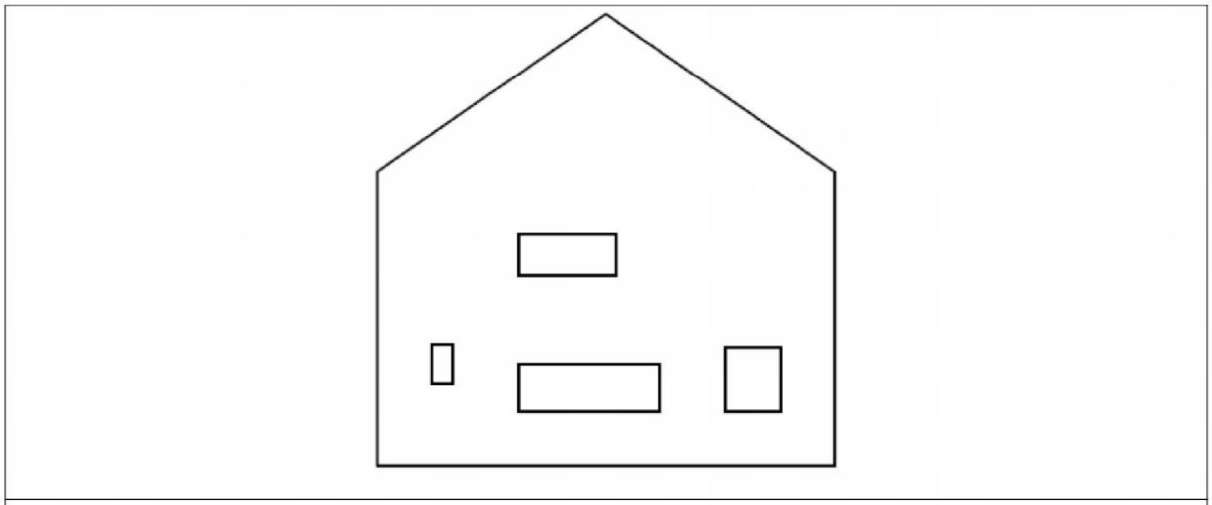


Figure D34. Angular distortion (^-1) against damage of Façade 5. Average results. Dashed lines refers to applied β^{-1}.

Façade 6



Façade 6 – A
8.40 x 8.30 m
L/H = 1.01
Opening % = 9.0%

Figure D35. Geometry variation of Façade 6.

Table D96. Percentage of models that reach a specific damage level. Soil variations of Façade 6.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
Soil A	100.0%	100.0%	100.0%	91.7%	83.3%	58.3%
Soil B	100.0%	100.0%	100.0%	91.7%	75.0%	41.7%

Table D97. Percentage of models that reach a specific damage level. Material variations of Façade 6.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
Weak	100.0%	100.0%	100.0%	100.0%	100.0%	75.0%
Sl Weak						
Standard	100.0%	100.0%	100.0%	100.0%	75.0%	62.5%
Sl Strong						
Strong	100.0%	100.0%	100.0%	75.0%	62.5%	12.5%

Table D98. Percentage of models that reach a specific damage level. Settlement variations of Façade 6.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
Asymmetric	100.0%	100.0%	100.0%	100.0%	91.7%	66.7%
Symmetric	100.0%	100.0%	100.0%	83.3%	66.7%	33.3%

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
Asym L/3	100.0%	100.0%	100.0%	100.0%	100.0%	83.3%
Asym L/5	100.0%	100.0%	100.0%	100.0%	83.3%	50.0%
Sym L/2	100.0%	100.0%	100.0%	100.0%	100.0%	66.7%
Sym L/4	100.0%	100.0%	100.0%	66.7%	33.3%	0.0%

Table D99. Percentage of models that reach a specific damage level. Façade 6.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
F6	100.0%	100.0%	100.0%	91.7%	79.2%	50.0%

Table D100. Measured value of β^{-1}. Soil variations of Façade 6.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
Soil A	20835	7751	4740	3087	1864	1120
Soil B	20177	7457	4996	3184	1993	988

Table D101. Measured value of β^{-1}. Material of Façade 6.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
Weak	45076	10150	5777	3562	1917	521
Sl Weak						
Standard	9056	6870	4711	3063	1982	1324
Sl Strong						
Strong	7385	5793	4115	2781	1886	1317

Table D102. Measured value of β^{-1}. Settlement variations of Façade 6.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
Asymmetric	21191	7557	4436	2759	1746	999
Symmetric	19821	7652	5299	3512	2110	1109

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
Asym L/3	21213	7605	4423	2692	1671	1078
Asym L/5	21169	7508	4450	2825	1822	919
Sym L/2	19474	7905	5234	3517	2305	810
Sym L/4	20167	7400	5364	3508	1915	1409

Table D103. Measured value of β^{-1} of Façade 6.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
F6	20506	7604	4868	3135	1928	1054

Table D104. Applied value of β^{-1}. Soil variations of Façade 6.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
Soil A	6862	1595	920	497	191	31
Soil B	3668	626	387	231	79	7

Table D105. Applied value of β^{-1}. Material variations of Façade 6.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
Weak	13923	1962	1136	717	272	0
Sl Weak						
Standard	1181	858	533	253	85	38
Sl Strong						
Strong	691	512	291	122	49	19

Table D106. Applied value of β^{-1}. Settlement variations of Façade 6.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
Asymmetric	5509	1181	697	416	157	24
Symmetric	5021	1040	610	312	114	15

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
Asym L/3	6548	1523	951	599	289	36
Asym L/5	4471	840	444	233	25	11
Sym L/2	6535	1578	915	531	225	28
Sym L/4	3507	502	305	93	2	2

Table D107. Applied value of β^{-1} of Façade 6.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.0
F6	5265	1111	654	364	135	19

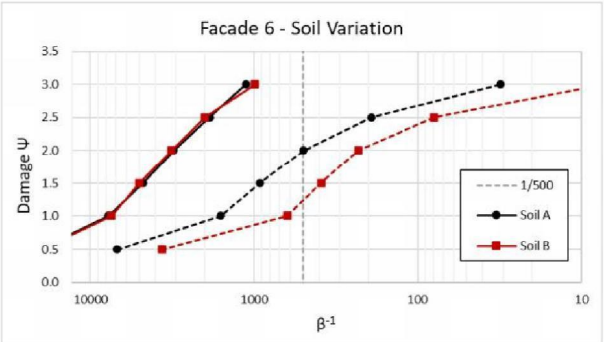


Figure D36. Angular distortion (^-1) against damage of Façade 6. Soil variation. Dashed lines refers to applied β^{-1}.

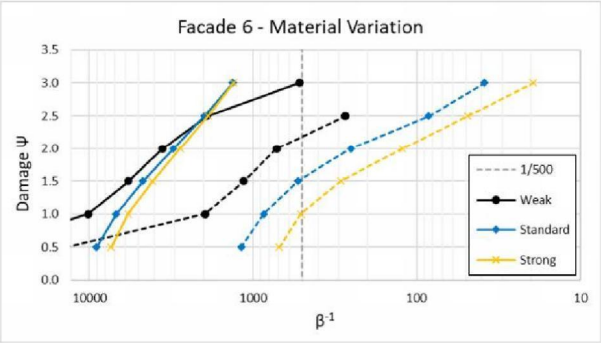


Figure D37. Angular distortion (^-1) against damage of Façade 6. Material variation. Dashed lines refers to applied β^{-1}.

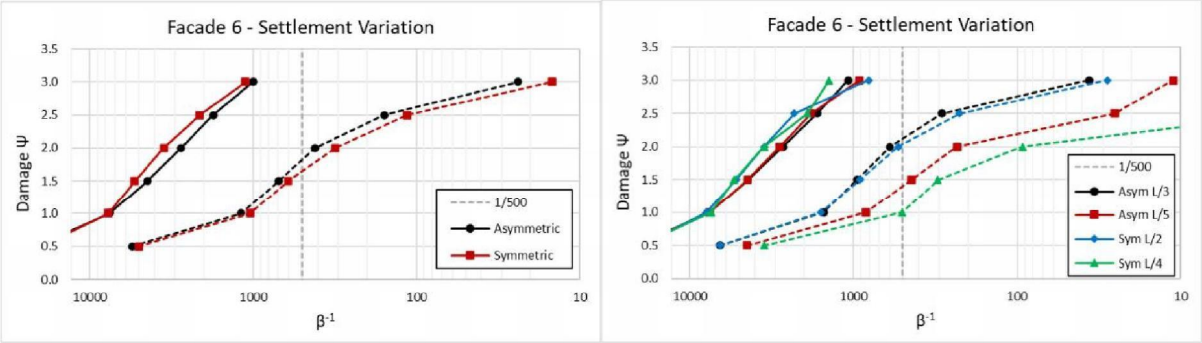


Figure D38. Angular distortion (^-1) against damage of Façade 6. Settlement variation. Dashed lines refers to applied β^{-1}.

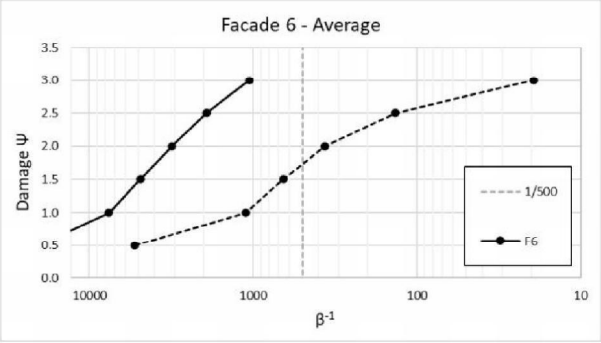


Figure D39. Angular distortion (^-1) against damage of Façade 6. Average results. Dashed lines refers to applied β^{-1}.

Façade 7

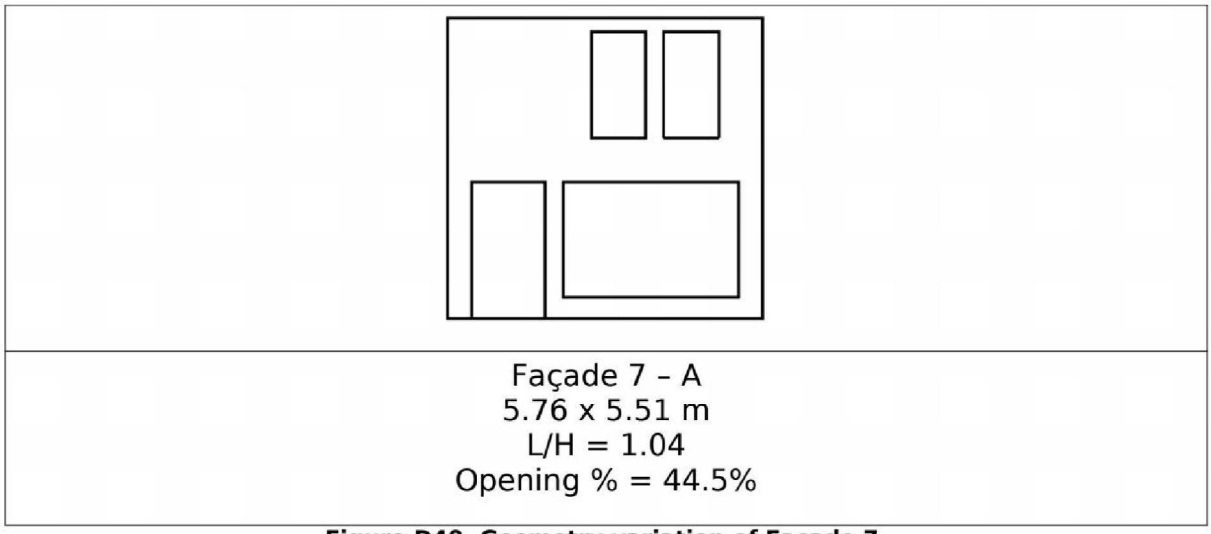


Figure D40. Geometry variation of Façade 7.

Table D108. Percentage of virgin models that reach a specific damage level. Façade 7.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F7	*	*	*	33.3%	0.0%	0.0%

Table D109. Measured value of β^{-1}. Soil variations of Façade 7.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	*	*	*	2593	425	153
Soil B	*	*	*	1712	12	6

Table D110. Measured value of β^{-1}. Material of Façade 7.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	*	*	*	5151	340	128
Sl Weak						
Standard	*	*	*	1066	290	103
Sl Strong						
Strong	*	*	*	241	26	8

Table D111. Measured value of β^{-1}. Settlement variations of Façade 7.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	*	*	*	1956	41	24
Symmetric	*	*	*	2349	397	136

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	*	*	*	1931	17	4
Asym L/5	*	*	*	1981	64	43
Sym L/2	*	*	*	2567	613	216
Sym L/4	*	*	*	2131	181	56

Table D112. Measured value of β^{-1} of Façade 7.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F7	*	*	*	2152	219	80

Table D113. Applied value of β^{-1}. Soil and interface variations of Façade 7.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	*	*	*	200	49	14
Soil B	*	*	*	13	2	1

Table D114. Applied value of β^{-1}. Material variations of Façade 7.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	*	*	*	204	55	16
Sl Weak						
Standard	*	*	*	96	21	5
Sl Strong						
Strong	*	*	*	20	1	0

Table D115. Applied value of β^{-1}. Settlement variations of Façade 7.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	*	*	*	19	3	1
Symmetric	*	*	*	194	48	13

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	*	*	*	27	4	1
Asym L/5	*	*	*	11	3	1
Sym L/2	*	*	*	334	85	23
Sym L/4	*	*	*	53	11	4

Table D116. Applied value of β^{-1} of Façade 7.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F7	*	*	*	106	26	7

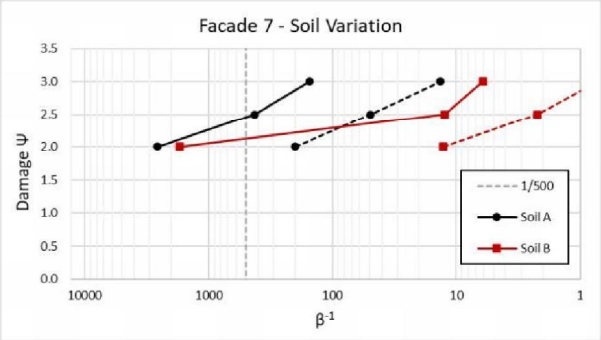


Figure D41. Angular distortion (^-1) against damage of Façade 7. Soil variation. Dashed lines refers to applied β^{-1}.

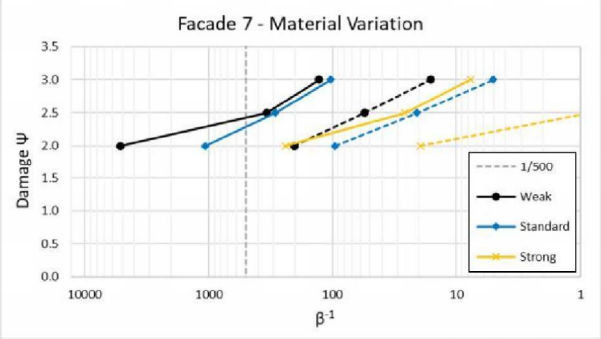


Figure D42. Angular distortion (^-1) against damage of Façade 7. Material variation. Dashed lines refers to applied β^{-1}.

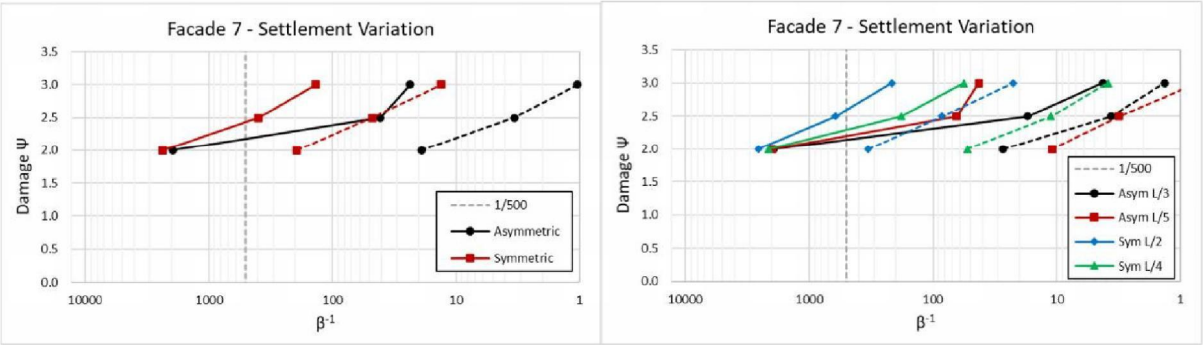


Figure D43. Angular distortion (^-1) against damage of Façade 7. Settlement variation. Dashed lines refers to applied β^{-1}.

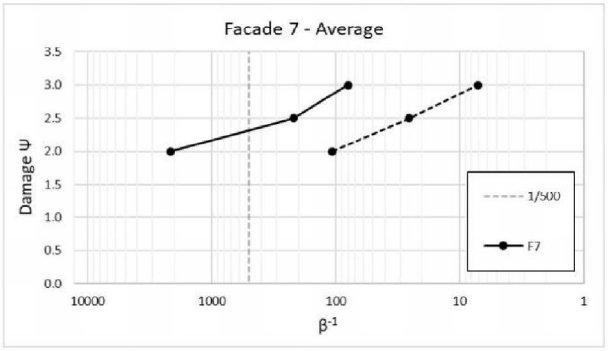


Figure D44. Angular distortion (^-1) against damage of Façade 7. Average results. Dashed lines refers to applied β^{-1}.

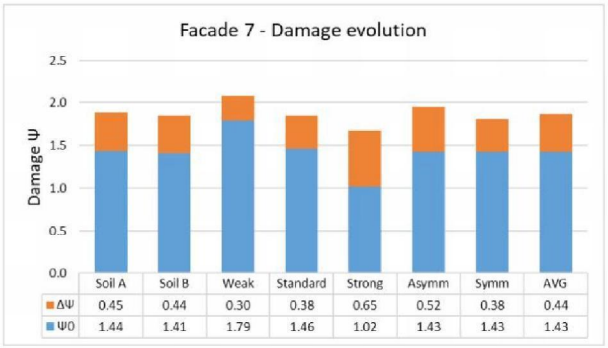


Figure D45. Damage evolution of different variations of Façade 7.

Façade 8

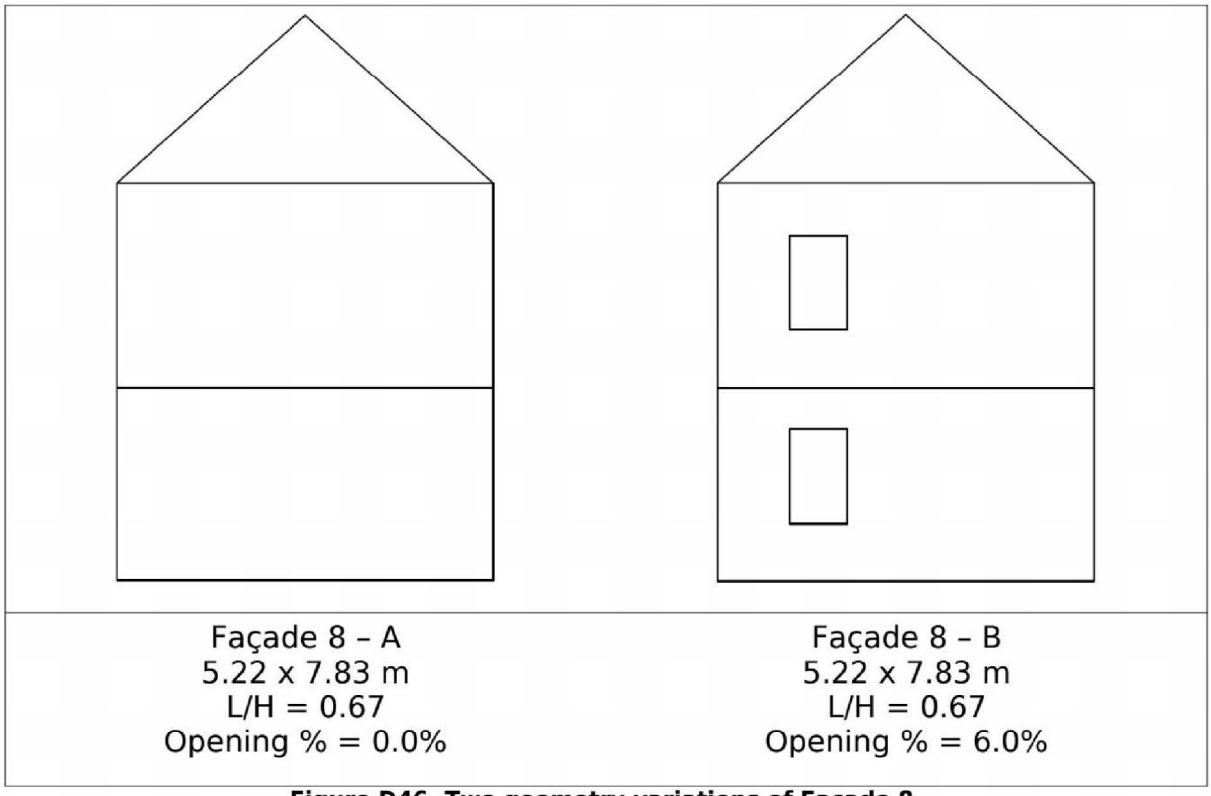


Figure D46. Two geometry variations of Façade 8.

Table D117. Percentage of models that reach a specific damage level. Geometry variations of Façade 8.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F8-A	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
F8-B	79.2%	58.3%	33.3%	0.0%	0.0%	0.0%

Table D118. Percentage of models that reach a specific damage level. Soil variations of Façade 8.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	45.8%	29.2%	16.7%	0.0%	0.0%	0.0%
Soil B	33.3%	29.2%	16.7%	0.0%	0.0%	0.0%

Table D119. Percentage of models that reach a specific damage level. Material variations of Façade 8.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	50.0%	50.0%	50.0%	0.0%	0.0%	0.0%
Sl Weak						
Standard	43.8%	37.5%	0.0%	0.0%	0.0%	0.0%
Sl Strong						
Strong	25.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table D120. Percentage of models that reach a specific damage level. Settlement variations of Façade 8.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	45.8%	33.3%	16.7%	0.0%	0.0%	0.0%
Symmetric	33.3%	25.0%	16.7%	0.0%	0.0%	0.0%

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	50.0%	33.3%	16.7%	0.0%	0.0%	0.0%
Asym L/5	41.7%	33.3%	16.7%	0.0%	0.0%	0.0%
Sym L/2	41.7%	33.3%	16.7%	0.0%	0.0%	0.0%
Sym L/4	25.0%	16.7%	16.7%	0.0%	0.0%	0.0%

Table D121. Percentage of models that reach a specific damage level. Façade 8.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F8	39.6%	29.2%	16.7%	0.0%	0.0%	0.0%

Table D122. Measured (left) and applied (right) value of β^{-1}. Geometry variations of Façade 8.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F8-A	21	1	1	1	1	1
F8-B	11245	6042	3539	1232	1075	974

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F8-A	1	1	1	1	1	1
F8-B	539	275	117	1	1	0

Table D123. Measured (left) and applied (right) value of β^{-1}. Soil variations of Façade 8.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	5905	3035	1824	416	323	263
Soil B	5360	3008	1716	817	753	712

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	405	210	93	1	1	1
Soil B	135	66	25	1	1	1

Table D124. Measured (left) and applied (right) value of β^{-1}. Material of Façade 8.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	9876	5803	3028	*	*	*
Sl Weak						
Standard	4526	2356	1459	1046	814	665
Sl Strong						
Strong	2496	907	824	803	799	798

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	679	390	171	*	*	*
Sl Weak						
Standard	121	23	6	2	1	1
Sl Strong						
Strong	10	1	1	1	1	1

Table D125. Measured value of β^{-1}. Settlement variations of Façade 8.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	5529	2773	1278	217	152	116
Symmetric	5736	3270	2262	1016	924	860

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	4925	2319	1246	50	21	10
Asym L/5	6133	3228	1311	383	283	221
Sym L/2	5799	2934	1998	730	614	526
Sym L/4	5674	3606	2526	1302	1234	1193

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	305	151	71	1	1	1
Symmetric	235	124	47	1	1	1

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	411	200	108	1	1	1
Asym L/5	198	102	34	1	1	1
Sym L/2	341	177	94	1	1	1
Sym L/4	130	72	1	1	1	1

Table D126. Measured value of β^{-1} of Façade 8.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F8	5633	3022	1770	616	538	488

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F8	270	138	59	1	1	1

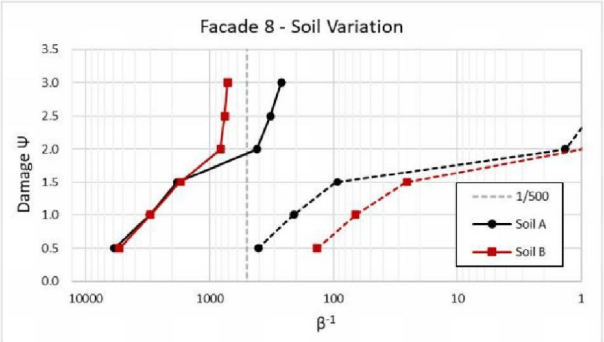


Figure D47. Angular distortion (^-1) against damage of Façade 8. Soil variation. Dashed lines refers to applied β^{-1}.

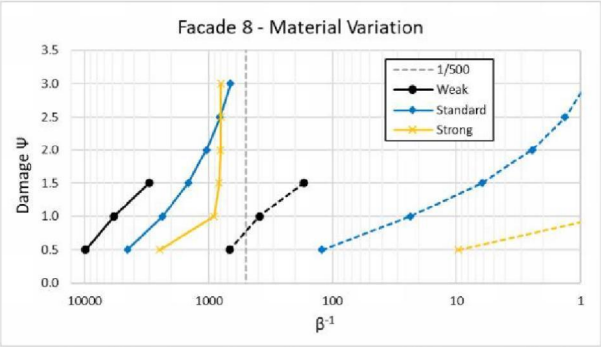


Figure D48. Angular distortion (^-1) against damage of Façade 8. Material variation. Dashed lines refers to applied β^{-1}.

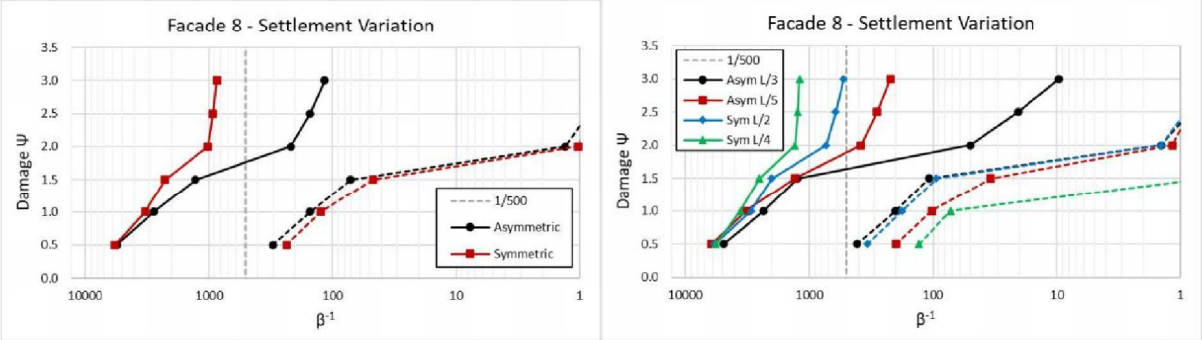


Figure D49. Angular distortion (^-1) against damage of Façade 8. Settlement variation. Dashed lines refers to applied β^{-1}.

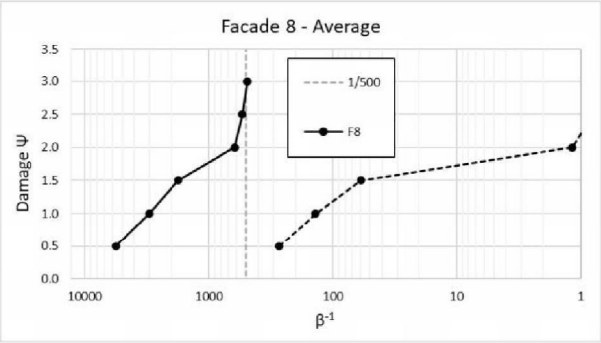


Figure D50. Angular distortion (^-1) against damage of Façade 8. Average results. Dashed lines refers to applied β^{-1}.

It must be noted that the models with weak materials show a plateau in the damage function (Figure D51). This results in less vulnerability with respect to the standard material (Figure D52). For this reason, the expected damage produced by Façade 8 with weak material is not computed.

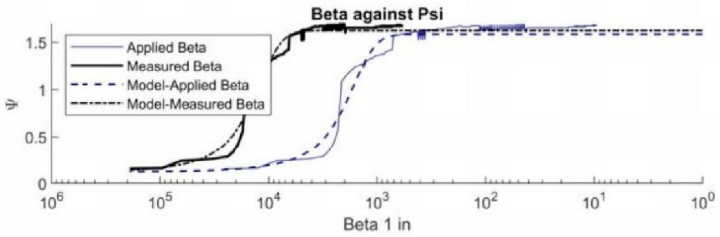


Figure D51. Angular distortion (^-1) against damage of Façade 8-B, weak material, asymmetric settlement, knick point=L/3. Extrapolation function.

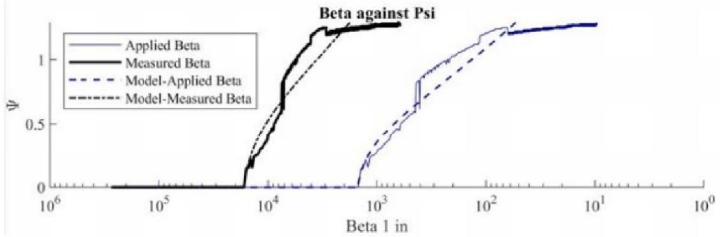


Figure D52. Angular distortion (^-1) against damage of Façade 8-B, standard material, asymmetric settlement, knick point=L/3. Extrapolation function.

Façade 9

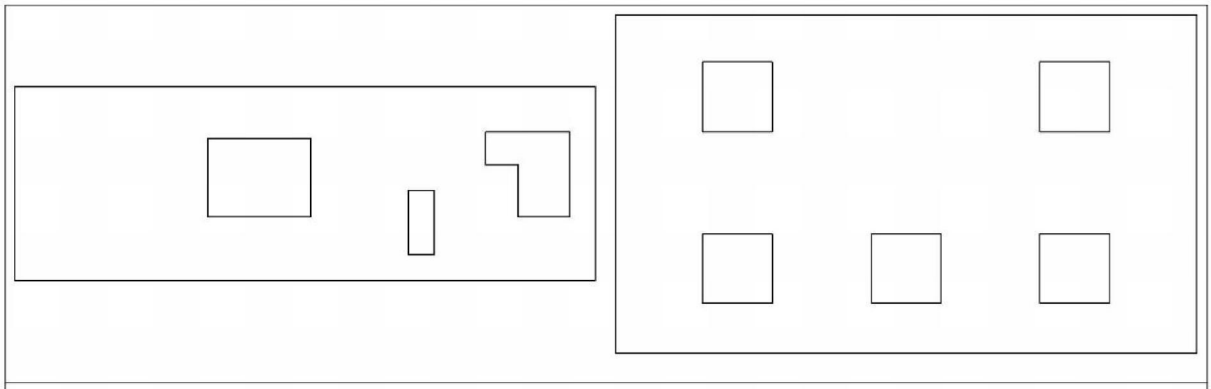


Figure D53. Two geometry variations of Façade 9.

Table D127. Percentage of models that reach a specific damage level. Geometry variations of Façade 9.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F9-A	100.0%	95.8%	91.7%	91.7%	91.7%	91.7%
F9-B	100.0%	100.0%	91.7%	79.2%	66.7%	66.7%

Table D128. Percentage of models that reach a specific damage level. Soil variations of Façade 9.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	100.0%	100.0%	91.7%	87.5%	79.2%	79.2%
Soil B	100.0%	95.8%	91.7%	83.3%	79.2%	79.2%

Table D129. Percentage of models that reach a specific damage level. Material variations of Façade 9.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Sl Weak						
Standard	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Sl Strong						
Strong	100.0%	93.8%	75.0%	56.3%	37.5%	37.5%

Table D130. Percentage of models that reach a specific damage level. Settlement variations of Façade 9.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	100.0%	100.0%	100.0%	91.7%	83.3%	83.3%
Symmetric	100.0%	95.8%	83.3%	79.2%	75.0%	75.0%

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	100.0%	100.0%	100.0%	100.0%	83.3%	83.3%
Asym L/5	100.0%	100.0%	100.0%	83.3%	83.3%	83.3%
Sym L/2	100.0%	100.0%	100.0%	91.7%	83.3%	83.3%
Sym L/4	100.0%	91.7%	66.7%	66.7%	66.7%	66.7%

Table D131. Percentage of models that reach a specific damage level. Façade 9.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F9	100.0%	97.9%	91.7%	85.4%	79.2%	79.2%

Table D132. Measured (left) and applied (right) value of β^{-1}. Geometry variations of Façade 9.

Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00	Geometry	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F9-A	11502	7180	5142	3951	3186	2653	F9-A	1410	809	572	484	454	430
F9-B	6945	4639	3395	2666	2190	1870	F9-B	1117	733	545	449	417	389

Table D133. Measured (left) and applied (right) value of β^{-1}. Soil variations of Façade 9.

Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00	Soil	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Soil A	9416	5985	4349	3397	2779	2356	Soil A	1824	1102	794	656	596	561
Soil B	9031	5834	4188	3220	2597	2167	Soil B	702	440	323	278	275	258

Table D134. Measured (left) and applied (right) value of β^{-1}. Material of Façade 9.

Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00	Material	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Weak	9961	7392	5746	4628	3848	3267	Weak	1895	1432	1148	967	879	805
Sl Weak							Sl Weak						
Standard	8861	5793	4290	3372	2757	2354	Standard	1069	620	430	360	358	357
Sl Strong							Sl Strong						
Strong	8848	4544	2769	1925	1459	1163	Strong	825	262	98	74	69	67

Table D135. Measured value of β^{-1}. Settlement variations of Façade 9.

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00	Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asymmetric	8117	5475	4064	3202	2630	2221	Asymmetric	1198	786	590	508	477	442
Symmetric	10330	6344	4473	3415	2746	2302	Symmetric	1328	756	527	425	394	377

Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00	Settlement	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
Asym L/3	8832	5776	4246	3341	2743	2321	Asym L/3	1669	1125	847	739	695	655
Asym L/5	7401	5175	3882	3062	2516	2121	Asym L/5	727	446	333	278	258	229
Sym L/2	10606	6618	4744	3669	2990	2530	Sym L/2	2063	1224	877	722	667	637
Sym L/4	10054	6069	4201	3161	2503	2073	Sym L/4	594	289	177	128	121	118

Table D136. Measured value of β^{-1} of Façade 9.

Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00	Façade	Ψ=0.5	Ψ=1.0	Ψ=1.5	Ψ=2.0	Ψ=2.5	Ψ=3.00
F9	9223	5910	4268	3308	2688	2261	F9	1263	771	559	467	435	410

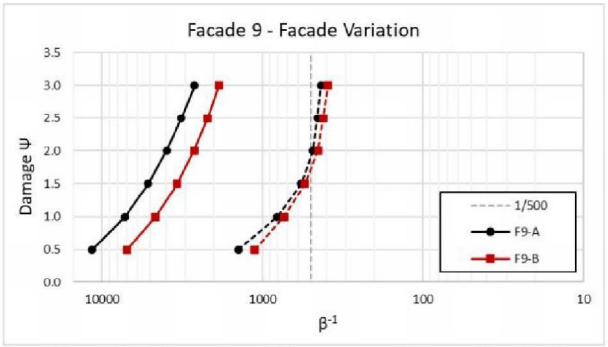


Figure D54. Angular distortion (^-1) against damage of Façade 9. Geometry variation. Dashed lines refers to applied β^{-1}.

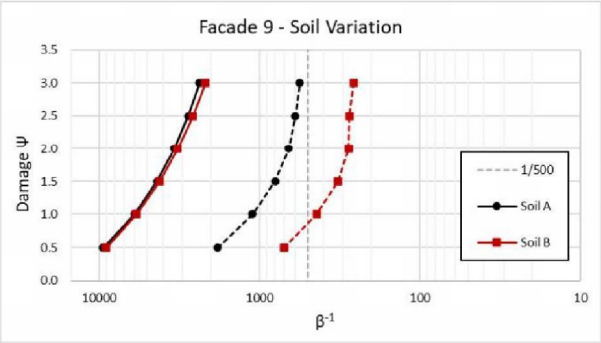


Figure D55. Angular distortion (^-1) against damage of Façade 9. Soil variation. Dashed lines refers to applied β^{-1}.

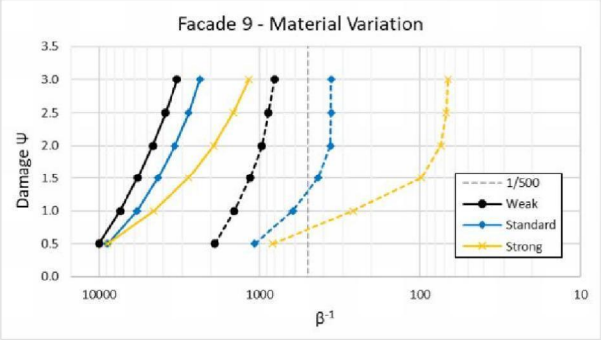


Figure D56. Angular distortion (^-1) against damage of Façade 9. Material variation. Dashed lines refers to applied β^{-1}.

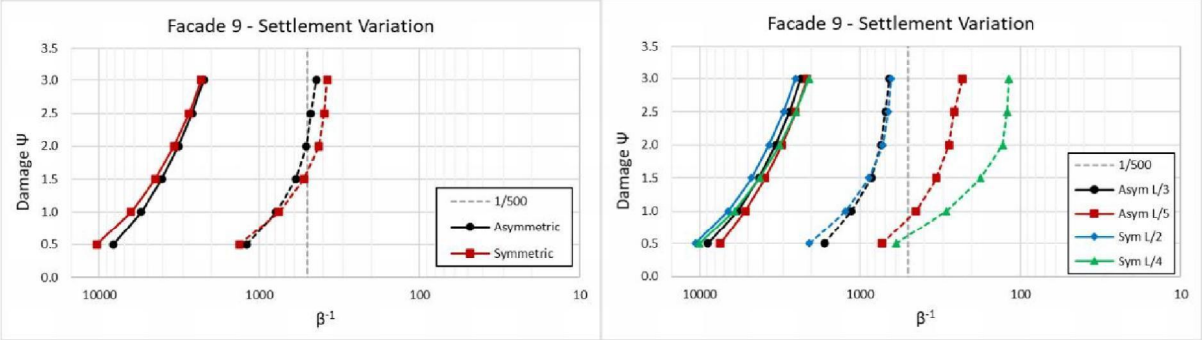


Figure D57. Angular distortion (^-1) against damage of Façade 9. Settlement variation. Dashed lines refers to applied β^{-1}.

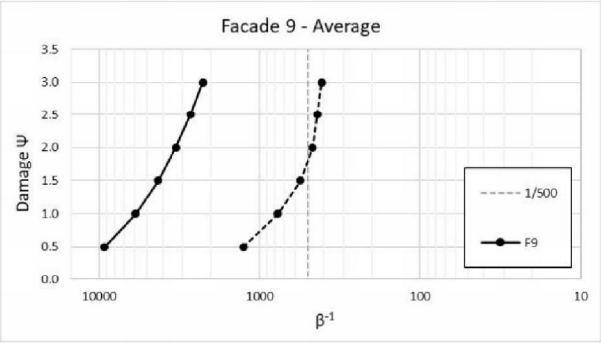


Figure D58. Angular distortion (^-1) against damage of Façade 9. Average results. Dashed lines refers to applied β^{-1}.