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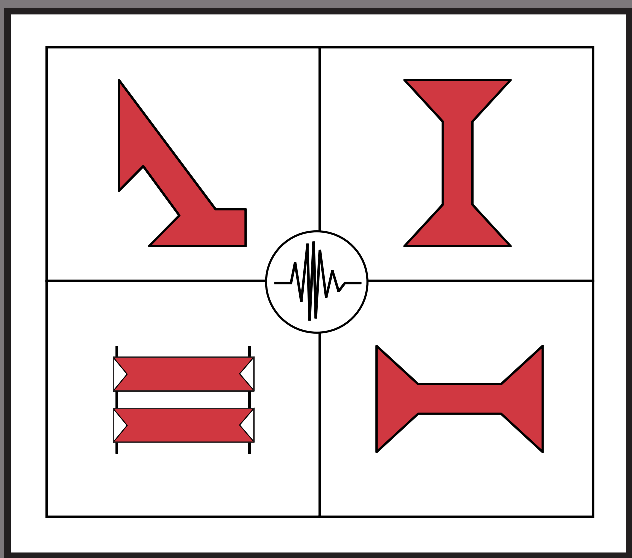
Ministry of Interior - Italian Fire Service
Coordination team for short term countermeasures

VADEMECUM
STOP
SHORING TEMPLATES AND OPERATING PROCEDURES FOR THE SUPPORT OF BUILDINGS DAMAGED BY EARTHQUAKES



PROJECT DEVELOPMENT OF RAPID HIGHLY-SPECIALIZED OPERATIVE UNITS FOR STRUCTURAL EVALUATION DRHOUSE

This project is funded by the European Union

Ministry of Interior

Italian Fire Service

NCP Coordination team for short term countermeasures

University of Udine

DCFA Department of Chemistry, Physics and Environment
SPRINT Safety and Protection Intersectoral Laboratory

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VADEMECUM

STOP

SHORING TEMPLATES AND OPERATING PROCEDURES FOR THE SUPPORT OF BUILDINGS DAMAGED BY EARTHQUAKES

Abruzzo earthquake 2009
Coordination team for short term countermeasures (NCP)

WORKING GROUP FOR THE STOP MANUAL
Under the supervision of Sergio Basti
Central director for emergency and urgent technical rescue

coordinator:
Stefano Grimaz
University of Udine

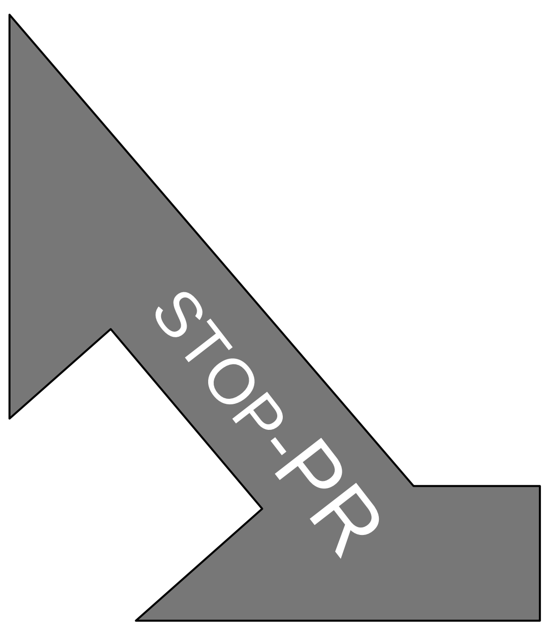
Marco Cavriani, Eros Mannino, Loris Munaro,
Mario Bellizzi, Ciro Bolognese, Mauro Caciolai,
Andrea D'Odorico, Alberto Maiolo, Luca Ponticelli
Italian Fire Service

with the contribute of:
Fausto Barazza, Petra Malisan, Alberto Moretti
University of Udine

April 2010

VADEMECUM STOP

TIMBER RAKER SHORES



ABRUZZO EARTHQUAKE 2009
COORDINATION TEAM FOR TEMPORARY WORKS

WORKING GROUP FOR THE VADEMECUM STOP
under the supervision of Sergio Basti - Central director for emergency and urgent technical rescue
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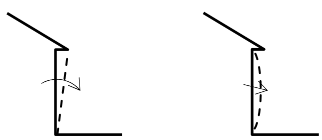
S.Grimaz (coordinator)
L.Munaro, M.Cavriani, E.Mannino, C.Bolognese, M.Caciolai, L.Ponticelli,
M.Bellizzi, A. D'Odorico, A.Maiolo

With the contribute of:
F.Barazza, P.Malisan, A.Moretti

Translated by:
L. Ponticelli, S. La Mendola, E. Gissi
and
Keith Bellamy
Section Leader, Urban Search & Rescue
Hampshire Fire and Rescue Service, UK

TIMBER RAKER SHORES: selection criteria

MAIN SCENARIOS



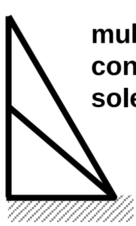
OUT OF VERTICAL PLANE ROTATION

BULGING OF THE WALL

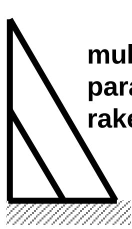
SOLUTION WITH

SOLID SOLE RAKERS

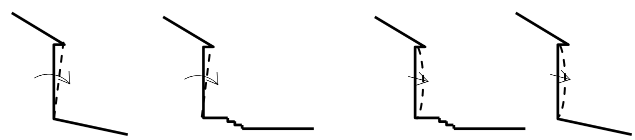
see STOP-**PR**/B
(from page 2/15)



multiple insertion, converging, solid sole, rakers



multiple insertion, parallel, solid sole, rakers



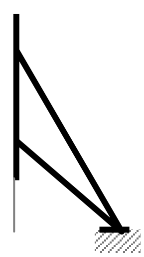
OUT OF VERTICAL PLANE ROTATION

BULGING OF THE WALL

SOLUTION WITH

FLYING RAKERS

see STOP-**PR**/S
(from page 9/15)



multiple insertion, converging flying raker on a single point base

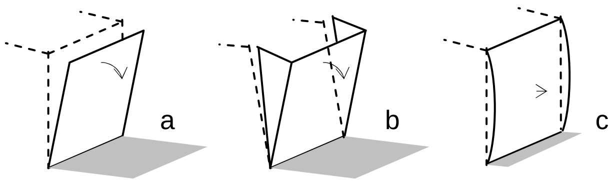
multiple insertion, flying raker on a short solid sole

NOTE: WALL RESTRAINING CAN BE ALSO DONE BY OTHER TECHNIQUES LIKE STEEL WIRE ROPE TIE BACKS. THE USE OF STEEL WIRE ROPE TIE BACKS SHALL BE PREFERRED WHEN THE DAMAGED WALL ABUTS ON A NARROW STREET.

SOLID SOLE RACKERS: general recommendations

STOP-**PR**/B

Movement to contrast:



rotation bulging

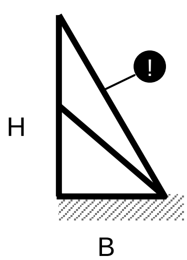
Description

Potential out of plane rotation of a wall due to:
a) break of the joint between two perpendicular walls
b) break of the supporting perpendicular wall

Evidence of bulging on the external walls

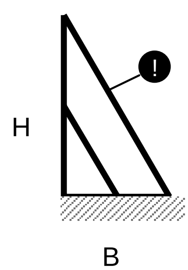
Function of the raker: to prevent further rotation or bulging of the wall

STRUCTURAL SKETCHES (the following tables shall be used for both solutions)



Critical element: !
the main raker

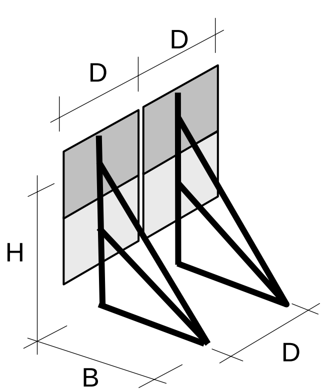
multiple insertion, converging, solid sole, rakers



Critical element: !
the main raker

multiple insertion, parallel, solid sole, rakers

Shored wall area and supporting areas for each raker



H main raker insertion point
D span between shores
B sole length

Table 1 – Selection of type depending on the height H

Height H (m)	**TYPE**
2.0 ≤ H ≤ 3.0 m	**R1** (see table R1)
3.0 < H ≤ 5.0 m	**R2** (see table R2)
5.0 < H ≤ 7.0 m	**R3** (see table R3)
H > 7.0 m	Use laminated timber or steel. Specific design required.

SOLID SOLE RACKERS: general recommendations

STOP-**PR**/B

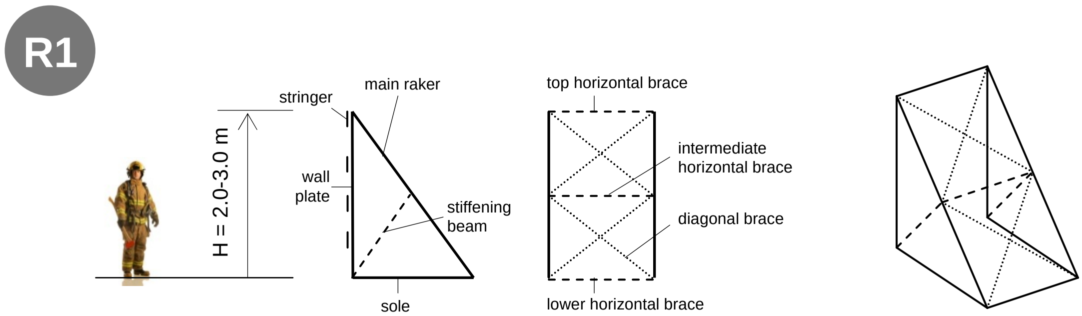


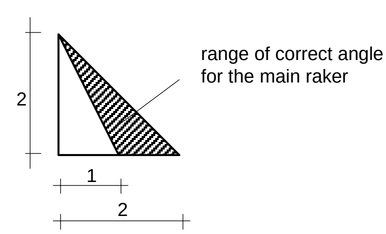
Table 2 – Main solid sole raker dimensions (cm x cm) for the type R1

R1 H 2.0-3.0 m	wall thickness s_m	≤ 0.6 m				0.6 – 1.0 m			
seismic class (see Annex 1)		class A		class B		class A		class B	
sole length B		1.5 m	2.5 m	1.5 m	2.5 m	1.5 m	2.5 m	1.5 m	2.5 m
span between shores D	D≤1.5 m	13 x 13	13 x 13	13 x 13	13 x 13	15 x 15	13 x 13	13 x 13	13 x 13
	1.5<D≤2.0 m	15 x 15	13 x 13	13 x 13	13 x 13	18 x 18	15 x 15	15 x 15	13 x 13

If no Annex 1 is provided, seismic class A should be used

Other elements	
sole	same as the main raker
wall plate	same as the main raker
stiffening beams	2 lengths of 2.5 x 12 cm screwed/nailed on the struts by 3 screws Ø5 x 100 mm or by 3 nails L = 80 mm each end
diagonal braces	lengths of 2.5 x 12 cm screwed/nailed by 2 screws Ø5 x 100 mm or by 3 nails L = 80 mm each end
horizontal braces	lengths of 8 x 8 cm screwed/nailed by 2 screws Ø6 x 160 mm or by 3 nails L = 150 mm each end
stringers	lengths of 5 x 20 cm with 1 m as the max distance between centres placed on the continuous parts of the wall

CORRECT ANGLE
OF THE MAIN RAKER



SOLID SOLE RACKERS: general recommendations

R2

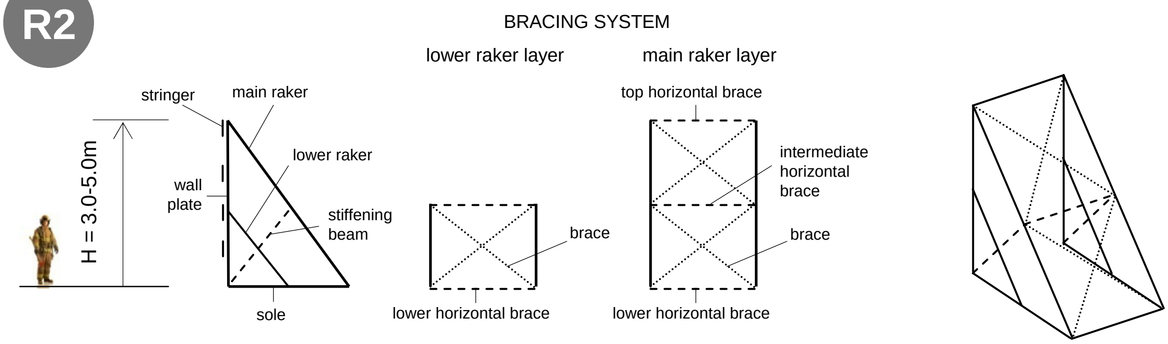


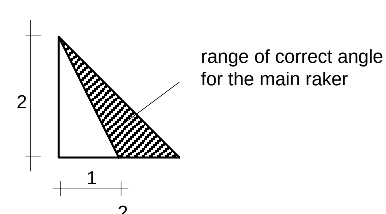
Table 3 - Main solid sole raker dimensions (cm x cm) for the type R2

R2 H 3.0-5.0m	wall thickness s_m	≤ 0.6 m				0.6 – 1.0 m			
seismic class (see Annex 1)		class A		class B		class A		class B	
sole length B		2.5 m	3.5 m	2.5 m	3.5 m	2.5 m	3.5 m	2.5 m	3.5 m
span between shores D	D≤1.0 m	13 x 13	13 x 13	13 x 13	13 x 13	15 x 15	15 x 15	15 x 15	13 x 13
	1.0<D≤1.5 m	15 x 15	15 x 15	15 x 15	13 x 13	18 x 18	18 x18	15 x 15	15 x 15
	1.5<D≤2.0 m	18 x 18	15 x 15	15 x 15	15 x 15	20 x 20	18 x 18	18 x 18	18 x 18
	2.0<D≤2.5 m	18 x 18	18 x 18	18 x 18	15 x 15	n.a.	18 x 18	20 x 20	18 x 18

n.a. - not avalilable, specific design required
If no Annex 1 is provided, seismic class A should be used

Other elements	
lower raker	same as the main raker
sole	same as the main raker
wall plate	same as the main raker
stiffening beams	2 lengths of 5 x 20 cm screwed/nailed on the struts by 3 screws Ø5 x 100 mm or by 3 nails L = 100 mm each end
braces	lengths of 5 x 20 cm screwed/nailed by 3 screws Ø5 x 100 mm or by 3 nails L = 100 mm each end *or* lengths of 8 x 8 cm screwed/nailed by 2 screws Ø6 x 160 mm or by 2 nails L = 150 mm each end
horizontal braces	lengths of 8 x 8 cm screwed/nailed by 2 screws Ø6 x 160 mm or by 2 nails L = 150 mm each end
stringers	lengths of 5 x 20 cm with 1 m as the max distance between centres placed on the continuous parts of the wall

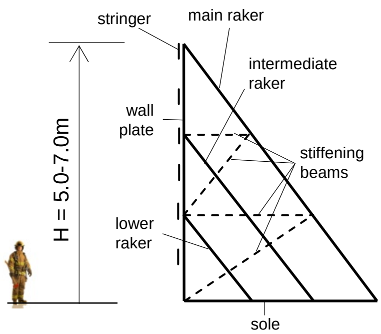
CORRECT ANGLE
OF THE MAIN RAKER



SOLID SOLE RACKERS: general recommendations

STOP-**PR**/B

R3



BRACING SYSTEM

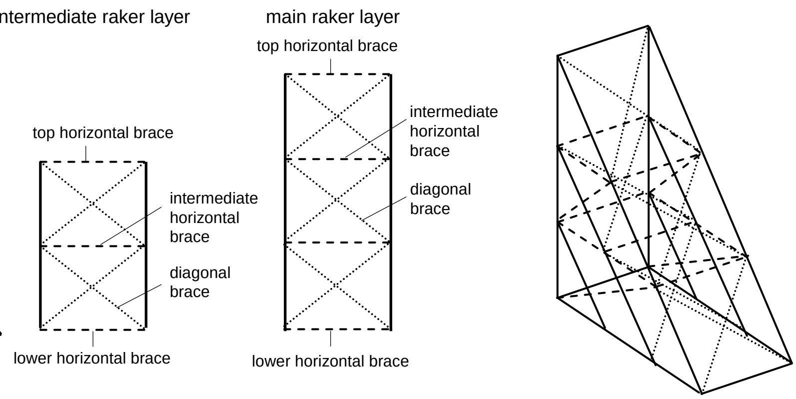


Table 4 - Main solid sole raker dimensions (cm x cm) for the type R3

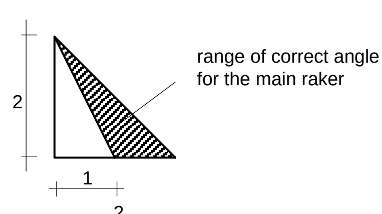
R3 H 5.0-7.0 m	wall thickness s_m	≤ 0.6 m				0.6 m – 1.0 m			
seismic class (see Annex 1)		class A		class B		class A		class B	
sole length B		3.5 m	4.5 m	3.5 m	4.5 m	3.5 m	4.5 m	3.5 m	4.5 m
span between shores D	D≤1.0 m	20 x 20	20 x 20	20 x 20	20 x 20	20 x 20	20 x 20	20 x 20	20 x 20
	1.5<D≤2.0 m	20 x 20	20 x 20	20 X 20	20 x 20	n.a.	20 x 20	n.a.	20 x 20

n.a - not avalilable, specific design required

If no Annex 1 is provided, seismic class A should be used

Other elements	
lower raker	same as the main raker
sole	same as the main raker
Wall plate	same as the main raker
stiffening beams	2 lengths of 5 x 20 cm screwed/nailed on the struts by 3 screws Ø5 x 100 mm or by 3 nails L = 100 mm each end
braces	lengths of 5 x 20 cm screwed/nailed by 3 screws Ø5 x 100 mm or by 3 nails L = 100 mm each end *or* lengths of 8 x 8 cm screwed/nailed by 2 screws Ø6 x 160 mm or by 2 nails L = 150 mm each end
horizontal braces	lengths of 8 x 8 cm screwed/nailed by 2 screws Ø6 x 160 mm or by 2 nails L = 150 mm each end
stringers	lengths of 5 x 20 cm with 1 m as the max distance between centres placed on the continuous parts of the wall

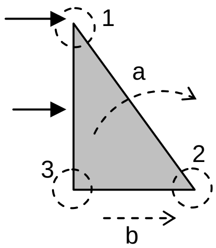
CORRECT ANGLE
OF THE MAIN RAKER



SOLID SOLE RAKERS: general recommendations

STOP-**PR**/B

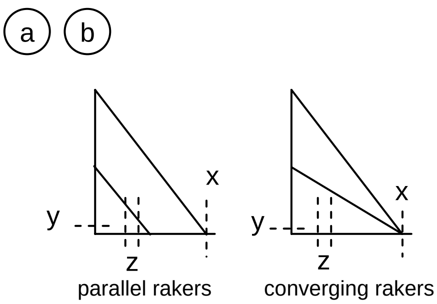
Critical considerations



Global considerations
a – global rotation
b – base sliding

Local considerations
1 – breaking of the top node
2 – breaking of the lower external node
3 – breaking of the lower internal node

Global solutions



x – installing a restraining system to avoid the base sliding outward

y – embedding the sole into the wall or
anchoring the wall plate to the wall

or, instead of y:

z – pinning the sole to the ground using solution A on page 7/15.
Nailing length shall be half the sole length and start from the wall end.

WARNING: the z solution shall be employed ONLY IF it is not possible to embed the sole into the wall. In this case the wall plate to wall interface shall guarantee enough friction as to prevent the upward sliding of the shore.

Local solutions

1 Wall plate-raker node

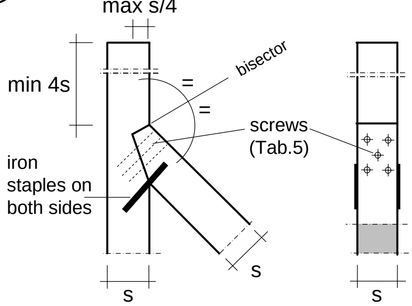
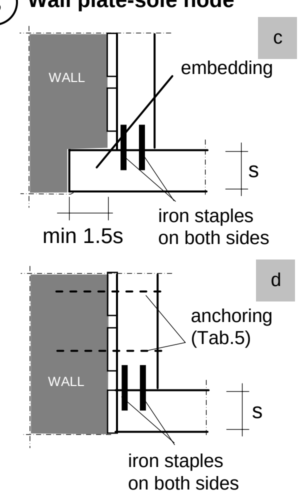


Table 5 – Screws and bolts

section	screws	bolts
13 x 13	5 ϕ10x150	2 ϕ16
15 x 15	5 ϕ12x180	3 ϕ16
18 x 18	5 ϕ12x200	4 ϕ16
20 x 20		

WARNING: Iron staples min ϕ8 or timber boards on both sides of the wall plate (2.5cm thickness, nailed or screwed)

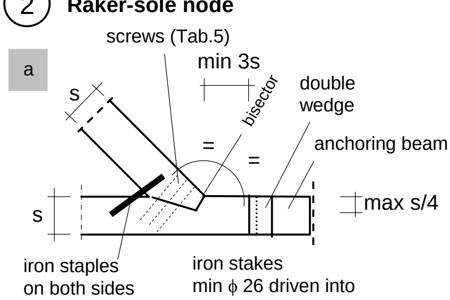
3 Wall plate-sole node

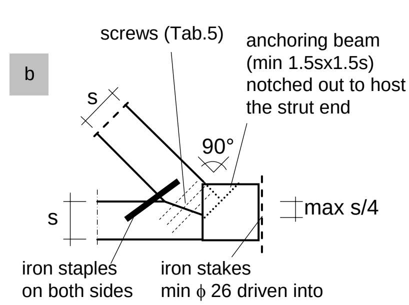


NOTE: (c) and (d) are alternative solutions

WARNING:
embedding or anchoring are not necessary when using the z solution.

2 Raker-sole node



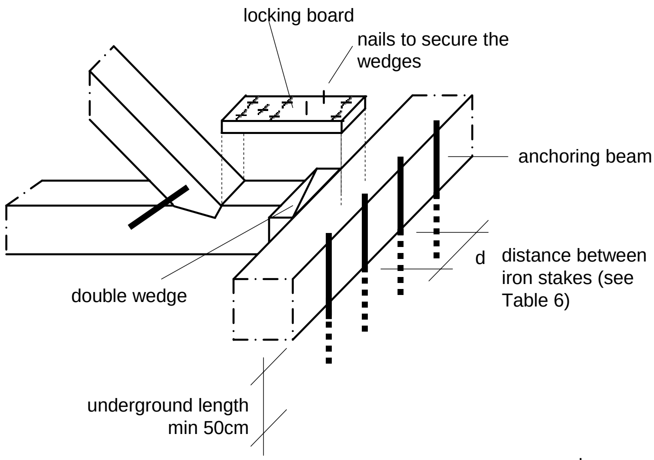


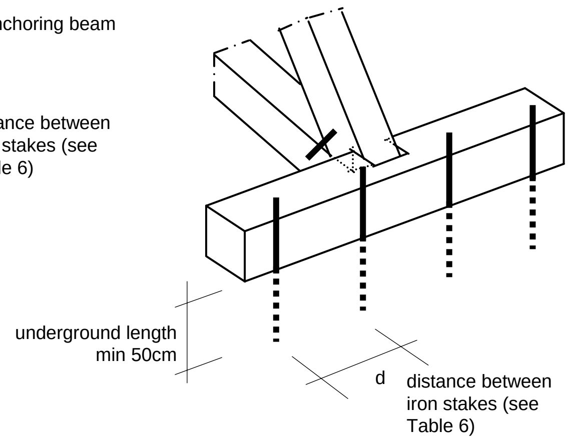
NOTE: both (a) and (b) are possible, but (a) is preferred

WARNING: the joint notch should never go deeper than s/4

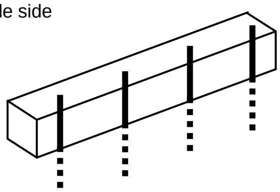
SOLID SOLE RAKERS: anchoring solutions for the base

STOP-**PR**/B

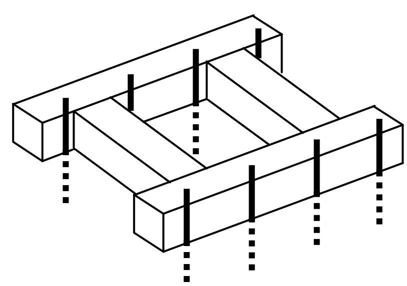




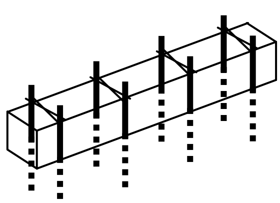
Stakes on a single side of the beam
(S)

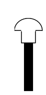


Double anchorage beam
(D)



Stakes coupled
(A)





WARNING: remember to install protective elements over the stakes.

Table 6 - Distance d between the stakes

STAKES FOR ANCHORING	R1		R2		R3	
wall thickness s_m	≤0.6m	0.6<s_m≤1.0m	≤0.6m	0.6<s_m≤1.0m	≤0.6m	0.6<s_m≤1.0m
seismic class A	1 Ø26 every 50 cm (S)	1 Ø26 every 40 cm (S)	1 Ø26 every 30 cm (S)	1 Ø26 every 25 cm (S) or 40 cm on two rows (A) o (D)	1 Ø26 every 12.5 cm (S) or every 25 cm on two rows (A) o (D)	1 Ø26 every 10 cm (S) or every 20 cm on two rows (A) o (D)
seismic class B	1 Ø26 every 60 cm (S)	1 Ø26 every 50 cm (S)	1 Ø26 every 40 cm (S)	1 Ø26 every 30 cm (S) or 50 cm on two rows (A) o (D)	1 Ø26 every 15 cm (S) or every 30 cm on two rows (A) o (D)	1 Ø26 every 12.5cm (S) or every 25 cm on two rows (A) o (D)

NOTE: given the same distance between the stakes, when the (S) solution is allowed, also (A) and (D) are; if the (A) solution is allowed, also (D) is.
If no Annex 1 is provided, seismic class A should be used

TIMBER SOLID SOLE RAKER SHORES

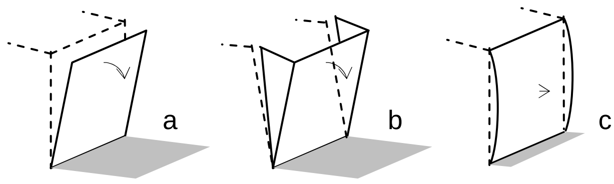
Field of application
These solutions shall be used to support buildings damaged by earthquakes.

General assumptions
These raker shores shall be employed to restrain load bearing masonry walls not exceeding 1m thick. Two solutions are proposed: the tables R1, R2 and R3 shall be used for both parallel or converging rakers having the same height H.
"H" is defined as the difference in height between the sole lower point and the raker upper edge. This edge should be placed at a corresponding insertion point on the other side of the restrained wall, for example a slab, a vault, an arch, or a perpendicular wall, in order to effectively transfer the forces to the raker shore.
Given the height "H", the raker shore type R1, R2, or R3 is therefore chosen using table 1 at page 2/15. When H>7.0m, using laminated timber or steel instead of ordinary timber is recommended, and specific design of the raker shore is required.
Given the thickness of the restrained wall "s_m" and the seismic class (see Annex 1), once the span "D" and the sole length "B" are chosen, the raker shore shall be sized using table 2 for R1 type, table 3 for R2 type, table 4 for R3 type.
Many raker shore elements share the same section size to ease timber procurement and simplify the shore's connections.
On page 6/15 main construction critical considerations are listed, and corresponding solutions are showed. Some construction details of the shore's connections are proposed.
On page 7/15 two kinds of construction details for anchoring of the sole are shown.
In particular the sole anchoring should:
- prevent the upward displacement of the sole-wall plate node;
- prevent the outward displacement of the sole-raker node.

WARNING
All the provided dimensions are intended as minimum values. During the construction phase, thicker sections can be used, if available.

FLYING RAKERS: general recommendations | STOP-**PR**/S

Movement to contrast:



rotation   bulging

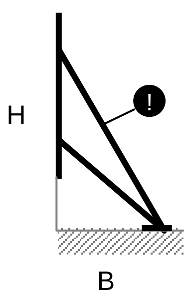
Description:

Potential out of plane rotation of a wall due to:
a) break of the joint between two perpendicular walls
b) break of the supporting perpendicular wall

Evidence of bulging on the external walls

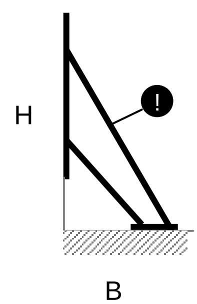
Function of the raker: to prevent further rotation or the bulging of the wall

STRUCTURAL SKETCHES (the following tables shall be used for both solutions)



Critical element: !
the main raker

multiple insertion, converging, flying raker, on a single point base



Critical element: !
the main raker

multiple insertion, flying raker, on a short solid sole

Shored wall area and supporting areas for each raker

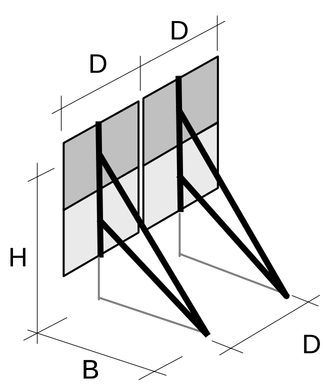


Table 7 – Selection of type depending on the height H

Height H (m)	**TYPE**
2.0 ≤ H ≤ 3.0 m	**R1** (see table R1)
3.0 < H ≤ 5.0 m	**R2** (see table R2)
5.0 < H ≤ 7.0 m	**R3** (see table R3)
H > 7.0 m	Use laminated timber or steel. Specific design required.

H main raker insertion point
D span between shores
B sole length

FLYING RAKERS: general recommendations

STOP-**PR**/S

R1

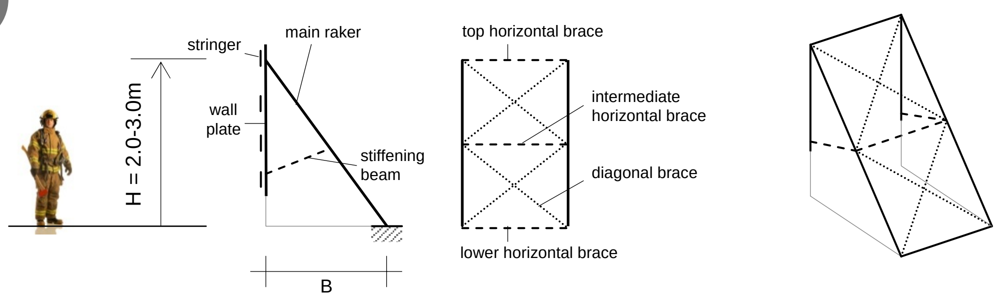


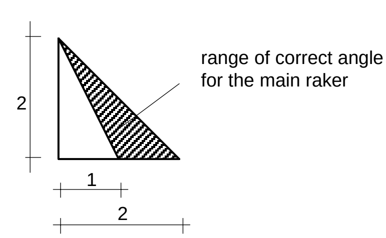
Table 8 – Main flying raker dimensions (cm x cm) for the type R1

R1 H 2.0-3.0m	wall thickness s_m	≤ 0.6 m				0.6 – 1.0 m			
seismic class (see Annex 1)		class A		class B		class A		class B	
sole length B		1.5 m	2.5 m	1.5 m	2.5 m	1.5 m	2.5 m	1.5 m	2.5 m
span between shores D	D≤1.5 m	13 x 13	13 x 13	13 x 13	13 x 13	15 x 15	13 x 13	13 x 13	13 x 13
	1.5<D≤2.0 m	15 x 15	13 x 13	13 x 13	13 x 13	18 x 18	15 x 15	15 x 15	13 x 13

If no Annex 1 is provided, seismic class A should be used

Other elements	
sole	same as the main raker
wall plate	same as the main raker
stiffening beams	2 lengths of 2.5 x 12 cm screwed/nailed on the struts by 3 screws Ø5 x 100 mm or by 3 nails L = 80 mm each end
diagonal braces	lengths of 2.5 x 12 cm screwed/nailed by 2 screws Ø5 x 100 mm or by 3 nails L = 80 mm each end
horizontal braces	lengths of 8 x 8 cm screwed/nailed by 2 screws Ø6 x 160 mm or by 3 nails L = 150 mm each end
stringers	lengths of 5 x 20 cm with 1 m as the max distance between centres placed on the continuous parts of the wall

CORRECT ANGLE
OF THE MAIN RAKER



FLYING RAKERS: general recommendations

STOP-**PR**/S

R2

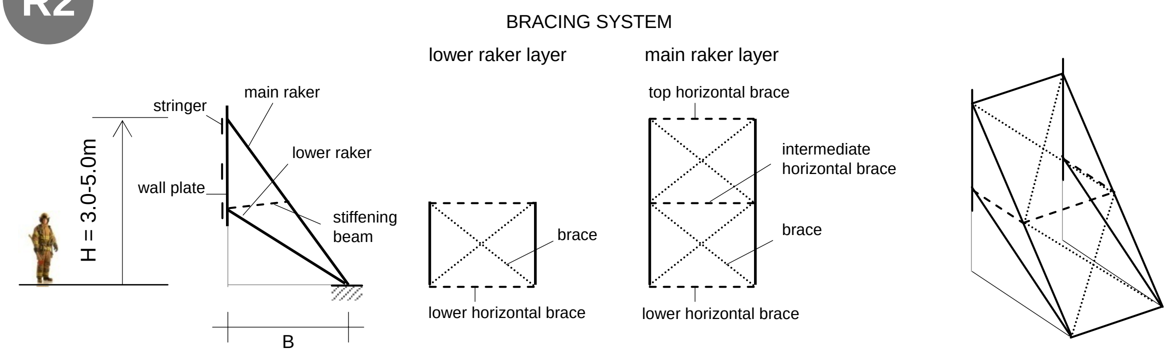


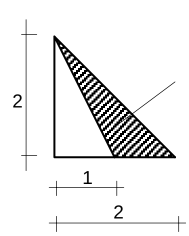
Table 9 - Main flying raker dimensions (cm x cm) for the type R2

R2 H 3.0-5.0 m	wall thickness s_m	≤ 0.6 m				0.6 – 1.0 m			
seismic class (see Annex 1)		class A		class B		class A		class B	
sole length B		2.5 m	3.5 m	2.5 m	3.5 m	2.5 m	3.5 m	2.5 m	3.5 m
span between shores D	D≤1.0 m	13 x 13	13 x 13	13 x 13	13 x 13	15 x 15	15 x 15	15 x 15	13 x 13
	1.0<D≤1.5 m	15 x 15	15 x 15	15 x 15	13 x 13	18 x 18	18 x18	15 x 15	15 x 15
	1.5<D≤2.0 m	18 x 18	15 x 15	15 x 15	15 x 15	20 x 20	18 x 18	18 x 18	18 x 18
	2.0<D≤2.5 m	18 x 18	18 x 18	18 x 18	15 x 15	n.a.	18 x 18	20 x 20	18 x 18

n.a. - not avalilable, specific design required
If no Annex 1 is provided, seismic class A should be used

Other elements	
lower raker	same as the main raker
sole	same as the main raker
wall plate	same as the main raker
stiffening beams	2 lengths of 5 x 20 cm screwed/nailed on the struts by 3 screws Ø5 x 100 mm or by 3 nails L = 100 mm each end
braces	lengths of 5 x 20 cm screwed/nailed by 3 screws Ø5 x 100 mm or by 3 nails L = 100 mm each end *or* lengths of 8 x 8 cm screwed/nailed by 2 screws Ø6 x 160 mm or by 2 nails L = 150 mm each end
horizontal braces	lengths of 8 x 8 cm screwed/nailed by 2 screws Ø6 x 160 mm or by 2 nails L = 150 mm each end
stringers	lengths of 5 x 20 cm with 1 m as the max distance between centres placed on the continuous parts of the wall

CORRECT ANGLE
OF THE MAIN RAKER



FLYING RAKERS: general recommendations

STOP-**PR**/S

R3

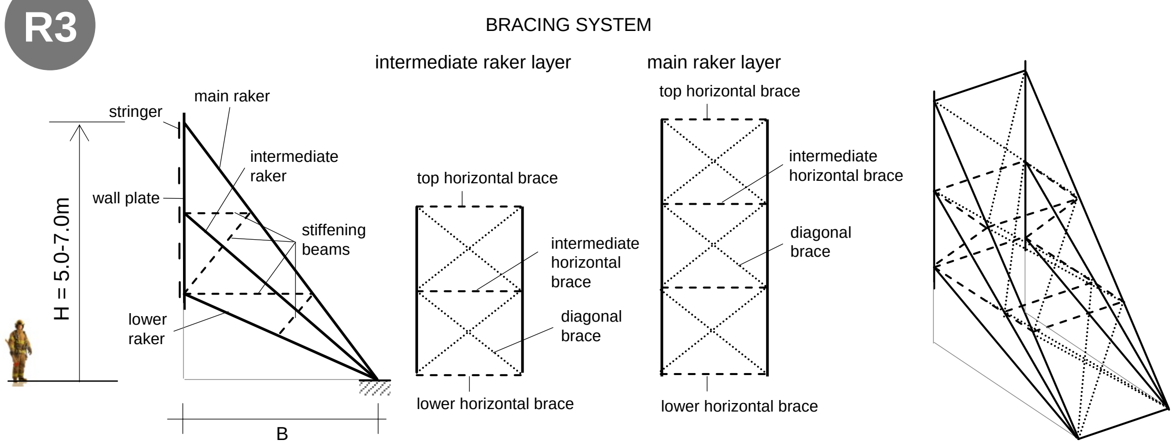


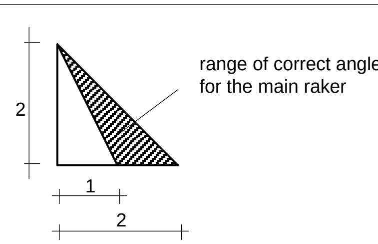
Table 10 - Main flying raker dimensions (cm x cm) for the type R3

R3 H 5.0-7.0 m	wall thickness s_m	≤ 0.6 m				0.6 m – 1.0 m			
seismic class (see Annex 1)		class A		class B		class A		class B	
sole lenght B		3.5 m	4.5 m	3.5 m	4.5 m	3.5 m	4.5 m	3.5 m	4.5 m
span between shores D	D≤1.0 m	20 x 20	20 x 20	20 x 20	20 x 20	20 x 20	20 x 20	20 x 20	20 x 20
	1.5<D≤2.0 m	20 x 20	20 x 20	20 X 20	20 x 20	n.a.	20 x 20	n.a.	20 x 20

n.a. - not avalilable, specific design required
If no Annex 1 is provided, seismic class A should be used

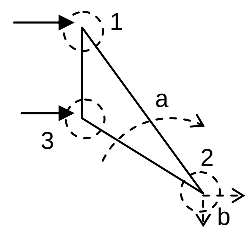
Other elements	
lower raker	same as the main raker
sole	same as the main raker
wall plate	same as the main raker
stiffening beams	2 lengths of 5 x 20 cm screwed/nailed on the struts by 3 screws Ø5 x 100 mm or by 3 nails L = 100 mm each end
braces	lengths of 5 x 20 cm screwed/nailed by 3 screws Ø5 x 100 mm or by 3 nails L = 100 mm each end *or* lengths of 8 x 8 cm screwed/nailed by 2 screws Ø6 x 160 mm or by 2 nails L = 150 mm each end
horizontal braces	lengths of 8 x 8 cm screwed/nailed by 2 screws Ø6 x 160 mm or by 2 nails L = 150 mm each end
stringers	lengths of 5 x 20 cm with 1 m as the max distance between centres placed on the continuous parts of the wall

CORRECT ANGLE
OF THE MAIN RAKER



FLYING RAKERS: general recommendations | STOP-**PR**/S

Critical considerations

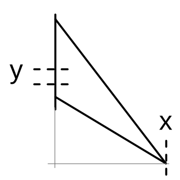


Global considerations
a – global rotation
b – base sliding/sinking

Local considerations
1 – breaking of the top node
2 – breaking of the lower external node
3 – breaking of the lower internal node

Global solutions

a b



x – installing a restraining system to avoid the base sliding outward

y – anchoring the wall plate to the wall

WARNING: if the y solution is not possible, the wall plate to wall interface shall guarantee enough friction as to prevent the upward sliding of the shore.

Local solutions

1 Wall plate-main raker node

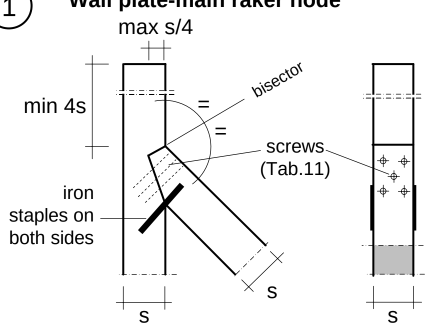
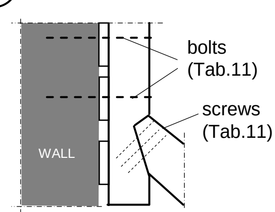


Table 11 – Screws and bolts

section	screws	bolts
13 x 13	5 ϕ10 x150	2 ϕ16
15 x 15	5 ϕ12 x180	3 ϕ16
18 x 18	5 ϕ12 x200	4 ϕ16
20 x 20		

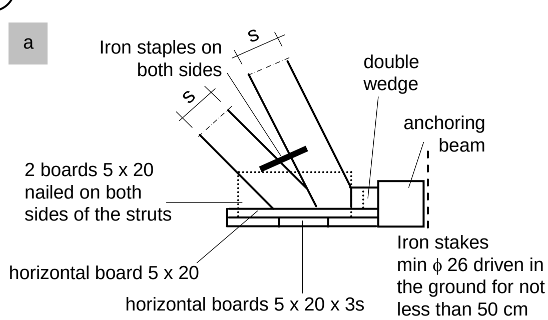
WARNING: Iron staples min ϕ8 or timber slabs on both sides of the wall plate (2.5cm thickness, nailed or screwed)

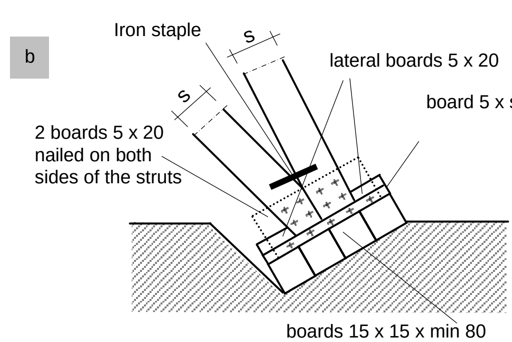
3 Wall plate-lower raker node



WARNING:
the bolts shall punch the stringers (if drilling the wall is not possible, follow previous global solutions)

2 Lower node

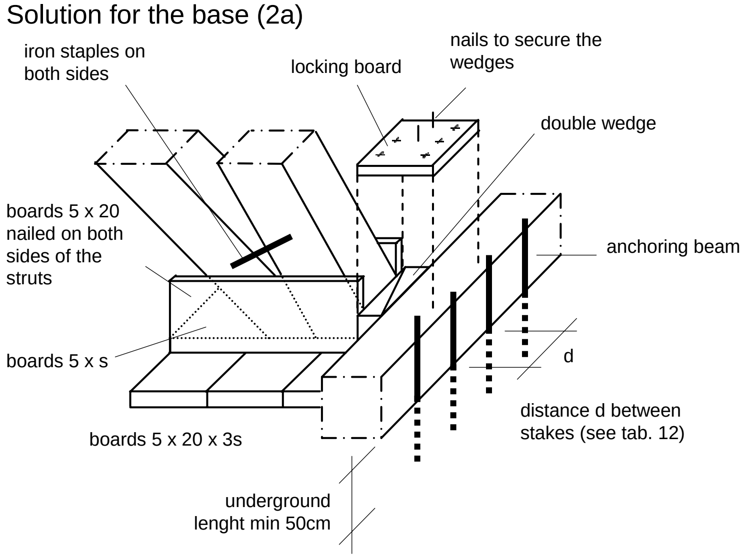


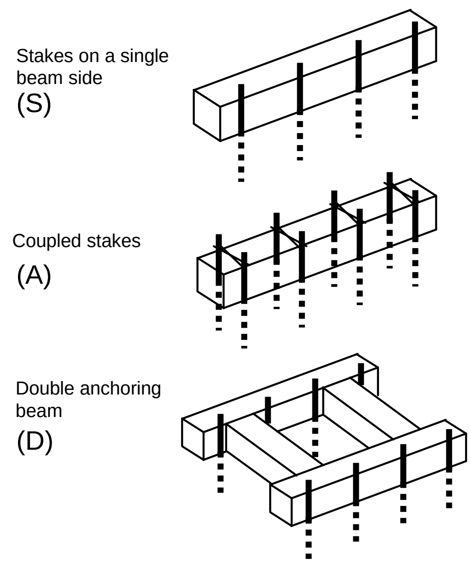


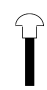
NOTE: both (a) and (b) are possible.
WARNING: The joint notch should never go deeper than s/4

FLYING RAKERS: anchoring solutions for the base

Solution for the base (2a)







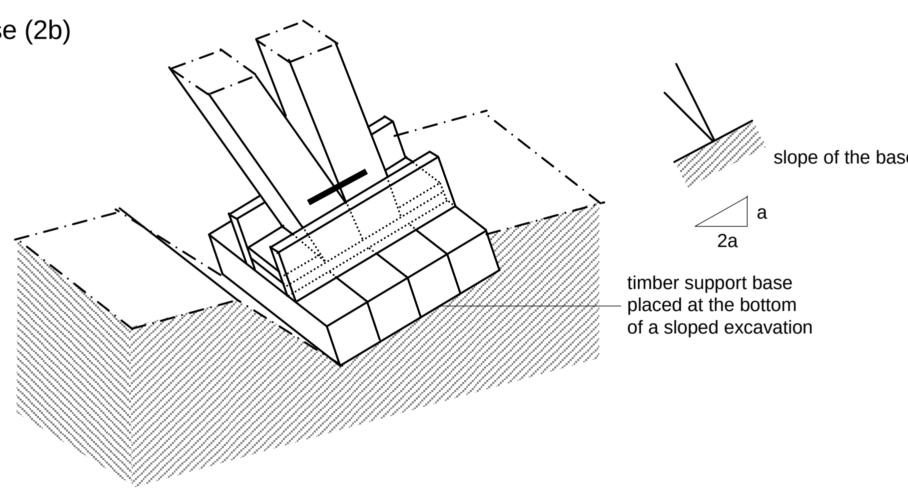
WARNING: remember to install protective elements over the stakes.

Table 12 - Distance d between the stakes

STAKES FOR ANCHORING	R1		R2		R3	
wall thickness s_m	≤0.6m	$0.6<s_m≤1.0$m	≤0.6m	$0.6<s_m≤1.0$m	≤0.6m	$0.6<s_m≤1.0$m
seismic class A	1 Ø26 every 50 cm (S)	1 Ø26 every 40 cm (S)	1 Ø26 every 30 cm (S)	1 Ø26 every 25 cm (S) or 40 cm on two rows (A) o (D)	1 Ø26 every 12.5 cm (S) or every 25 cm on two rows (A) o (D)	1 Ø26 every 10 cm (S) or every 20 cm on two rows (A) o (D)
seismic class B	1 Ø26 every 60 cm (S)	1 Ø26 every 50 cm (S)	1 Ø26 every 40 cm (S)	1 Ø26 every 30 cm (S) or 50 cm on two rows (A) o (D)	1 Ø26 every 15 cm (S) or every 30 cm on two rows (A) o (D)	1 Ø26 every 12.5cm (S) or every 25 cm on two rows (A) o (D)

NOTE: given the same distance between the stakes, when the (S) solution is allowed, also (A) and (D) are; if the (A) solution is allowed, also (D) is.

Solution for the base (2b)



TIMBER FLYING RAKER SHORES

Field of application
These solutions shall be used to support buildings damaged by earthquakes.

General assumptions
These raker shores shall be employed to restrain load bearing masonry walls not exceeding 1m thick. Two solutions are proposed: the tables R1, R2 and R3 shall be used for both “single point base” and “short solid sole base” shores having the same height H.
“H” is defined as the difference in height between the sole lower point and the main raker upper edge. This edge should be placed at a corresponding insertion point on the other side of the restrained wall, as for example a slab, a vault, an arch, or an perpendicular wall, in order to effectively transfer the forces to the raker shore.
Given the height “H”, the raker shore type R1, R2, or R3 is therefore chosen using table 7 at page 9/15. When H>7.0m, using laminated timber or steel instead of ordinary timber is recommended, and specific design of the raker shore is required.
Given the thickness of the restrained wall “s_m” and the seismic class (see Annex 1), once the span “D” and the sole length “B” are chosen, the raker shore shall be sized using table 8 for R1 type, table 9 for R2 type, table 10 for R3 type.
Many raker shore elements share the same section size to ease timber procurement and simplify the shore’s connections.
On page 13/15 main construction critical considerations are listed, and corresponding solutions are showed. Some construction details of the shore’s connections are proposed.
On page 14/15 two kinds of construction details for anchoring of the sole are shown.
In particular the sole anchoring should prevent the sole from sliding.

WARNING
All the provided dimensions are intended as minimum values. During the construction phase, thicker sections can be used, if available.

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VADEMECUM STOP

TIMBER WALL TO WALL SHORES (horizontal and sloped)

STOP-PC

ABRUZZO EARTHQUAKE 2009
COORDINATION TEAM FOR TEMPORARY WORKS

WORKING GROUP FOR THE VADEMECUM STOP
under the supervision of Sergio Basti - Central director for emergency and urgent technical rescue
manual licensed by note no. EM3064/5001-11 dated 2009-06-15

S.Grimaz (coordinator)
L.Munaro, M.Cavriani, E.Mannino, C.Bolognese, M.Caciolai, L.Ponticelli,
M.Bellizzi, A. D'Odorico, A.Maiolo

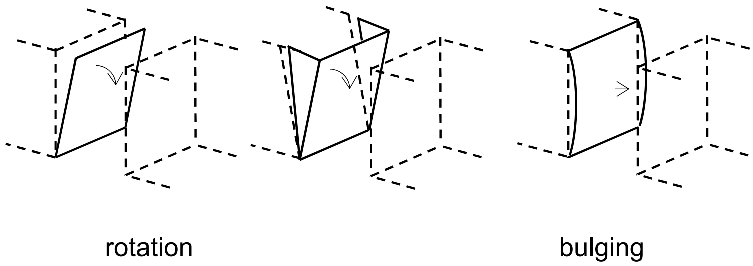
With the contribute of:
F.Barazza, P.Malisan, A.Moretti

Translated by:
L. Ponticelli, S. La Mendola, E. Gissi
and
Keith Bellamy
Section Leader, Urban Search & Rescue
Hampshire Fire and Rescue Service, UK

TIMBER WALLL TO WALL SHORES: general recommendations

STOP-**PC**

Movement to constrain:



Description

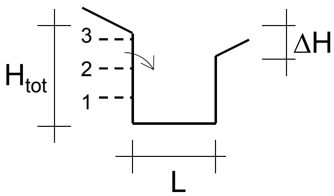
The intervention consists of the placement of a supporting timber structure between buildings that are not too far apart.

Warning

The intervention is allowed only under the permission of local Authorities because of the possibilities of damages to the support building due to aftershocks.

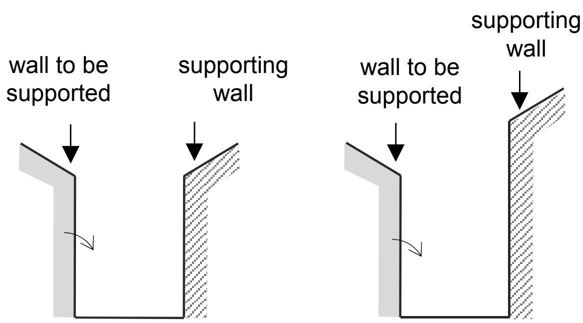
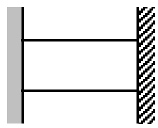
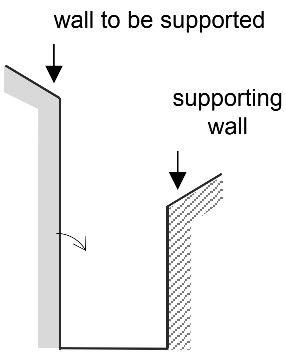
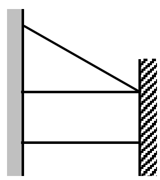
Function of the shore: to prevent further rotation or bulging of the wall.

SELECTION CRITERIA



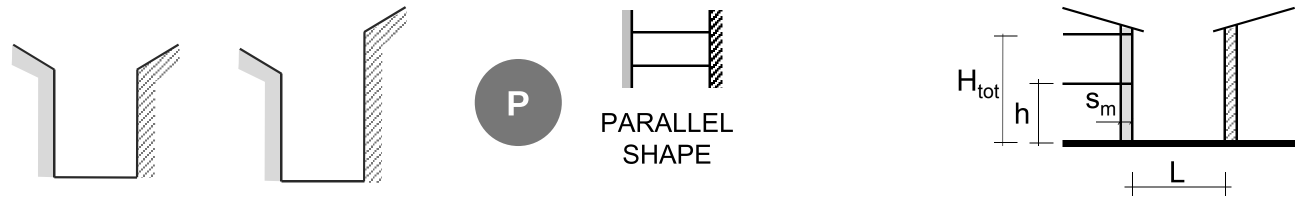
The use of the present procedure is allowed if:
$L \leq 8.0$ m, $H_{tot} \leq 9.0$m, $\Delta H \leq 4.0$m
(see below)

If $L > 8.0$ m or $\Delta H > 4.0$m or the number of the floors is more than 3 or $H_{tot} > 9.0$m, other specific procedures are required

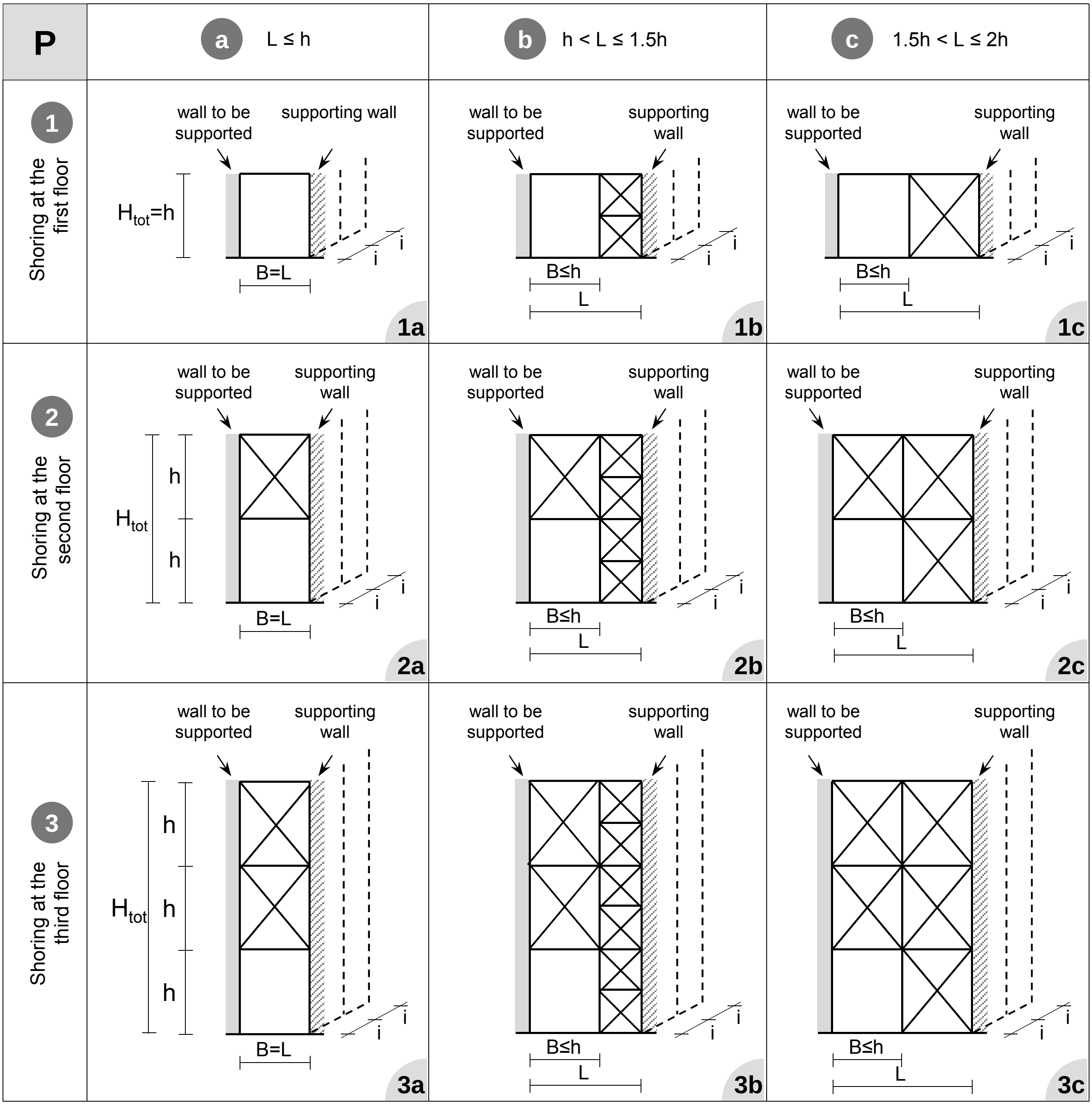
SCENARIO		SOLUTION
The heigth of the wall to be supported is the same as the heigth of the supporting wall		P PARALLEL SHAPE 
The wall to be supported is higher than the supporting wall		S SLOPE SHAPE 

PARALLEL SHAPE SHORE: main scenarios

STOP-**PC**

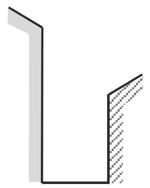


MAIN SCENARIOS



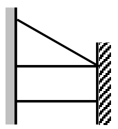
SLOPED SHORE: main scenarios

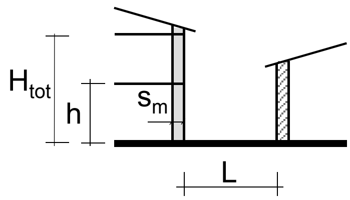
STOP-**PC**



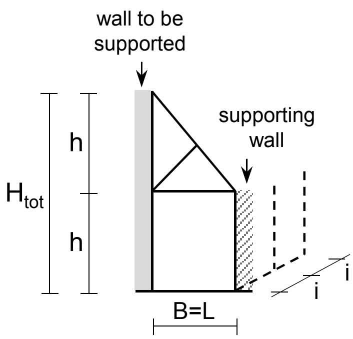
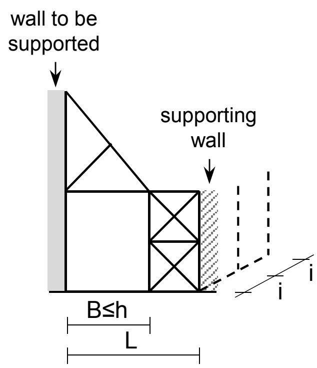
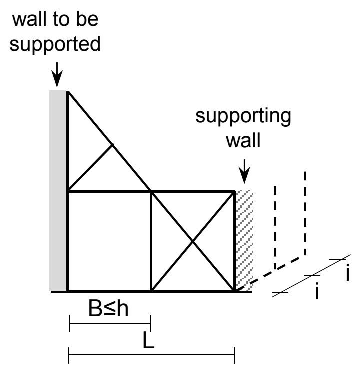
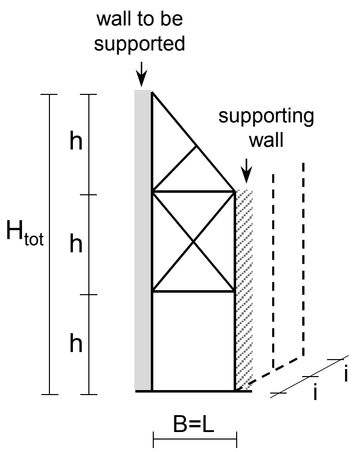
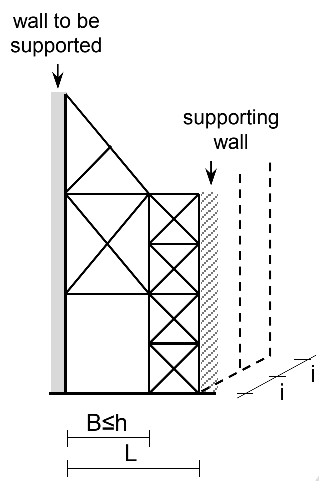
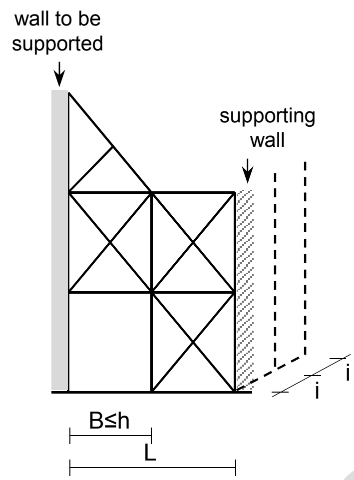
S

SLOPING SHAPE



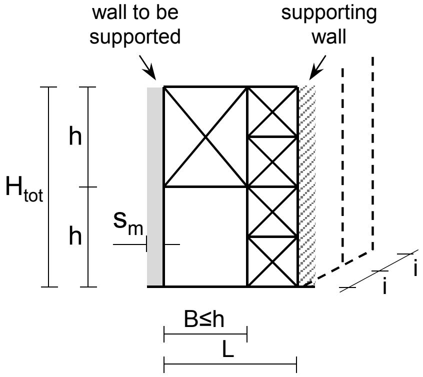


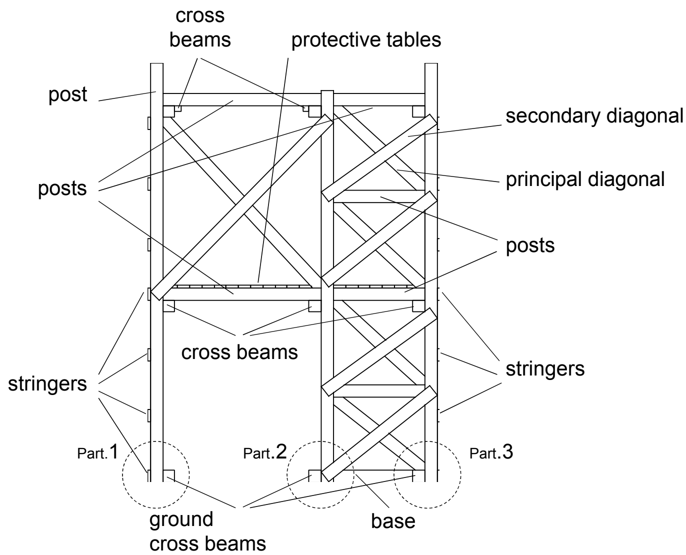
MAIN SCENARIOS

S	a L ≤ h	b h < L ≤ 1.5h	c 1.5h < L ≤ 2h
2 Shoring from the second to the first floor	 2a	 2b	 2c
3 Shoring from the third to the second floor	 3a	 3b	 3c

HORIZONTAL SHORE: sizing — STOP-PC

Structural sketches





See pages from 8/14 to 12/14

Table 1 – Horizontal shore: sizing of the main elements

P	Minimum dimensions of UPRIGHTS, POSTS, CROSS BEAMS AND DIAGONAL TIMBERS							
	Seismic class A *				Seismic class B *			
Height H_{tot} (m)	Maximum width of the wall to be supported: $s_m \leq 0.6$ m		Maximum width of the wall to be supported: $0.6 \text{ m} < s_m \leq 1.0$ m		Maximum width of the wall to be supported: $s_m \leq 0.6$ m		Maximum width of the wall to be supported: $0.6 \text{ m} < s_m \leq 1.0$ m	
	Section (cmxcm)	Distance between the axes i (m)	Section (cmxcm)	Distance between the axes i (m)	Section (cmxcm)	Distance between the axes i (m)	Section (cmxcm)	Distance between the axes i (m)
$6\text{m}<H_{tot} \leq 9\text{m}$	20 x 20	max 2.0	20 x 20	max 1.5	20 x 20	max 2.0	20 x 20	max 2.0
$3\text{m}<H_{tot} \leq 6\text{m}$	18 x 18	max 2.0	20 x 20	max 2.0	15 x 15	max 2.0	18 x 18	max 2.0
$H_{tot} \leq 3\text{m}$	15 x 15	max 2.0	18 x 18	max 2.0	13 x 13	max 2.0	15 x 15	max 2.0

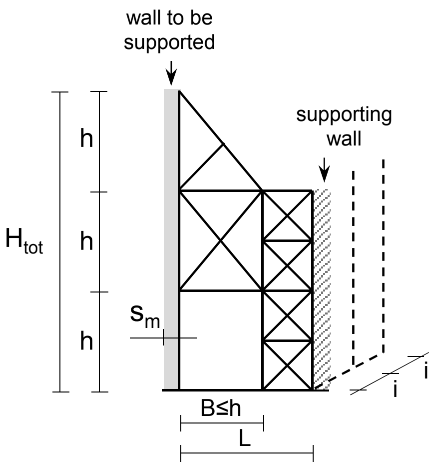
(*) For the seismic classes see the Annex 1
If no Annex 1 is provided, seismic class A should be used

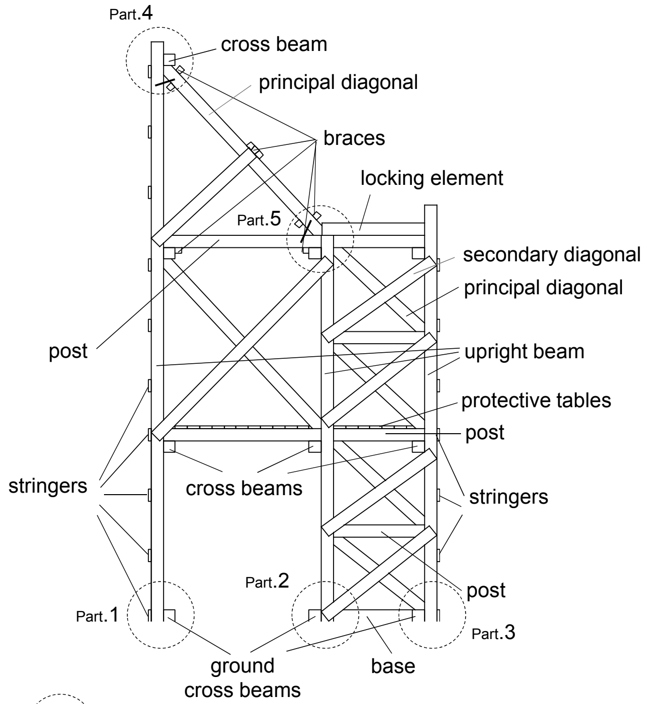
Secondary elements	
base	as the main elements
locking elements (see page 7/14)	as the main elements
ground cross beams	sections 15x15 cm or more
cross beams	sections 10x10 cm
secondary diagonal	boards 5x20 cm screwed/nailed by 3 screws Ø5x100 mm or by 3 nails L = 100 mm each edge placed on both the sides of the principal diagonal
stringers	boards 5 x 20 cm with 1 m as the max distance between centres placed on the continuous parts of the wall
protective tables	boards 5x20 cm

The dimensions in table 1 can be used for all the configurations showed on page 2/14

HORIZONTAL SHORE: sizing

Structural sketches





See pages from 8/14 to 12/14

Table 2 - Sloped shore: sizing of the main elements

S	Minimum dimensions of UPRIGHTS, POSTS, CROSS BEAMS AND PRINCIPAL DIAGONAL TIMBERS							
	Seismic class A *				Seismic class B *			
Height H_{tot} (m)	Maximum width of the wall to be supported: $s_m \leq 0.6$ m		Maximum width of the wall to be supported: 0.6 m < $s_m \leq 1.0$ m		Maximum width of the wall to be supported: $s_m \leq 0.6$ m		Maximum width of the wall to be supported: 0.6 m < $s_m \leq 1.0$ m	
	Section (cmxcm)	Distance between the axes i (m)	Section (cmxcm)	Distance between the axes i (m)	Section (cmxcm)	Distance between the axes i (m)	Section (cmxcm)	Distance between the axes i (m)
6m<H_{tot} ≤9m	18 x 18	max 2.0	20 x 20	max 2.0	15 x 15	max 2.0	18 x 18	max 2.0
3m<H_{tot} ≤6m	15 x 15	max 2.0	18 x 18	max 2.0	15 x 15	max 2.0	15 x 15	max 2.0

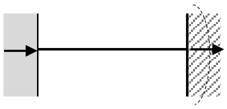
(*) For the seismic classes see the Annex 1
If no Annex 1 is provided, seismic class A should be used

Secondary elements	
base	as the main elements
locking elements (see page 7/14)	as the main elements
ground cross beams	sections 15x15 cm or more
cross beams	sections 10x10 cm
secondary diagonal	boards 5x20 cm screwed/nailed by 3 screws Ø5x100 mm or by 3 nails L = 100 mm each edge placed on both the sides of the principal diagonal
stringers	boards 5 x 20 cm with 1 m as the max distance between centres placed on the continuous parts of the wall
protective tables	boards 5x20 cm

The dimensions in table 2 can be used for all the configurations showed on page 3/14

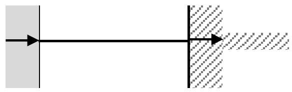
TIMBER WALLL TO WALL SHORES: critical considerations

Critical consideration
Posts could punch through the supporting wall



Plan

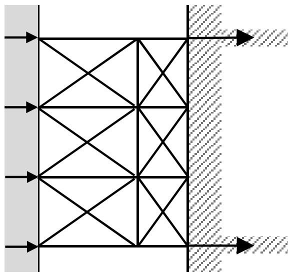
Safety criteria:
position the posts in line with perpendicular walls attached to the supporting wall



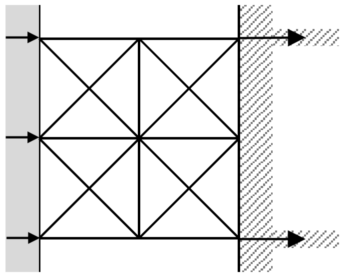
Plan

Critical consideration
The supported structure could impact on the supporting wall.

Safety criteria:
if it is not possible to position the posts in line with perpendicular walls a 10x10 sections horizontal distribution substructure should be provided.

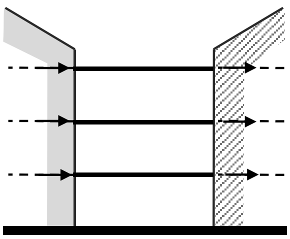


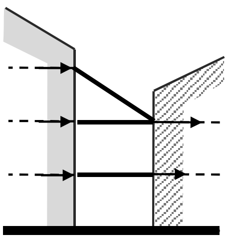
Plan



Plan

Floors at the same height

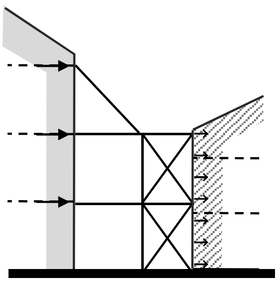




Vertical section

Safety criteria:
the principal diagonals and the posts should be positioned in line with the floors.

Floors at different height



Vertical section

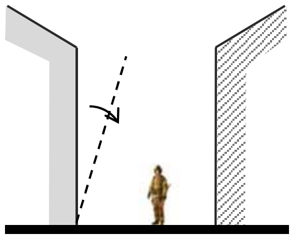
Critical consideration
The supported structure could impact on the supporting wall

Safety criteria:
a vertical distribution substructure should be provided

KEY wall to be supported supporting wall

TIMBER WALLL TO WALL SHORES: safety instructions

STOP-**PC**



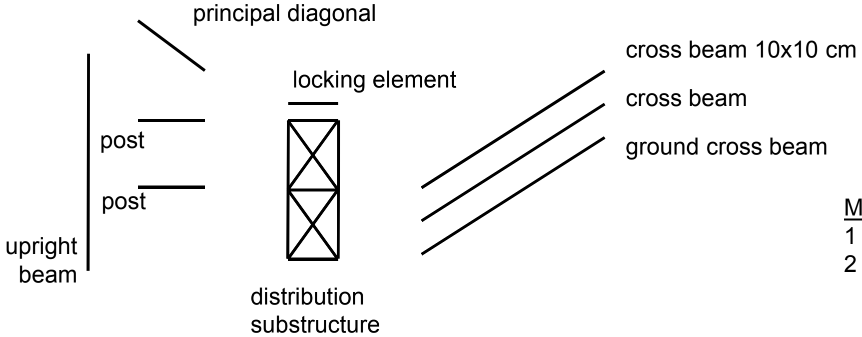
Vertical section

Critical consideration

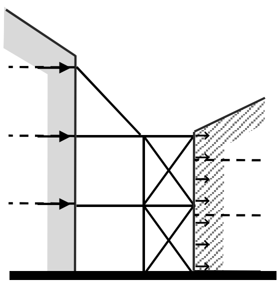
The wall to be supported could collapse during the shoring operations.

Safety instruction:
build the modular elements of the shore in a safe zone

ASSEMBLING THE ELEMENTS



Main phases:
1 – measuring of the elements
2 – building of the shore in a safe zone



Vertical section

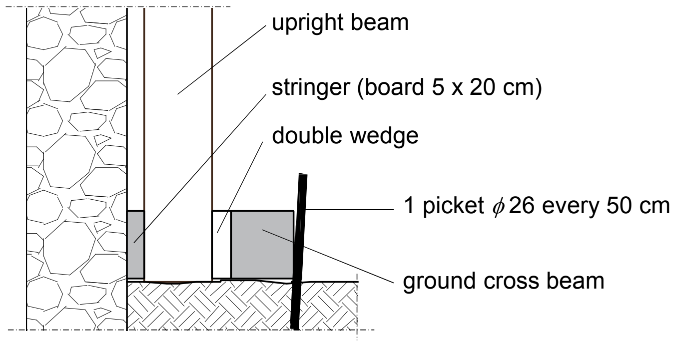
Assembling criteria:
1 – positioning of the upright beams on the side of the wall to be supported and the distribution substructure on the opposite side
2 – positioning of the posts
3 – positioning of the principal diagonals and the locking elements
4 – positioning of the protective tables
5 – complete the shore

TIMBER WALLL TO WALL SHORES: construction details

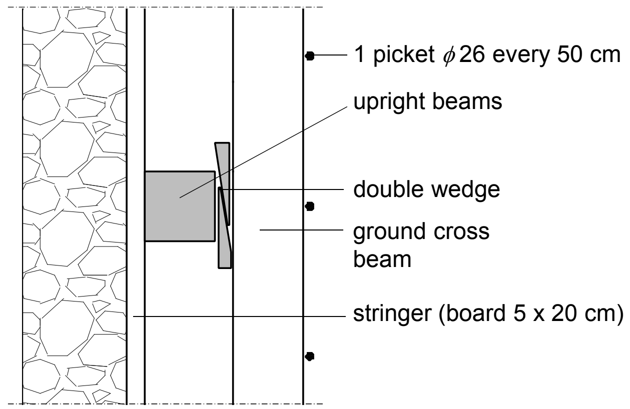
STOP-**PC**

Detail 1	BASE ANCHORAGE ON THE SIDE OF THE WALL TO BE SUPPORTED
BASE ANCHORAGE WITH EXTERNAL SUPPORT	

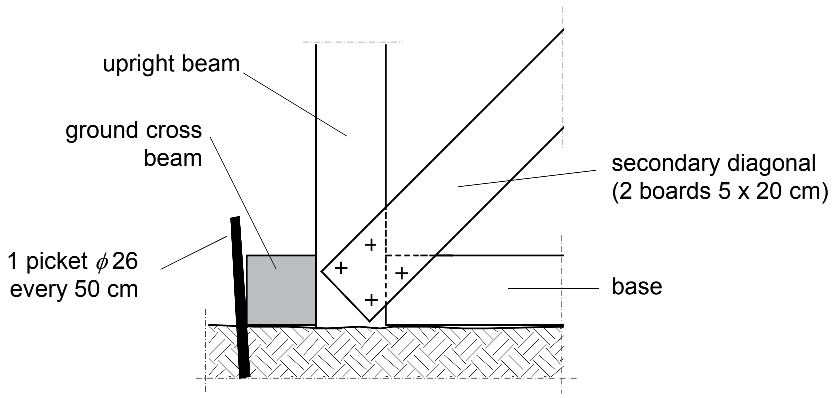
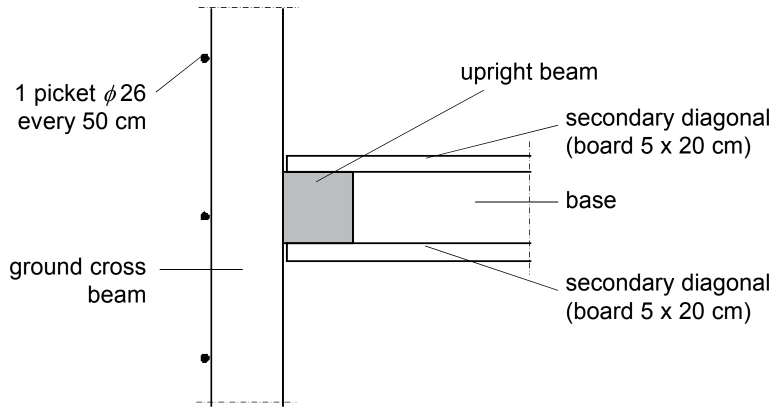
VERTICAL SECTION



PLAN



TIMBER WALLL TO WALL SHORES: construction details

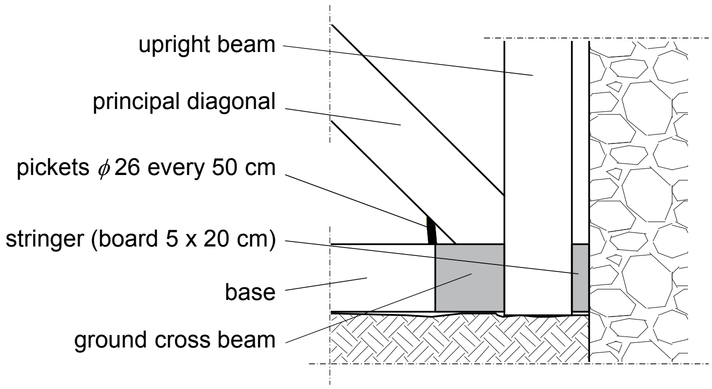
Detail 2	BASE ANCHORAGE ON THE SIDE FURTHEST FROM THE SUPPORTING WALL
BASE ANCHORAGE WITH EXTERNAL SUPPORT	 VERTICAL SECTION  PLAN

TIMBER WALLL TO WALL SHORES: construction details

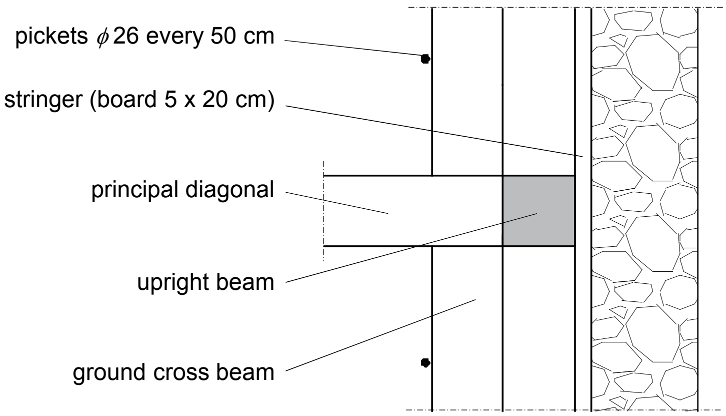
Detail 3

BASE ANCHORAGE ON THE SIDE NEAREST THE SUPPORTING WALL

BASE ANCHORAGE WITH EXTERNAL SUPPORT

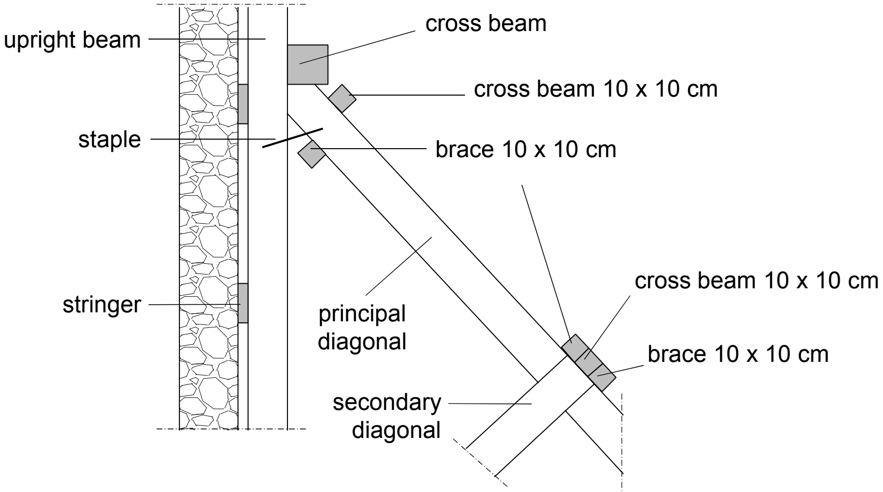


VERTICAL SECTION

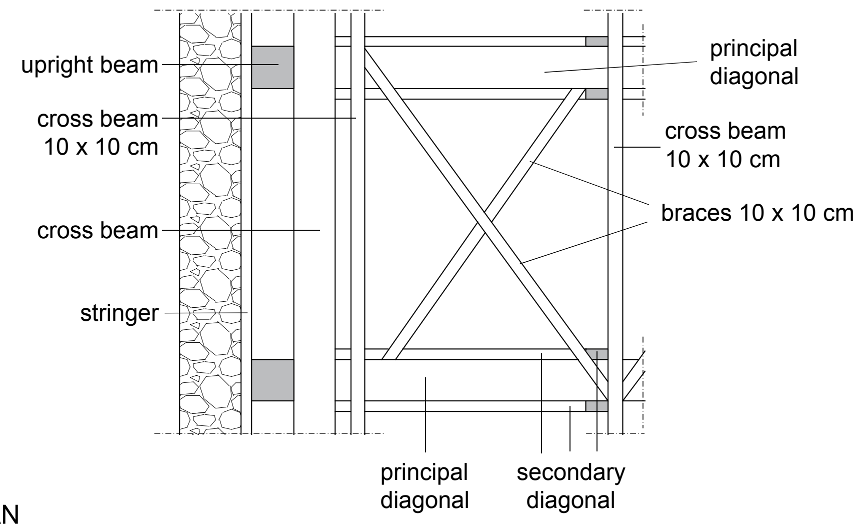


PLAN

TIMBER WALLL TO WALL SHORES: construction details

Detail 4	UPPER CONNECTION
CONNECTION BETWEEN THE UPRIGHT BEAM AND THE PRINCIPAL DIAGONAL ON THE SIDE OF THE WALL TO BE SUPPORTED	

VERTICAL SECTION



PLAN

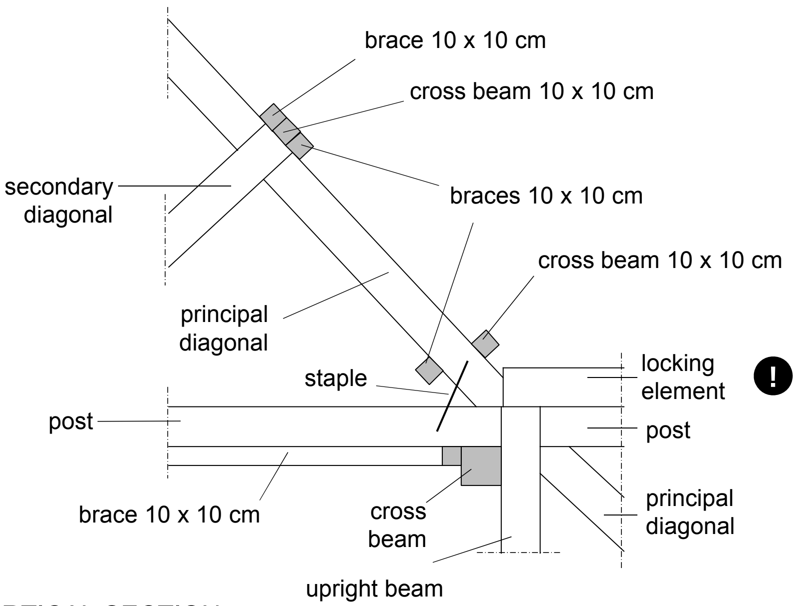
TIMBER WALLL TO WALL SHORES: construction details

Detail 5 — LOWER CONNECTION

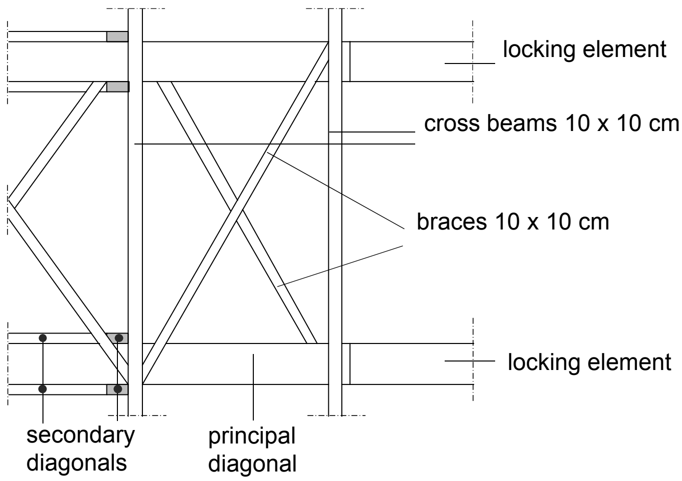
CONNECTION BETWEEN THE PRINCIPAL DIAGONAL AND THE POST

WARNING

The locking element should be linked to the post using at least 1 bolt ϕ10 every 50cm.

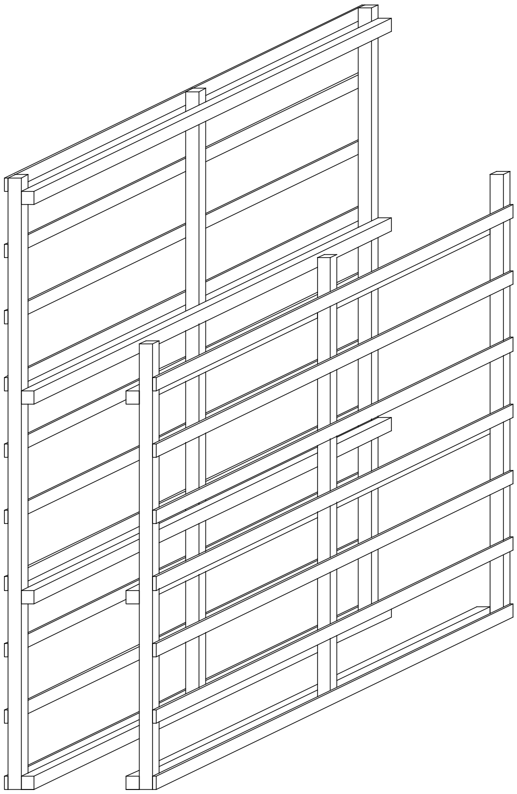


VERTICAL SECTION

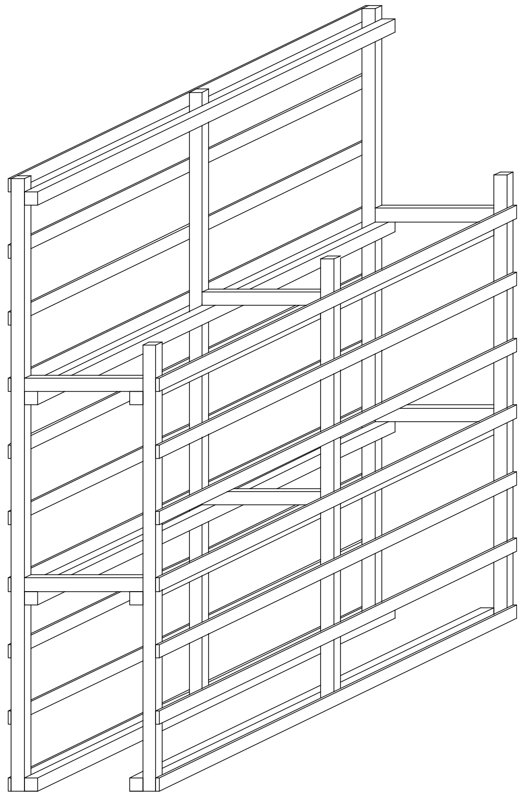


PLAN

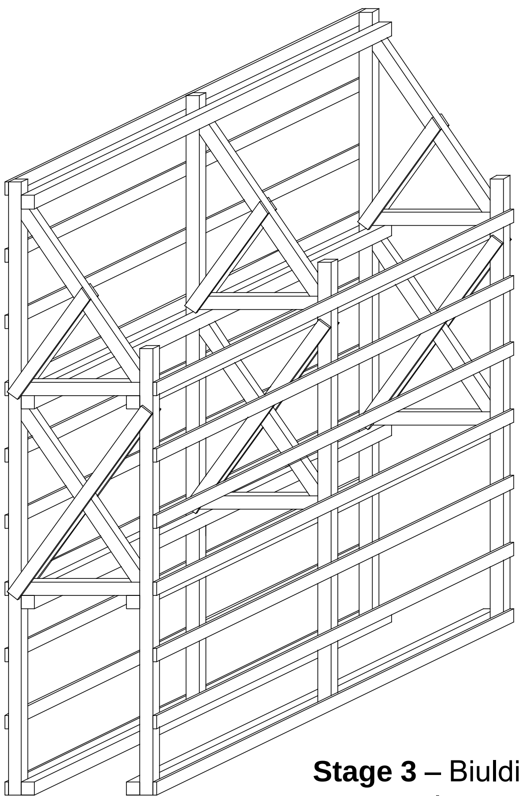
TIMBER WALLL TO WALL SHORES: assembling phases



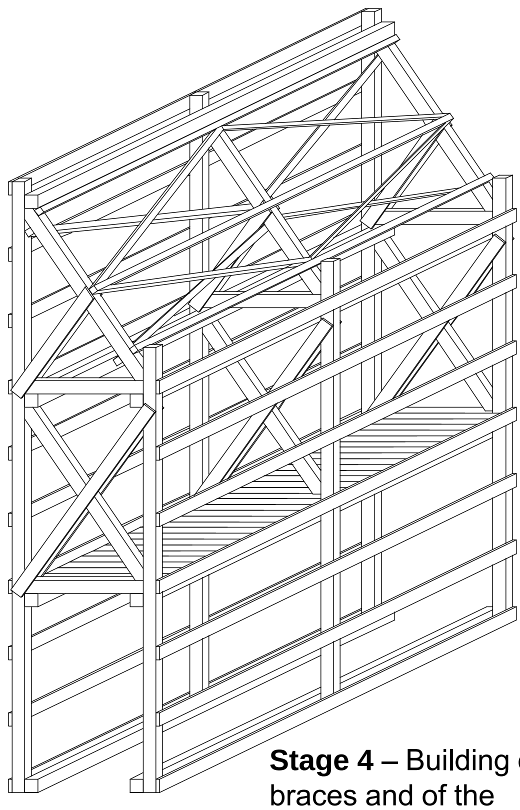
Stage 1 – Building of the trellises



Stage 2 – Joining of the trellises



Stage 3 – Biulding of the support elements



Stage 4 – Building of the braces and of the protective tables

TIMBER WALL TO WALL SHORES

Field of application

The use of this procedure is allowed only with 9 m high masonry structures and only for wall thickness of 1 m. The maximum free height of the wall is 8 m.
The maximum distance between the wall to support and the supporting wall is 2 times the distance between two consecutive floors (h).
The supporting structure should be made of wood.

General assumptions

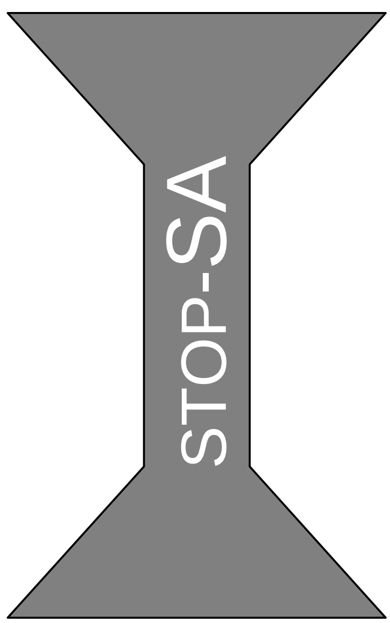
The intervention is allowed only under the permission of local Authorities because of the possibility of damage to the supporting building due to aftershocks. Check the solutions to the critical considerations shown on page 6/14.

Instructions for the use of the procedure

After the check of the site to be shored, define the type of the shore (P or S) on pages 1/14, 2/14 and 3/14.
On page 4/14 the table to size the parallel shape shore (P) is shown.
On page 5/14 the table to size the slope shape shore (S) is shown.
The sizing of the shore's elements is dependent on: the type of the shore (P o S), the total height of the wall to support (H_{tot}), the thickness of the wall to support (s_m) and of the seismic classification (see the Annex 1).
On the pages 6-7/14 the main critical considerations are shown.
On the pages 8-12/14 the details of the shore structure are shown.

VADEMECUM STOP

SHORES FOR APERTURES



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COORDINATION TEAM FOR TEMPORARY WORKS

WORKING GROUP FOR THE VADEMECUM STOP
under the supervision of Sergio Basti - Central director for emergency and urgent technical rescue
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S.Grimaz (coordinator)
L.Munaro, M.Cavriani, E.Mannino, C.Bolognese, M.Caciolai, L.Ponticelli,
M.Bellizzi, A. D'Odorico, A.Maiolo

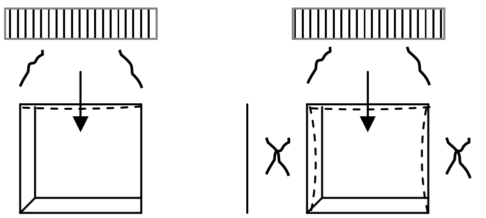
With the contribute of:
F.Barazza, P.Malisan, A.Moretti

Translated by:
L. Ponticelli, S. La Mendola, E. Gissi
and
Keith Bellamy
Section Leader, Urban Search & Rescue
Hampshire Fire and Rescue Service, UK

SHORES FOR APERTURES: general recommendations

STOP-**SA**

Movement to constrain:
breaking of a lintel
and lateral distortion (if present)



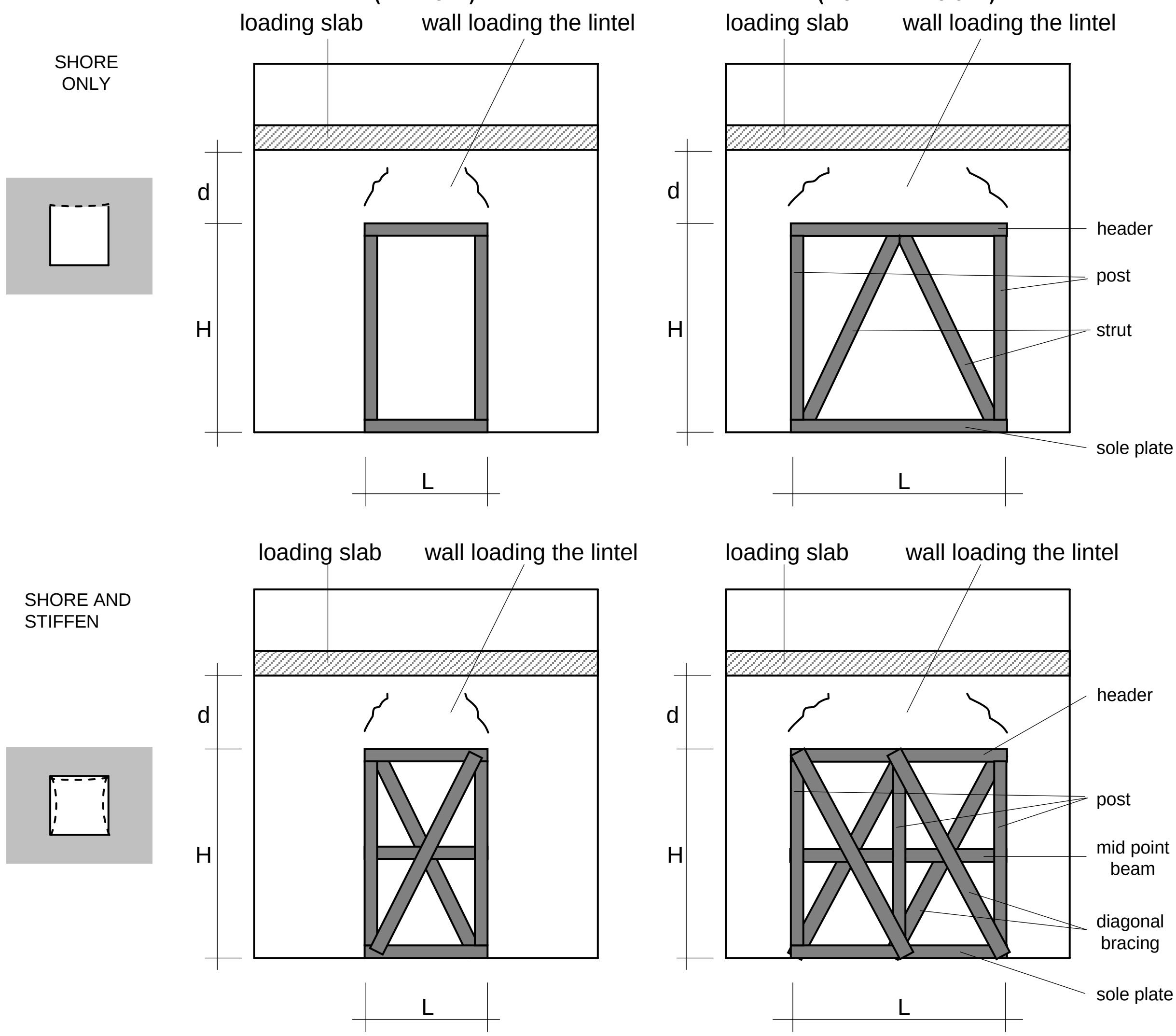
Description
Potential fall of blocks over the opening and loss of restrainment of the slab.

Lateral distorsion of the walls.

Function of the shore: to restrain the vertical loads

"TIGHT" OPENINGS
(L ≤ 1.5 m)

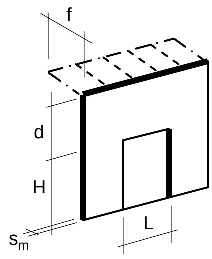
"LARGE" OPENINGS
(1.5 m < L ≤ 3.0 m)



SHORES FOR APERTURES: general recommendations

STOP-**SA**

External wall



Internal wall

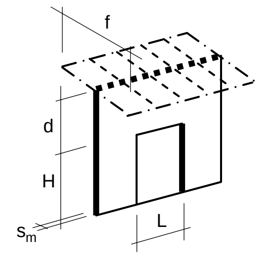
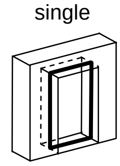
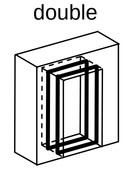
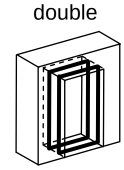
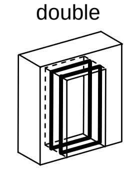
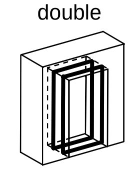


Table 1 – Sizing of the elements (posts, struts and mid point beams)

		Width of loading slab f	s_m ≤ 0.4 m		0.4 - 0.6 m	0.6 - 0.8 m	0.8 - 1.0 m
			single 	double 	double 	double 	double 
"Tight" openings	L ≤1.0 m	f = 0m	10x10	8x8	8x8	8x8	10x10
		0m < f ≤ 1m	13x13	10x10	10x10	10x10	13x13
		1m < f ≤ 3m	18x18	13x13	13x13	13x13	13x13
		3m < f ≤ 5m	n.p.	15x15	15x15	15x15	18x18
	1.0 m<L≤1.5 m	f = 0m	13x13	10x10	13x13	13x13	13x13
		0m < f ≤ 1m	18x18	13x13	15x15	15x15	15x15
		1m < f ≤ 3m	n.p.	18x18	18x18	18x18	18x18
		3m < f ≤ 5m	n.p.	18x18	20x20	20x20	20x20
"Large" openings	1.5 m<L≤2.0 m	f = 0m	13x13	10x10	10x10	13x13	13x13
		0m < f ≤ 1m	15x15	13x13	13x13	13x13	15x15
		1m < f ≤ 3m	20x20	15x15	15x15	18x18	18x18
		3m < f ≤ 5m	n.p.	18x18	18x18	20x20	20x20
	2.0 m<L≤3.0 m	f = 0m	18x18	13x13	15x15	18x18	18x18
		0m < f ≤ 1m	20x20	15x15	18x18	18x18	20x20
		1m < f ≤ 3m	n.p.	20x20	20x20	n.p.	n.p.

n.p. - not present: a specific design is needed

Other elements	
Braces	Planks 2.5 x 12 cm screwed/nailed on the struts by 3 screws Ø5x100 mm or by 3 nails L = 80 mm each edge for sections not bigger than 15x15 *or* Planks 5 x 20 cm screwed/nailed on the struts by 3 screws Ø5x100 mm or by 3 nails L = 100 mm each edge for sections bigger than 15x15

WARNING:
If **d > L** no loading slab should be considered.
If the slab is ribbed parallel to the wall, the width of the loading slab should be safely assumed as 1m.

SHORES FOR APERTURES

Field of application
These shores can be used only on buildings damaged by earthquakes.

General assumptions
These shores transfer the loads from the damaged lintel to the remaining structure, through as much as possible, the previous load path.

In case of necessity, the shores can stiffen the openings. Appropriate bracing should be provided (see page 2/3).

To simplify, only square cross section timber is used.

Instructions for the use of this procedure
By using the dimensions of the opening (height "H" and width "L"), the width "s_m" of the wall and the length of the slab loading the lintel, it is possible to calculate the sizing of the system using table 1 on page 2/3.
Only if the width of the wall is less than 0.4 m, it is possible to use either the single or the double system (see the table1 on page 2/3).

WARNING
All the values should be intended as a minimum. Bigger timbers can be used if necessary.

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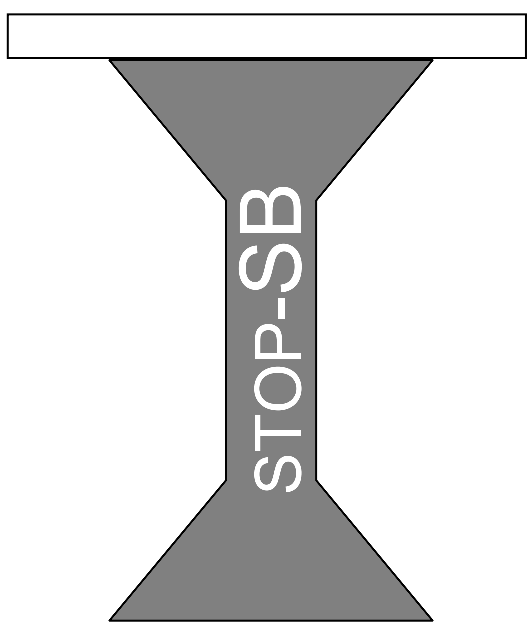
VADEMECUM STOP

SHORES FOR SLABS AND BALCONIES



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Translated by:
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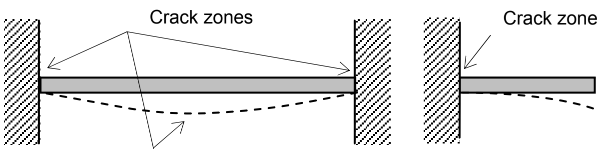
and
Keith Bellamy
Section Leader, Urban Search & Rescue
Hampshire Fire and Rescue Service, UK

SHORES FOR SLABS AND BALCONIES: general recommendations

STOP-**SB**

Movement to constrain:
sagging or excessive deflection



SLAB BALCONY

Description

Excessive deflection of the slab due to a vertical seismic acceleration or excessive loads.
Evidence of the damages:
a) For balconies: rotation and cracks at the upper areas of the connections.
b) For slabs: excessive deflection, cracks in the middle on the underside and at the upper areas of the connections.

Function of the shore: to reduce either the deflections and/or the loads

SHORES FOR SLABS: MAIN SCENARIOS AND SELECTION CRITERIA

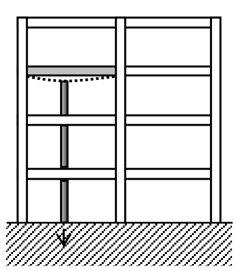
SCENARIO

- A new single load path to the ground is available
- The ground is solid
- Shores for all the underlying slabs are possible
- Easy to build

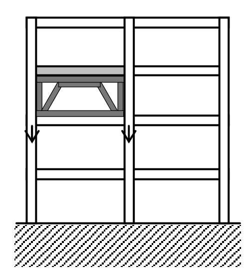
- No new load path to the ground is available
Shores for all the underlying slabs are impossible
- New load path is possible

SOLUTION

S SINGLE LINE
see STOP-**SB**/S (page 2/10)

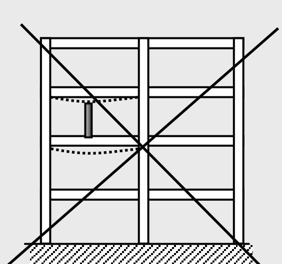


T TRUSS
see STOP-**SB**/T (page 8/10)

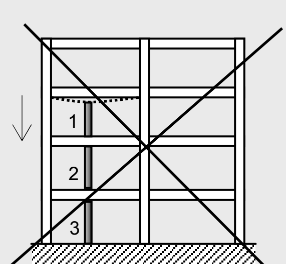


WARNING: correct procedure to implement a single line solution

In the case of a single line solution, it is necessary to start from the bottom of the building and work to the top (see below).



NO



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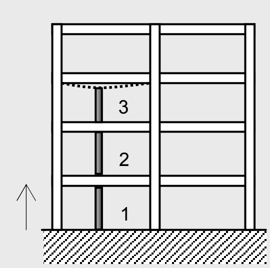


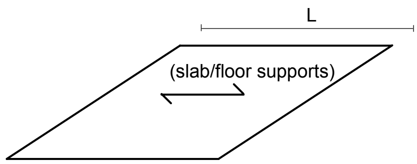
YES

1-2-3 : building sequence

SHORES FOR SLABS AND BALCONIES “S” SOLUTION: general recommendations | STOP-SB/S

Reference sketches

S

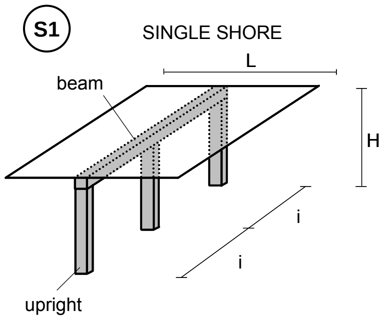


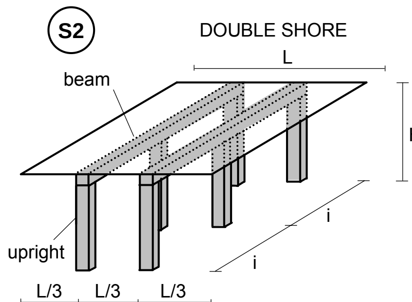
Geometrical parameters

L : span

i : transverse distance between uprights

H : distance between two consecutive floors





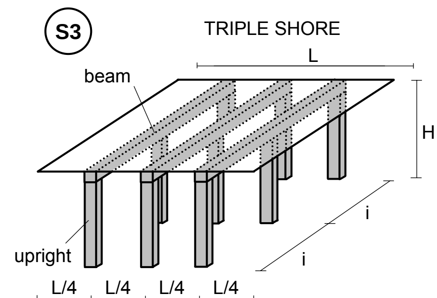


Table 1 – Sizing of the wooden shore
Cross section of the uprights and of the beams (cmxcm) – [reference sketch]

	L (m) / i (m)	L ≤ 3.0m	3.0m < L ≤ 4.0m	4.0m < L ≤ 5.0m	5.0m < L ≤ 6.0m	6.0m < L ≤ 7.0m
H ≤ 4 m	1.0	13x13-[S1]	13x13-[S1]	13x13-[S2]	13x13-[S3]	13x13-[S3]
	1.5	13x13-[S1]	13x13-[S2]	13x13-[S3]	15x15-[S3]	n.p.
	2.0	15x15-[S2]	15x15-[S2]	15x15-[S3]	n.p.	n.p.
	2.5	15x15-[S3]	n.p.	n.p.	n.p.	n.p.
4m<H≤6m	S1 is not allowed if H > 4m. The same sections used for the sketches S1 and S2 for H ≤ 4m are allowed if properly braced (the bracing system can be implemented using planks 2.5 x 12 cm nailed on the uprights with 3 nails L = 80 mm in both directions).					

Table 2 – Sizing of the shore made with wooden beams and telescopic steel upright struts
Cross section of the beams (cmxcm) – Class of the iron prop (see EN 1065) - [reference sketch]

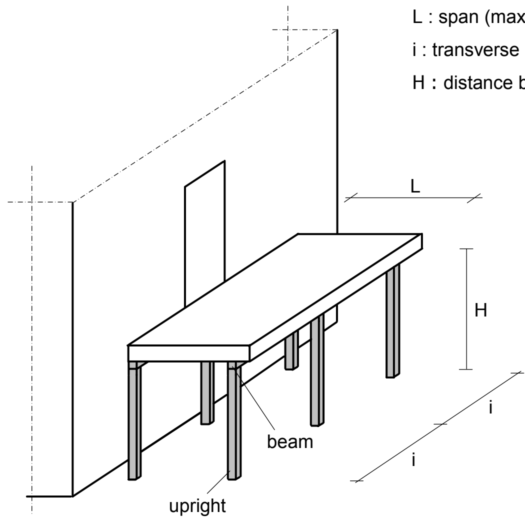
	L (m) / i (m)	L ≤ 3.0m	3.0m < L ≤ 4.0m	4.0m < L ≤ 5.0m	5.0m < L ≤ 6.0m	6.0m < L ≤ 7.0m
H< 3 m	1.0	13x13-C30-[S1]	13x13-C30-[S2]	13x13-E30-[S2]	13x13-E30-[S3]	13x13-E30-[S3]
	1.5	13x13-E30-[S1]	13x13-E30-[S2]	13x13-E30-[S3]	n.p.	n.p.
	2.0	15x15-E30-[S2]	15x15-C30-[S3]	n.p.	n.p.	n.p.
	2.5	15x15-E30-[S3]	n.p.	n.p.	n.p.	n.p.
H= 3-4 m	1.0	13x13-D40-[S1]	13x13-D40-[S2]	13x13-E40-[S2]	13x13-E40-[S3]	13x13-E40-[S3]
	1.5	13x13-E40-[S1]	13x13-E40-[S2]	13x13-E40-[S3]	n.p.	n.p.
	2.0	15x15-E40-[S2]	15x15-E40-[S3]	n.p.	n.p.	n.p.
	2.5	15x15-E40-[S3]	n.p.	n.p.	n.p.	n.p.
H= 4-5 m	1.0	13x13-D50-[S1]	13x13-D50-[S2]	13x13-E50-[S2]	13x13-E50-[S3]	13x13-E50-[S3]
	1.5	13x13-E50-[S1]	13x13-E50-[S2]	13x13-E50-[S3]	n.p.	n.p.
	2.0	15x15-E50-[S2]	15x15-E50-[S3]	n.p.	n.p.	n.p.
	2.5	15x15-E50-[S3]	n.p.	n.p.	n.p.	n.p.

n.p. - not present: a specific design is needed

WARNING: fix the steel strut to the wooden beam with one nail for each hole on the end of the strut.

SHORES FOR BALCONIES: general recommendations

Reference sketch



(B2) DOUBLE SHORE

Geometrical parameters

L : span (max 3 m)

i : transverse distance between uprights

H : distance between two consecutive floors

Table 3 – Sizing of the wooden beams and the wooden uprights

H ≤ 4 m				
L (m) / i (m)	L ≤1.0m	1.0m<L≤1.5m	1.5m<L≤2.0m	2.0m<L≤3.0m
1.0	13x13-[B2]	13x13-[B2]	13x13-[B2]	15x15-[B2]
1.5	13x13-[B2]	13x13-[B2]	15x15-[B2]	n.p.
2.0	13x13-[B2]	15x15-[B2]	n.p.	n.p.
2.5	15x15-[B2]	n.p.	n.p.	n.p.

n.p. - not present: a specific design is needed

If 4m < H ≤ 6m, it is necessary to provide a bracing system (n. 2 planks 2.5 x 12 cm nailed on the uprights with 3 nails L = 80 mm in both directions).

Table 4 – Sizing of the wooden beams and of the steel stuts. Reference sketch [B2].
(see EN 1065 for the classification of the steel struts)

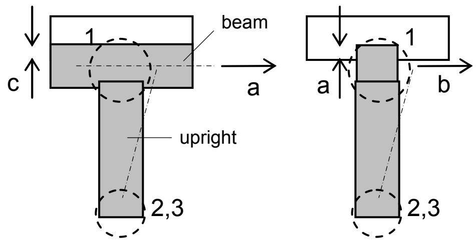
	L(m) / i(m)	L ≤1.0m	1.0m<L ≤1.5m	1.5m<L ≤2.0m	2.0m<L ≤3.0m
H< 3 m	1.0	A30	B30	C30	E30
	1.5	B30	C30	E30	n.p.
	2.0	C30	E30	n.p.	n.p.
	2.5	C30	n.p.	n.p.	n.p.
H= 3-4 m	1.0	B40	C40	D40	E40
	1.5	C40	D40	E40	n.p.
	2.0	D40	E40	n.p.	n.p.
	2.5	D40	n.p.	n.p.	n.p.
H= 4-5 m	1.0	B50	C50	D50	E50
	1.5	C50	D50	E50	n.p.
	2.0	D50	E50	n.p.	n.p.
	2.5	D50	n.p.	n.p.	n.p.
To size the wooden beams see Table 3					

n.p. - not present: a specific design is needed

WOODEN SHORES FOR SLABS AND BALCONIES: critical considerations

STOP-**SB**/S

Critical considerations



Overall critical considerations

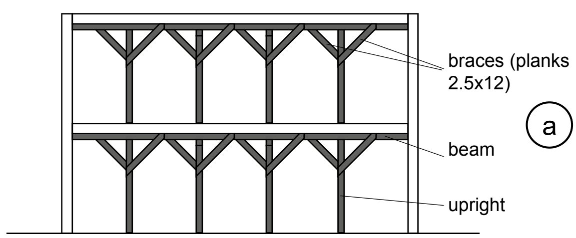
a, b – horizontal displacement
c – separation or punching of the beam

Localised critical considerations

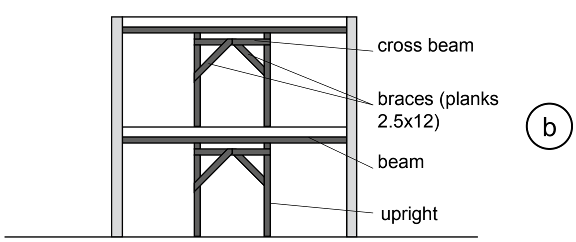
1 – separation of the beam/upright connection
2 – unloading of the shore
3 – collapse due to excessive load

Managing the critical areas of WOODEN SHORES

SHORES FOR SLABS

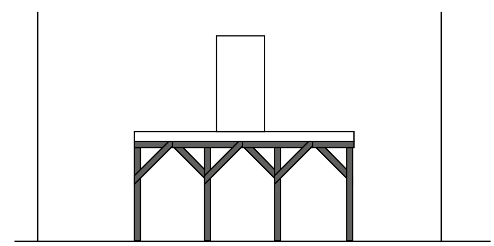


Longitudinal section

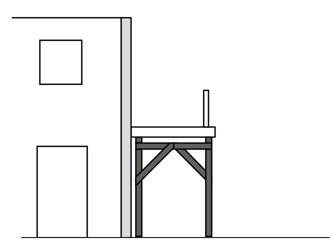


Transverse section

SHORES FOR BALCONIES

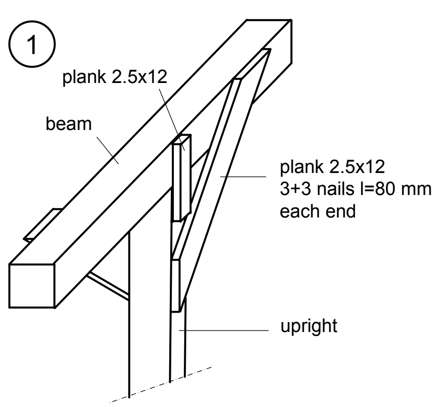


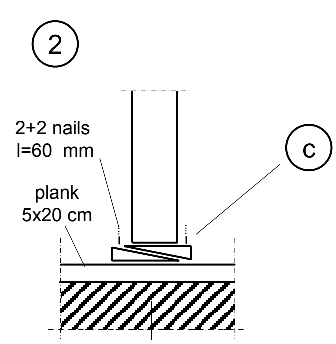
Longitudinal view

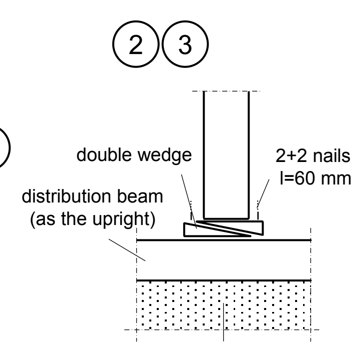


Lateral view

Provide a bracing system to stiffen the struts in transverse and longitudinal directions (n. 2 planks 2.5 x 12 cm nailed on the uprights with 3 nails L = 80 mm). The cross section of the cross beam is the same as the uprights.

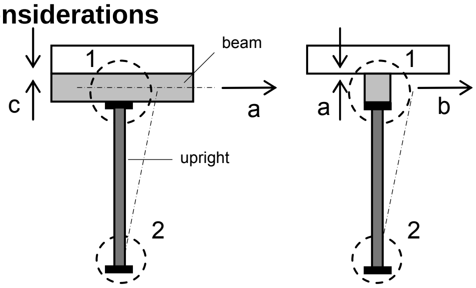






WOODEN/STEEL SHORES FOR SLABS AND BALCONIES: critical considerations | STOP-SB/S

Critical considerations



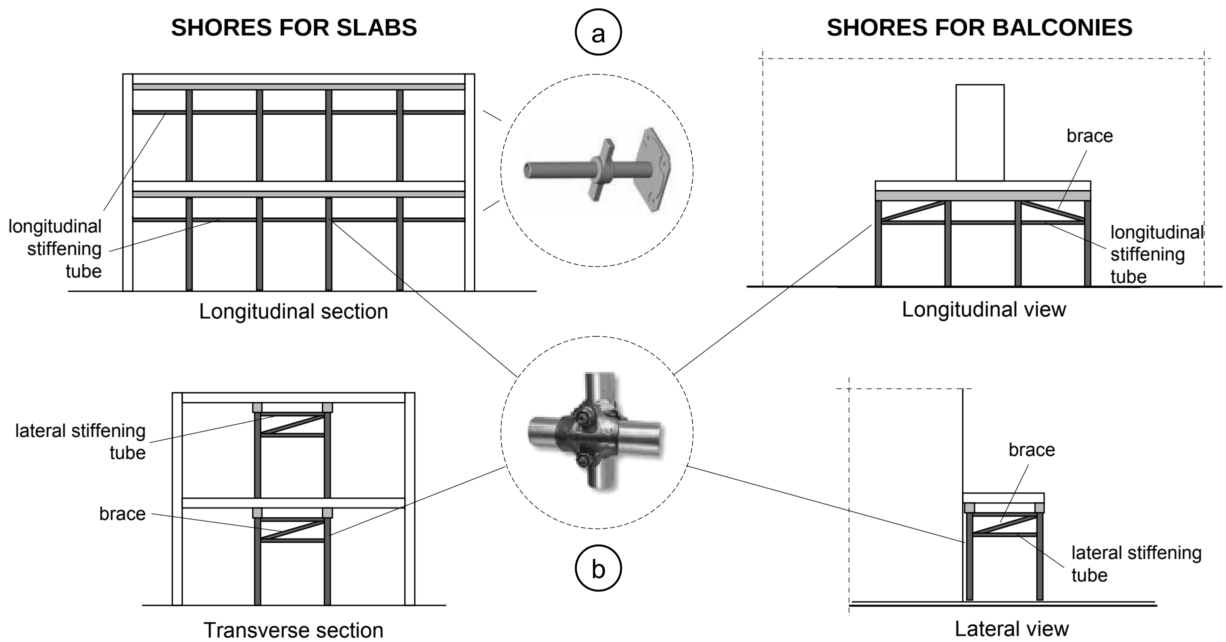
Overall critical considerations

a, b – horizontal displacement
c – separation or punching of the beam

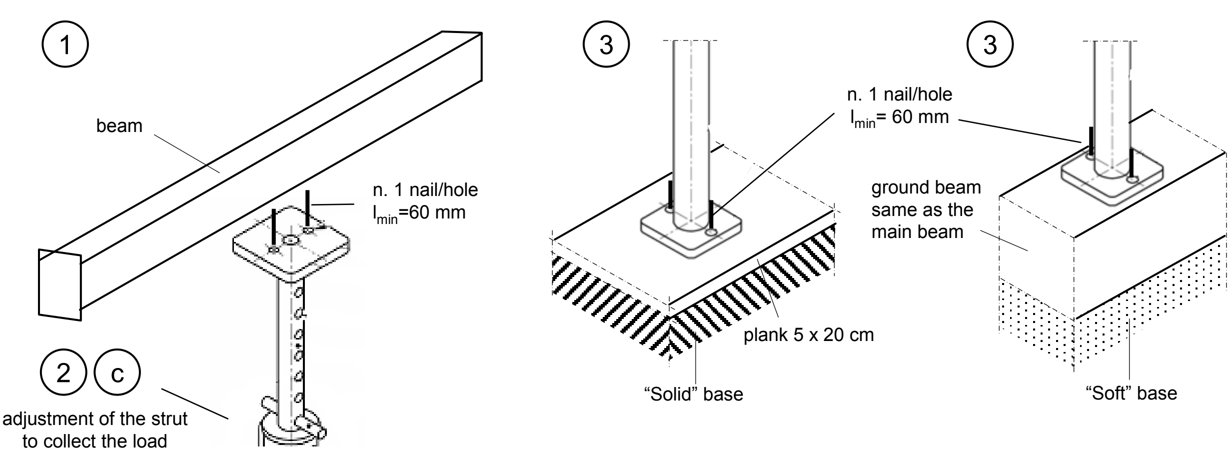
Localised critical considerations

1 – separation of the beam/upright connection
2 – unloading of the shore
3 – collapse due to excessive load

Managing the critical areas of STEEL SHORES



Steel tubes and special joints (b) to be linked to the extension on the telescopic strut to stiffen the structure. “Touch” the external structures with the special elements (a) to lock the system.

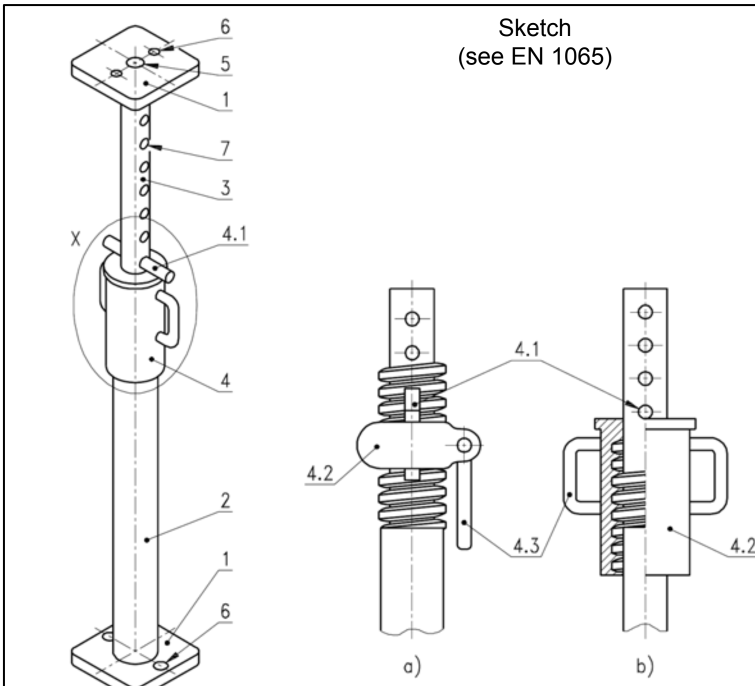


General assumptions
Steel struts can only be used if:
• they are compliant to the EN 1065 standard;
• the provider is in possession of the conformity certification, relating to the above-mentioned technical rule, and issued by an official laboratory;
• the telescopic struts must come with a document or a manual that includes:
  - a brief description of the struts and their components, also stating their definition in accordance with the UNI EN 1065 standard;
  - any useful direction for a proper end-use;
  - the instructions relating to maintenance and storage;
  - reference to the test certificates required by the UNI EN 1065 standard;
  - A provider's declaration of conformity to the DM 06/08/2004.

Check the class of the strut before using.
Every steel strut should be stamped as below:
- Conformity to the EN 1065 standard;
- Manufacturer
- Year of production;
- For the classification of the steel telescopic strut see EN 1065 (ex. C30, D40, E40, E50 …).

Key
1. Endplate
2. Outer tube
3. Inner tube
4. Length adjustment device
4.1 Attached pin
4.2 Outer ring
4.3 Handle
5. Central hole
6. Connection hole
7. Pin hole

Sketch
(see EN 1065)



a) Open thread (= DO) b) Covered thread (= DC)

SHORES FOR SLABS AND BALCONIES: general recommendations

SHORES FOR SLABS – SINGLE LINE "S"

Main assumptions

This shore has been designed for clay-concrete floors, having a thickness equal to 1/25 of its span, and a distribution slab 4 cm thick, loaded according to the regulation in force for civil buildings. This shore has been sized assuming that the connections at the ends of the load bearing floor's members can prevent vertical movement while allowing rotation.

General recommendations

On page 2/10 three solutions for supporting the floor are proposed (S1, S2 and S3), depending on the floor span and on the chosen spacing between shores.
It must be noted that the span "L" must be intended as the distance between supports, which should be measured once that the floor support structure direction has been identified. To this aim, the main load bearing members should be carefully and correctly identified, by removing sections of plaster, if necessary.
It must be noted that, for intermediate floors, the utilization of the "S" solution requires that all the lower floors are shored up following the sequence shown on page 1/10. In any case, the solidity of the lower structure support plane should be assessed.
Once that the material of the supporting structure has been defined (entirely in wood or wood with steel struts), the span "L" and the distance between floors "H" should be measured. For wooden structures, the design is carried out according to tab. 1 which gives the dimensions for the uprights and for the supporting beam as well as the type of shoring system depending on the selected spacing of the uprights "i". For structures with steel shores, the design is carried out according to tab. 2 which gives the dimensions of the uprights and of the supporting beams as well as the type of shoring system depending on the selected spacing of the uprights "i" and on the floor distance "H".
The wooden members have been selected as far as possible with the same cross sections, in order to make it easier to find the correct materials and to make the connections between the elements themselves more effective .

SHORES FOR BALCONIES

Main assumptions

This shore has been designed for balconies with a load bearing structure made from a solid concrete slab 15 cm thick and loaded according to the regulation in force.
This shore has been designed to support all the load.

General recommendations

On page 3/10 only one system for the balcony support has been proposed, taking into account that the scope of this shore is limited to balconies having an overhang not higher than 3 m.
The balcony shores should be designed in a similar way to that described for slab shores, according to tables 3 and 4 on page 3/10.

WARNING

All the dimensional figures must be intended as minimum design values. If a material specified in this section is not available, larger cross section for wooden elements may be used and, for steel members, the alternative materials shown in the table on the right, after consulting the following guidance, may be used. Once that the lower-right diagonal corresponding to the suggested shore is identified in the table, the cells positioned below the suggested cell and on that diagonal starting from the suggested cell should be considered. All the cells that are within the triangle described and up to the border of the table may be used.

For example, instead of B40 it is possible to use:

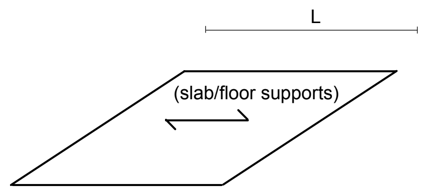
C40, D40, E40, C45, D45, E45, D50, E50, E55

	25	30	35	40	45	50	55
A					X	X	X
B							
C							
D							
E							

SHORES FOR SLABS AND BALCONIES "T" SOLUTION: general recommendations | STOP-SB/T

Reference sketches

T

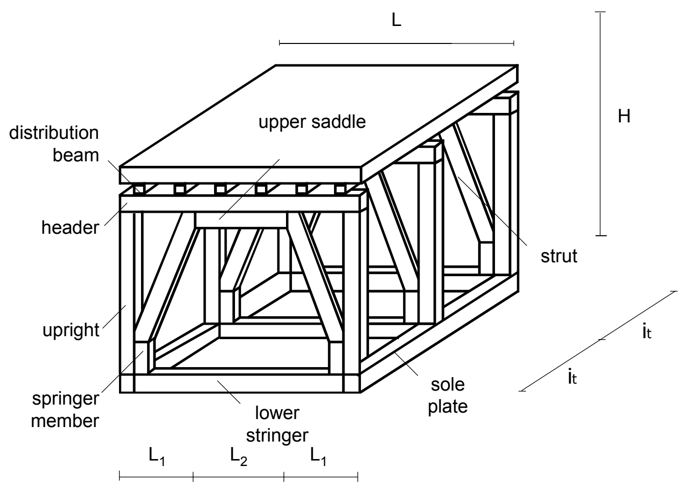


Nomenclature and reference geometrical parameters

L : span

i : distance between shores

H : distance between two consecutive floors



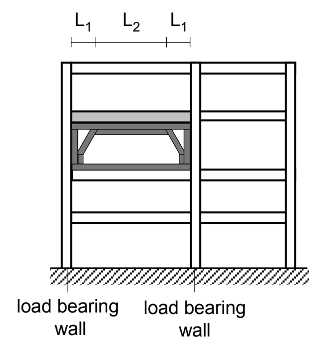


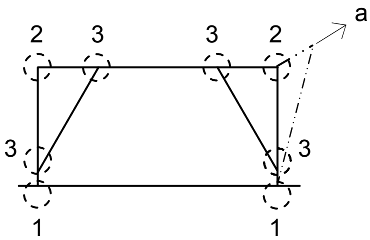
Table 5 – Sizing of the supporting system

	L (m)	L_1 (m)	L_2 (m)	i_t	header
H ≤ 4m	< 3.0	about L/3	about L/3	max 1.5 m	13x13
	3.0 - 4.0	1m < L_1 ≤ 1.25m	1m < L_2 ≤ 1.5m		15x15
	4.0 - 5.0	1.25m < L_1 ≤ 1.5m	1.5m < L_2 ≤ 2m		18x18
	5.0 - 6.0	1.5m < L_1 ≤ 1.75m	2m < L_2 ≤ 2.5m		20x20
4 < H ≤ 6m	Stiffening beams should be placed close to about half length of struts and uprights (n.2 planks 2.5x12 fixed by n.3 nails l=80 mm) in order to reduce their free flexural length.				

Other members	
upright	same as the header
strut	same as the header
sole plate	same as the header
upper saddle	same as the header
springer member	same as the header
distribution beam	beams 10x10 cm with transverse spacing equal to 50 cm

WOODEN SHORE "T" SOLUTION: critical considerations | STOP-**SB**/T

Critical considerations



Overall critical considerations
a - possible side ways overturning/instability

Localised critical considerations
1 - possible unloading of the shore
2,3 - possible separation of the connections

Managing overall and localised critical considerations

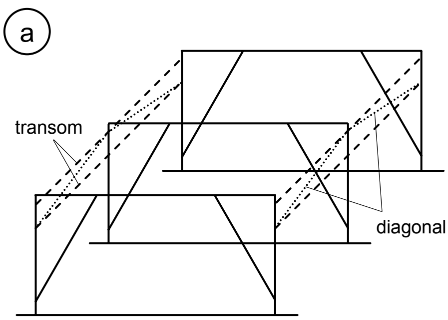
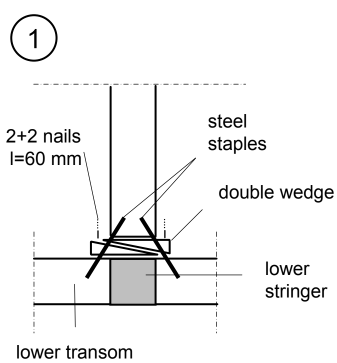
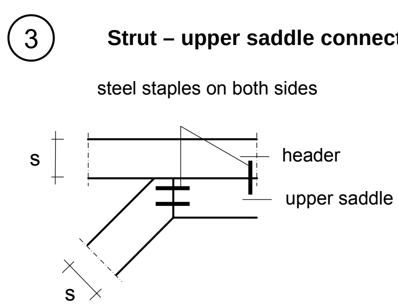


Table 6 – Placement of stiffening members

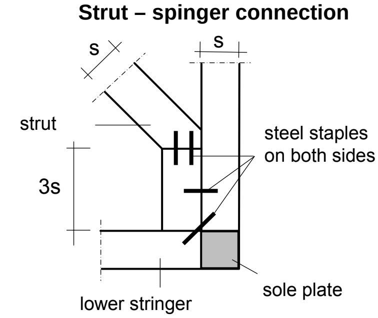
L (m)	Cross bracing and diagonals
L ≤ 3.0m	Planks 2.5x12 cm fixed on the side by 2 x 80 nails or 2 screws ϕ5x100 at each end
3.0m < L ≤ 4.0m	
4.0m < L ≤ 5.0m	beams 8x8 cm by 2 screws ϕ6x160 or 2 x 150 nails at each end *or* planks 5x20 cm by 2 screws ϕ5x100 or 2 x 100 nails for each end
5.0m < L ≤ 6.0m	

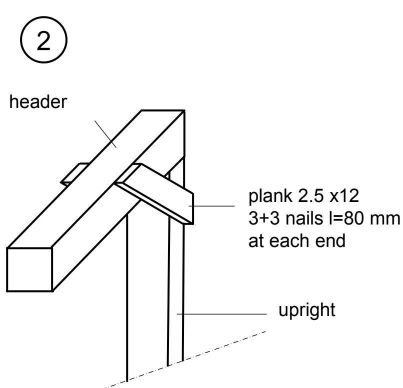


Strut – upper saddle connection

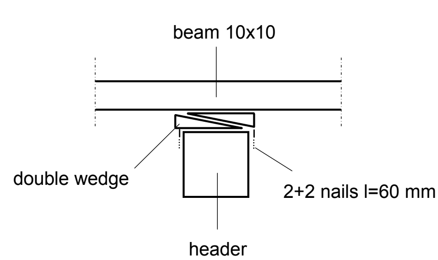


Strut – spinger connection





Distribution beam– header support



WARNING: the steel staples (minimum ϕ8) can be replaced by connecting gussets on both sides (boards 2.5 cm thick nailed or screwed)

SHORES FOR BALCONIES – "T" SOLUTION

Main assumptions

This shore has been designed for clay-concrete floors, having a thickness equal to 1/25 of the span, and a distribution slab 4 cm thick, loaded according to the regulation in force for civil buildings. This shore is sized to support the whole floor, irrespective of any supports at the extremities.

General directions

On page 8/10 a solution with minimum spacing of 1.5 m between each frame is proposed.
It must be noted that the proposed solution is aimed at transferring loads onto already existing load bearing members, which are assumed to be in good conditions.
Therefore, the position of load bearing elements should be carefully detected, in order to place the shore's supports close to them.
Once that the building type and the position of load bearing members has been defined, the span "L" and the distance between two consecutive floors should be measured. The design should be carried out according to table 5, which reports the relevant dimensions of the frame members and further reference for the geometrical definition of the structure.
The wooden members have been selected as far as possible with the same cross sections, in order to make it easier to find the correct materials and to make the connections between the elements themselves more effective.

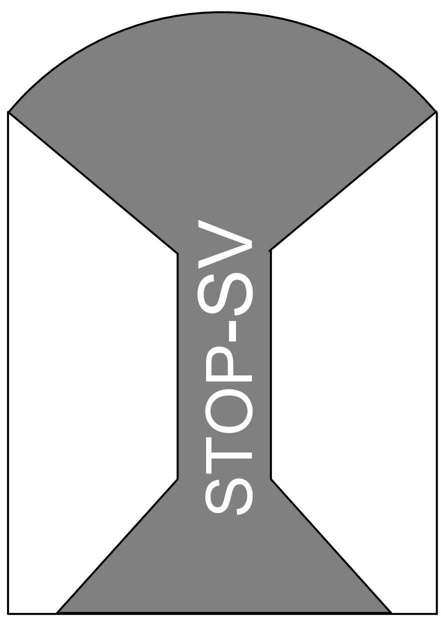
WARNINGS

All the dimensional figures should be intended as minimum design values. If the specified materials are not available, timbers with larger cross sections may be used.
The static conditions of load bearing walls should be preliminarily assessed in order to verify that their damage is light or that the load bearing capacity of the structure has not been significantly modified by the earthquake.
For this purpose, the following situations are assumed as acceptable:

- cracks less than 1 mm wide, no matter how distributed on the masonry, with no material ejection
- limited detachments or light displacements (< 1 mm) between portions of structures, for example between walls and floors or between walls and stairs or between perpendicular walls.
- out-of-plumb having limited extension and not related to in-elevation detachments phenomena or to foundations settlings due to the earthquake, which can be considered pre-existing and not affecting the load bearing capacity of structures.

VADEMECUM STOP

SUPPORT OF VAULTS AND ARCHES



ABRUZZO EARTHQUAKE 2009
COORDINATION TEAM FOR TEMPORARY WORKS

WORKING GROUP FOR THE VADEMECUM STOP
under the supervision of Sergio Basti - Central director for emergency and urgent technical rescue
manual licensed by note no. EM3064/5001-11 dated 2009-06-15

S.Grimaz (coordinator)
L.Munaro, M.Cavriani, E.Mannino, C.Bolognese, M.Caciolai, L.Ponticelli,
M.Bellizzi, A. D'Odorico, A.Maiolo

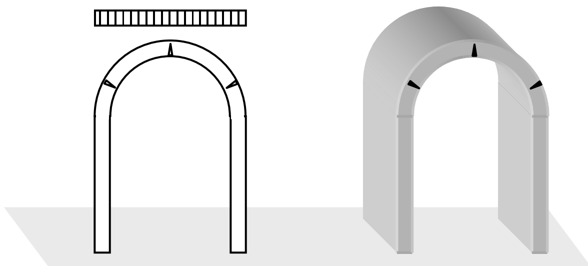
With the contribute of:
F.Barazza, P.Malisan, A.Moretti

Translated by:
L. Ponticelli, S. La Mendola, E. Gissi
and
Keith Bellamy
Section Leader, Urban Search & Rescue
Hampshire Fire and Rescue Service, UK

SUPPORT OF VAULTS AND ARCHES: general recommendations

STOP-**SV**

Typical damage:
cracks appear at the crown and at the reins of the vault/arch



Description

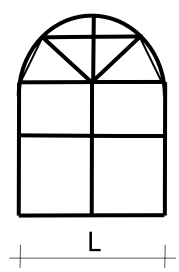
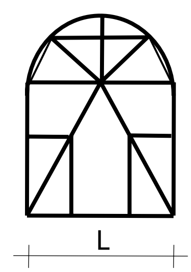
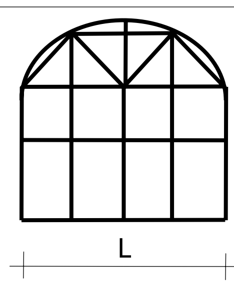
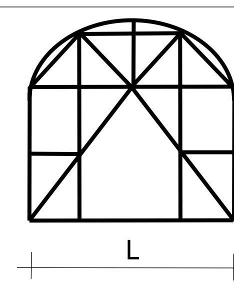
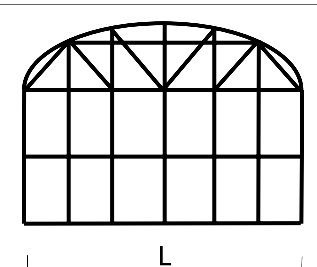
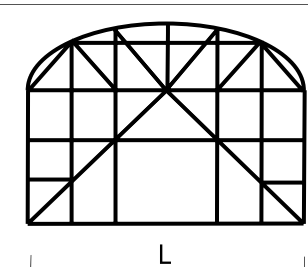
In general vaults and arches with excessive loads show cracks at the crown and at the reins. In this case the shore is needed to discharge the structure.

Warning

The use of the present procedure is not allowed for reinforced concrete vaults or arches and it can only be used for rounded or reduced wall arches. For the carpentry of reduced wall arches it is possible to refer to rounded arches.

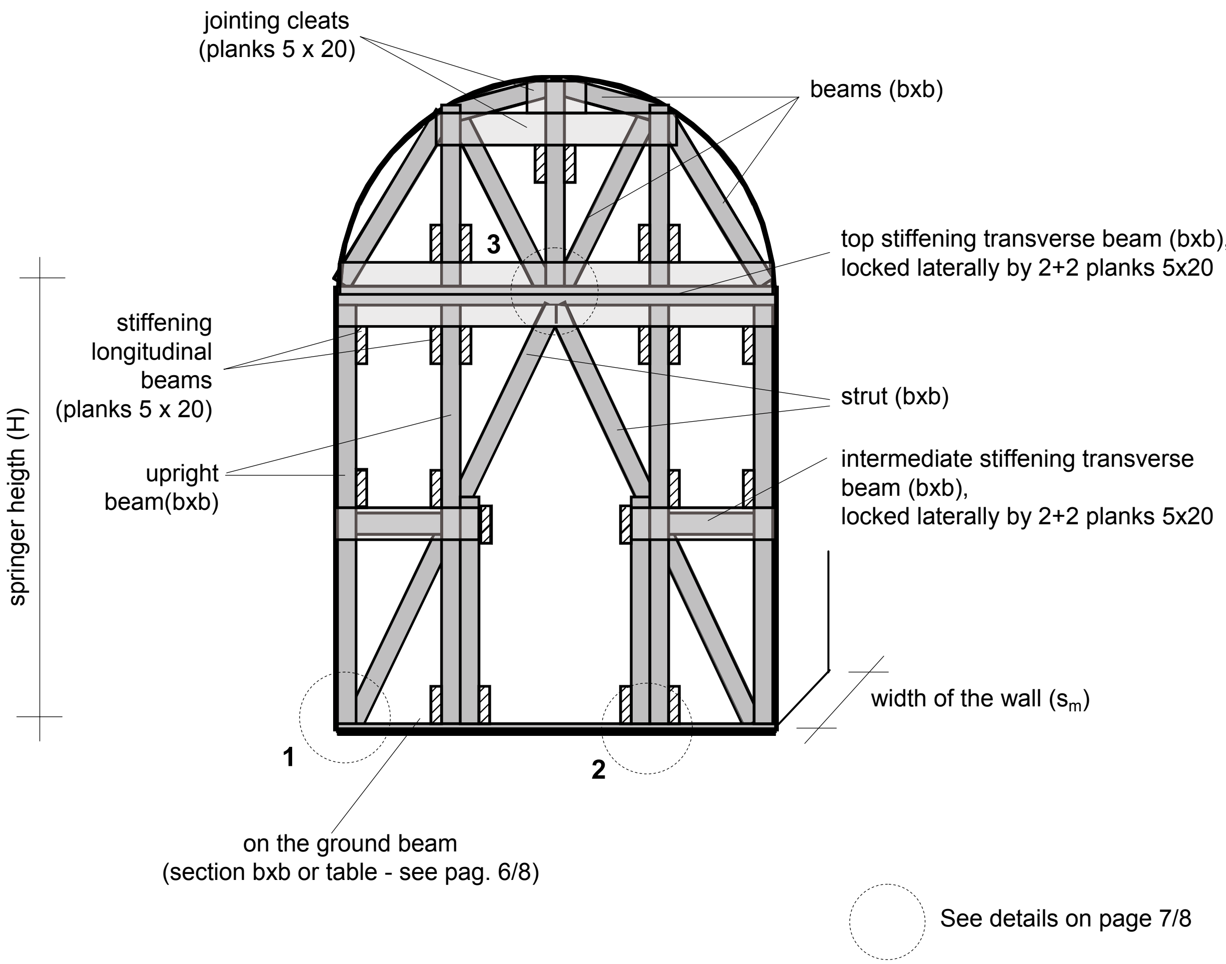
Function of the support: to direct the loads to the ground discharging the lateral masonry structure.

TYPES AND SELECTION CRITERIA

		FUNCTIONAL PARAMETERS	
		There's no need to pass through (Closed passage)	There's need to pass through (Allowed passage)
DIMENSIONAL PARAMETERS	0m<L≤3m	 C1	 A1
	3m<L≤6m	 C2	 A2
	6m<L≤8m	 C3	 A3

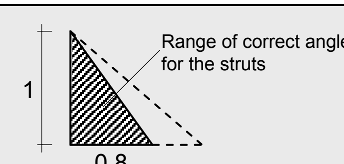
SUPPORT OF VAULTS AND ARCHES: parts list

STOP-**SV**



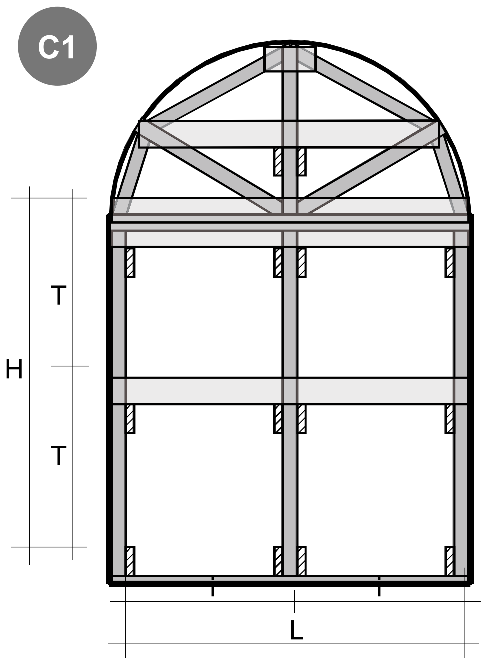
WARNING:

This symbol indicates the range of inclination allowed for the struts.

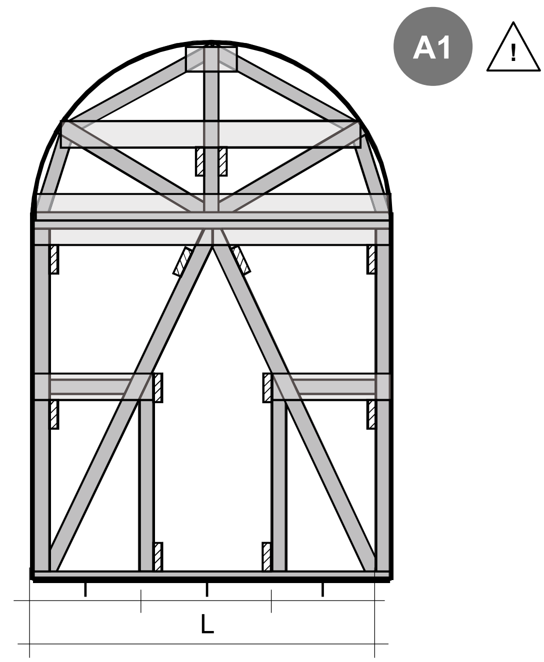


SUPPORT OF VAULTS AND ARCHES: Shores with span between 1.5 and 3 m | STOP-**SV**

SHORING WITH 3 OR 4 UPRIGHT BEAMS: SIZING CRITERIA



Closed passage



Allowed passage

Table 1 – Arches: maximum distance between transverse beams for braced multiple shores (T) and maximum springer heigth (H) for single shores

Span (L)	**Shores for wall width 0.5m ≤ s_m ≤ 1.0 m** Braced multiple shores				**Shores for wall width s_m ≤ 0.5 m** Single shore	
	Cross sections of beams and struts (bxb)				Cross sections of beams and struts (bxb)	
	13x13	15x15	18x18	20x20	18x18	20x20
L ≤ 1.5 m	T ≤ 2.0m	T ≤ 3.0 m	T ≤ 4.0 m	T ≤ 4.5 m	H ≤ 5.0 m	H ≤ 6.0 m
1.5 m < L ≤ 2.0 m	T ≤ 1.5 m	T ≤ 2.5 m	T ≤ 3.5 m	T ≤ 4.0 m	H ≤ 4.5 m	H ≤ 5.5 m
2.0 m < L ≤ 3.0 m	-	T ≤ 1.0 m	T ≤ 2.0 m	T ≤ 2.5 m	H ≤ 3.0 m	H ≤ 4.0 m

Table 2 - Vaults: maximum distance between transverse beams (T)

Span (L)	**Shores for barrel vaults** Maximum longitudinal distance between shores: 1.0 m		
	Cross sections of beams and struts (bxb)		
	15x15	18x18	20x20
L ≤ 1.5 m	T ≤ 1.5 m	T ≤ 2.5 m	T ≤ 3.0 m
1.5 m < L ≤ 2.0 m	-	T ≤ 1.5 m	T ≤ 2.0 m
2.0 m < L ≤ 3.0 m	-	-	T ≤ 1.0 m

N.B. remember to provide a continuous layer of planks under the wall structure to transfer the load from the masonry to the shore

SUPPORT OF VAULTS AND ARCHES: shores with spans between 3 and 6 m | STOP-**SV**

SHORES WITH 5 OR 6 UPRIGHT BEAMS: SIZING CRITERIA

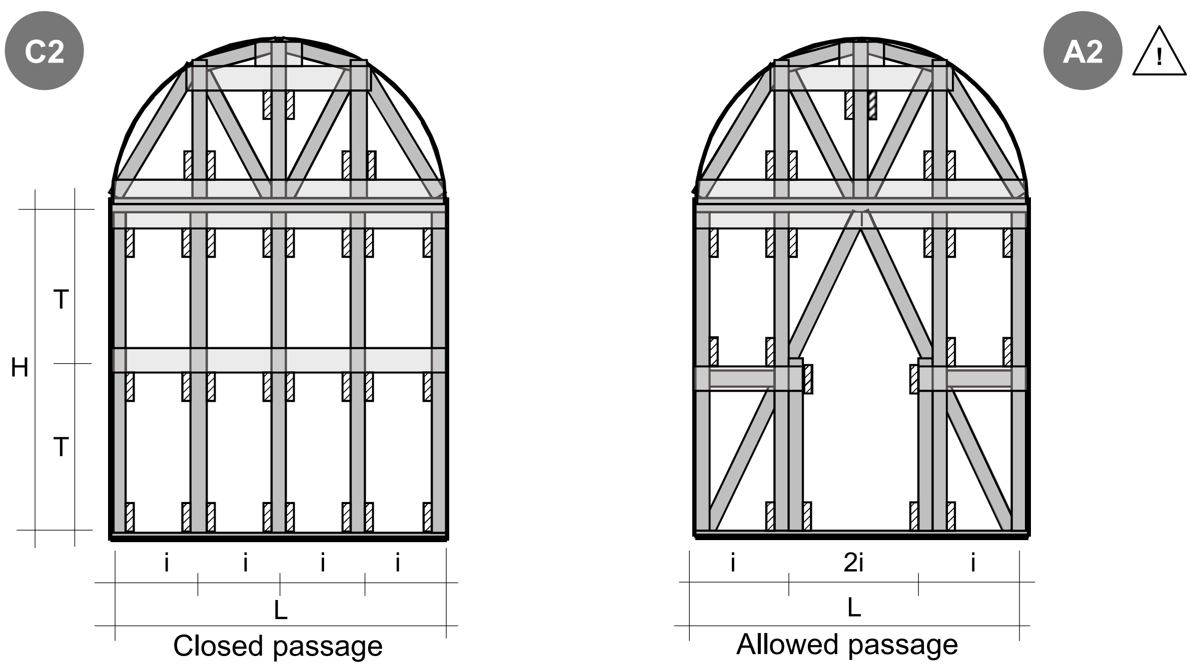


Table 3 – Arches: maximum distance between transverse beams for braced multiple shores (T) and maximum springer heigth (H) for single shores

Span (L)	**Shores for wall width 0.5m ≤ s_m ≤ 1.0 m** Braced multiple shores				**Shores for wall width s_m ≤ 0.5 m** Single shore	
	Cross sections of beams and struts (bxb)				Cross sections of beams and struts (bxb)	
	13x13	15x15	18x18	20x20	18x18	20x20
3.0 m < L ≤ 4.5 m	T ≤ 1.0 m	T ≤ 2.0 m	T ≤ 3.5 m	T ≤ 3.5 m	H ≤ 4.5 m	H ≤ 5.0 m
4.5 m < L ≤ 6.0 m	T ≤ 1.0 m	T ≤ 2.0 m	T ≤ 3.0 m	T ≤ 3.5 m	H ≤ 4.0 m	H ≤ 5.0 m

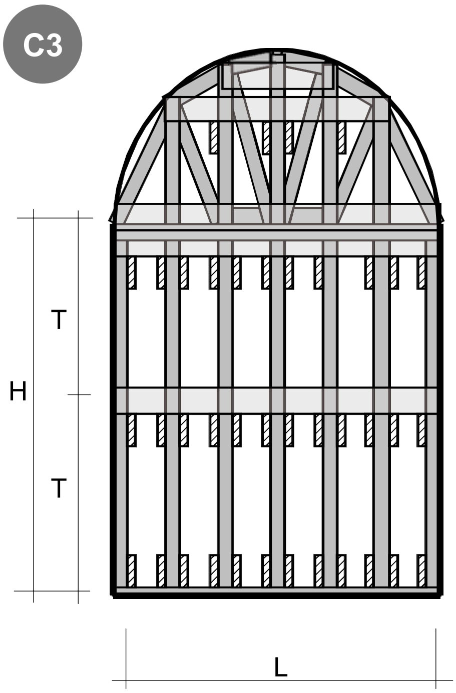
Table 4 - Vaults: maximum distance between transverse beams (T)

Span (L)	**Shores for barrel vaults** Maximum longitudinal distance between shores: 1.0 m	
	Cross sections of beams and struts (bxb)	
	18x18	20x20
3.0 m < L ≤ 4.5 m	T ≤ 1.5 m	T ≤ 2.0 m
4.5 m < L ≤ 6.0 m	T ≤ 1.0 m	T ≤ 2.0 m

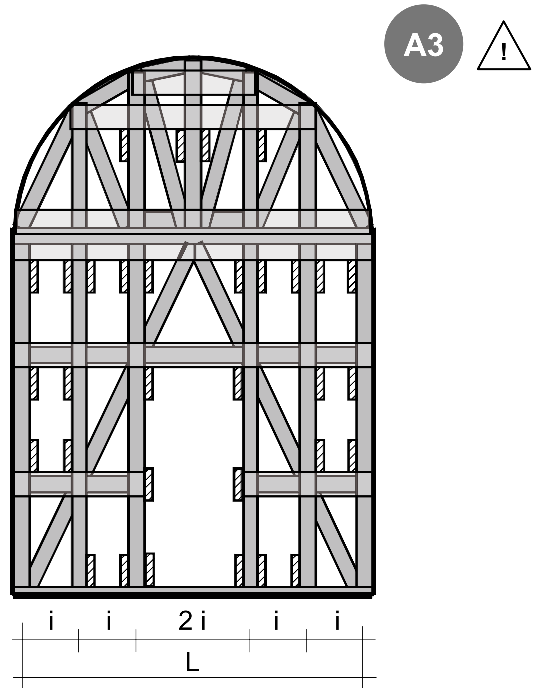
N.B. remember to provide a continuous layer of planks under the wall structure to transfer the load from the masonry to the shore

SUPPORT OF VAULTS AND ARCHES: shores with spans between 6 and 8 m	STOP-**SV**

SHORES WITH 7 OR 8 UPRIGHT BEAMS: SIZING CRITERIA



Closed passage



Allowed passage

Table 5 – Arches: maximum distance between transverse beams for braced multiple shores (T) and maximum springer heigth (H) for single shores

Span (L)	**Shores for wall width 0.5m ≤ s_m ≤ 1.0 m** Braced multiple shores				**Shores for wall width s_m ≤ 0.5 m** Single shore	
	Cross sections of beams and struts (bxb)				Cross sections of beams and struts (bxb)	
	13x13	15x15	18x18	20x20	18x18	20x20
6.0 m < L ≤ 8.0 m	T ≤ 1.5 m	T ≤ 2.0 m	T ≤ 3.0 m	T ≤ 4.0 m	H ≤ 4.0 m	H ≤ 5.5 m

Table 6 - Vaults: maximum distance between transverse beams (T)

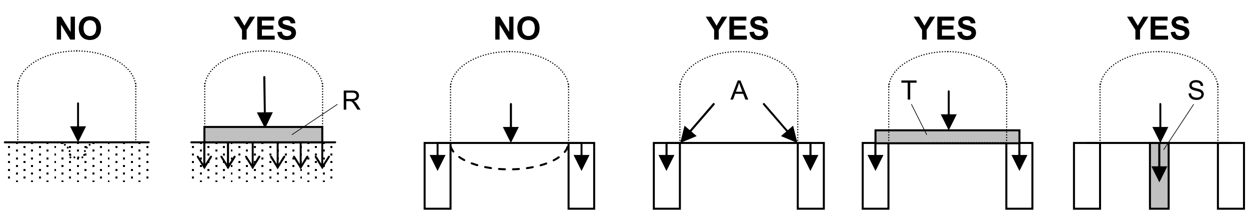
Span (L)	**Shores for barrel vaults** Maximum longitudinal distance between shores: 1.0 m	
	Cross sections of beams and struts (bxb)	
	18x18	20x20
6.0 m < L ≤ 8.0 m	T ≤ 1.5 m	T ≤ 2.0 m

N.B. remember to provide a continuous layer of planks under the wall structure to transfer the load from the masonry to the shore

SUPPORT OF VAULTS AND ARCHES: critical considerations | STOP-**SV**

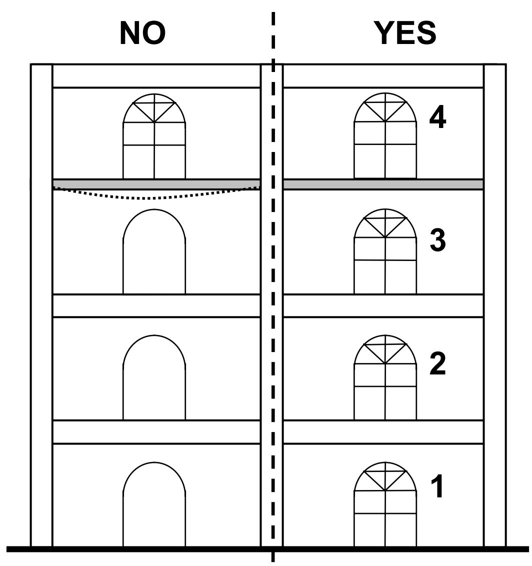
CRITICAL CONSIDERATIONS

One of the most significant critical considerations is the transferring of the loads from the shore to the ground. If the ground is too soft, it is important to provide a distribution element (R) under the structure or a lateral discharge pattern for the loads (A) or a horizontal beam (T) or an alternative path for the loads (S).



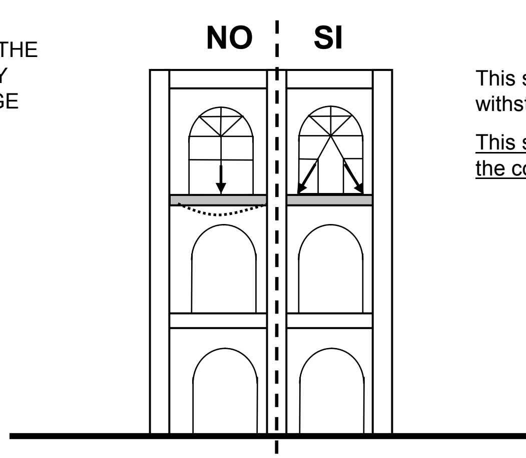
The following two examples are significant:

PRESENCE OF VOIDS UNDER THE FLOOR



In this case see the correct sequence for the implementation of the shores: bottom-top approach

PRESENCE OF VOIDS UNDER THE FLOOR WITH THE POSSIBILITY OF A NEW PATH TO DISCHARGE THE LOADS



This solution can be used if the structure can withstand the new path for the load.

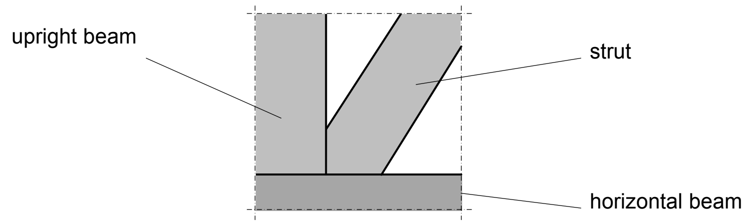
This solution is the best as it doesn't require the construction of shores under the floor.

SUPPORT OF VAULTS AND ARCHES: details

STOP-**SV**

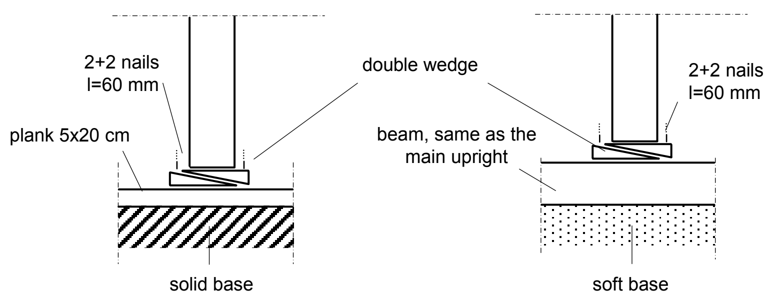
Detail 1 — CONNECTION UPRIGHT BEAM - STRUT

DOUBLE CHAMFER IS ALWAYS REQUIRED



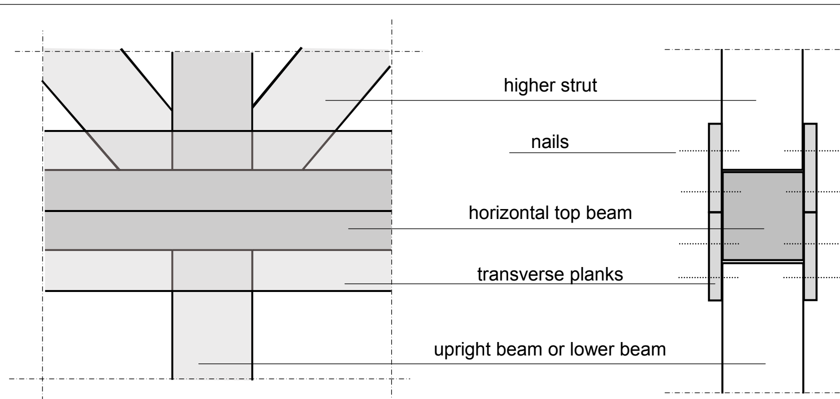
Detail 2 — GROUND CONNECTION

SYSTEM TO CONNECT THE SHORES TO THE GROUND



Detail 3 — TOP CONNECTION

2+2 PLANKS TO CONNECT THE HORIZONTAL BEAM



SUPPORT OF VAULTS AND ARCHES

Field of application
The present procedure can be used only for wall arches or wall rounded or reduced barrel vaults. It can't be used for concrete structures. If the lateral walls are in rotation other measures should be used. The maximum value of the stringer height is 8.0 m for vaults and 6 m for arches ($s_m \leq$ 1.0 m).

General assumptions
The purpose of the shore is to maintain the arch/vault and to reduce the loads on the lateral walls. **It is necessary to verify the load bearing capacity of the surface under the shore** (see page 6/8).
For vaults it is necessary to provide a continuous set of planks between the wall and the shore.

Instructions
After measuring the span "L" it is possible to select the type of shore:
- on page 3/8 the solutions for a span of no more than 3 m are listed;
- on page 4/8 the solutions for a span of no more than 6 m are listed;
- on page 5/8 the solutions for a span of no more than 8 m are listed.

For arches, it is possible to provide a single shore if the width of the wall is less than 50 cm and two braced shores if the width of the wall is less than 100 cm.
After the selection of the type, it is possible to define the cross section of the beams and then the maximum distance between the transverse planks for multiple shores or the maximum height of the arch for single shore solutions (if $s_m \leq$ 50 cm)
All the beams have the same cross section.
The type with passage allowed is possible if the inclination of the strut is less than 1/0.8.
For example, each of the two shores to provide for an arch in a wall with s_m = 0.7 m and span of 5.5 m can be built using beams 13x13 with the distance between the transverse beams not more than 1.0 m or with beams 15x15 with the maximum distance between the transverse beams equal to 2.0 m and so on.
The maximum longitudinal distance between the shores is 1.0m. For distances less than 1.0 m it is only necessary to link the beam with screws.

VADEMECUM STOP

STEEL WIRE ROPE
TIE BACKS

STOP-TA

ABRUZZO EARTHQUAKE 2009
COORDINATION TEAM FOR TEMPORARY WORKS

WORKING GROUP FOR THE VADEMECUM STOP
under the supervision of Sergio Basti - Central director for emergency and urgent technical rescue
manual licensed by note no. EM3064/5001-11 dated 2009-06-15

S.Grimaz (coordinator)
L.Munaro, M.Cavriani, E.Mannino, C.Bolognese, M.Caciolai, L.Ponticelli,
M.Bellizzi, A. D'Odorico, A.Maiolo

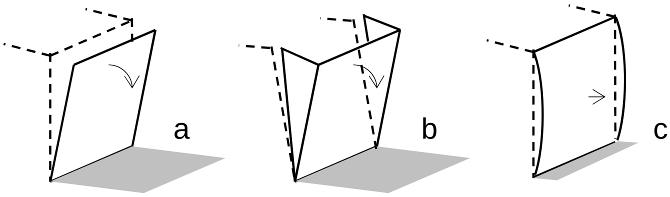
With the contribute of:
F.Barazza, P.Malisan, A.Moretti

Translated by:
L. Ponticelli, S. La Mendola, E. Gissi
and
Keith Bellamy
Section Leader, Urban Search & Rescue
Hampshire Fire and Rescue Service, UK

STEEL TIE BACKS: general recommendations

STOP-**TA**

Forces to constrain:



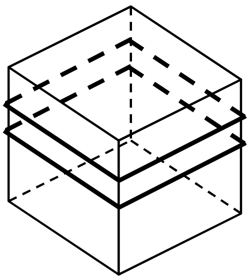
rotation   bulging

Description
Potential out of plane rotation of a wall due to:
a) break of the joint between the wall and connecting walls
b) break of the connecting wall

Evidence of bulging on the external walls

Function of the steel wire rope tie back: to prevent further rotation or bulging of the wall

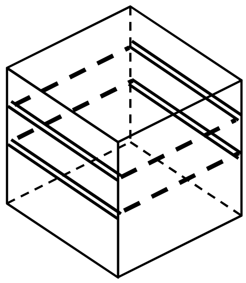
TYPES AND SELECTION CRITERIA



CE FULL EXTERNAL HOOP

Full winding possibility

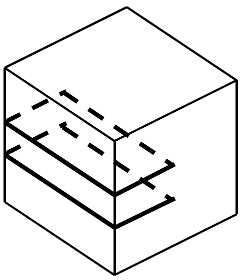
Walls not too wide to be restrained



TL TRANSOM WITH EXTERNAL SIDE WIRE ROPES

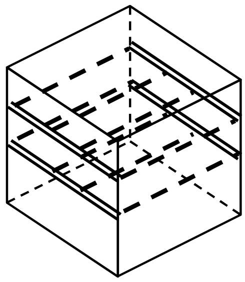
Opposed parallel walls whereon the transoms can be placed

Presence of cross walls which the wire ropes are tensioned close to



CP PARTIAL THROUGH HOOP

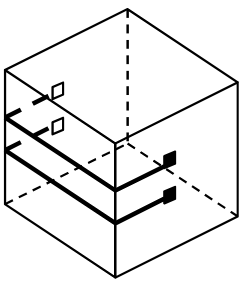
Presence of aligned side openings (or possibility to make holes) not in proximity to the wall to be restrained or possibility to make through holes in concrete or stone blocks



TI TRANSOM WITH THROUGH INTERNAL DISTRIBUTED WIRE ROPES

Opposed parallel walls whereon the transoms can be placed

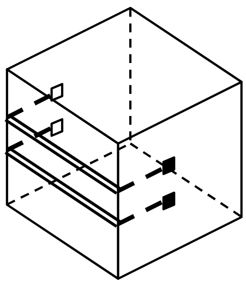
Presence of member or spacing system in correspondence to wire ropes (beams/frameworks/floors)



CV CONSTRAINED HOOP

Presence of side walls whereon the wire rope is anchored in concrete or stone blocks not in proximity to the wall to be restrained

!



TV TRANSOM WITH CONSTRAINED SIDE WIRE ROPES

Presence of side walls whereon the wire rope is anchored in concrete or stone blocks not in proximity to the wall to be restrained

!

WARNING: tie backs should always be placed close to (or coupled to) members (main inside walls, stiff floors, main beams) able to perform a spacing function to avoid that their ends getting closer under traction or seismic actions

! This symbol means that a solution is allowed only if the anchorage is made in concrete blocks, in squared stone blocks or in tight masonry

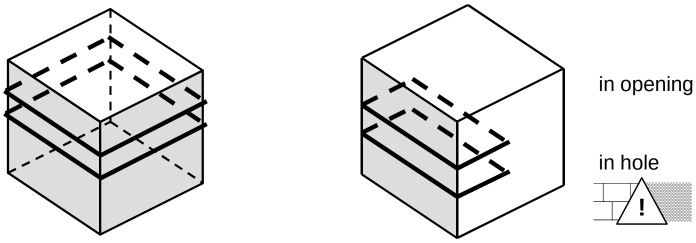
FULL AND PARTIAL HOOP: general recommendations

STOP-**TA**

CE FULL EXTERNAL HOOP

CP PARTIAL THROUGH HOOP

Wall to be retained

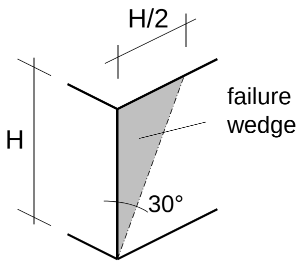


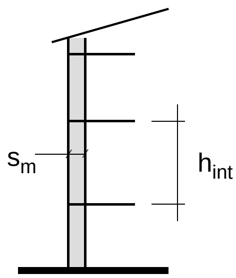
PRIMARY ZONE TO BE RETAINED:

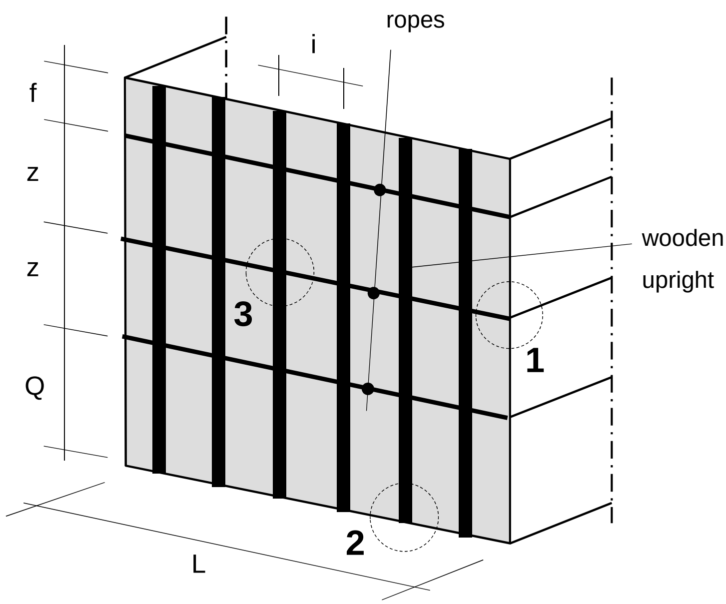
Rotation: upper half of the wall
Buckling: middle zone with larger bulging

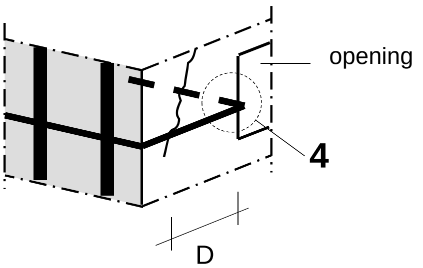
WARNING

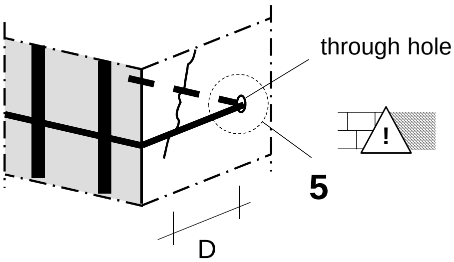
This symbol means that this solution is allowed only on concrete or stone blocks











Detail drawings are shown in the relevant sections

WARNING
The wire rope turn should always be placed beyond the failure wedge shown above

If evident cracks are present, the wire rope turn should be placed at a distance longer or equal to D, measured from the detachment crack, along the wire rope and in any case beyond the respect wedge

KEY

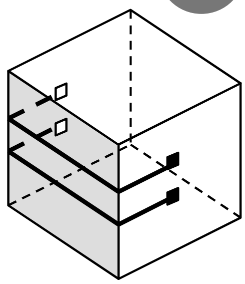
L = width of the wall to be restrained
H = height of the wall to be restrained
h_{int} = maximum space between two floors
s_m = average thickness of the masonry to be restrained
i = distance between uprights
z = distance between wire ropes
f = maximum extrusion of uprights over the top rope
D = minimum wire rope turning distance from the detachment crack
Q = bottom rope height

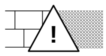
Definition of Q:
The bottom wire rope should be positioned at the same height as the failure wedge lower end (wall detachment crack beginning)
In case of full detachment it should be assumed Q = z

PARTIAL CONSTRAINED HOOP: general recommendations

STOP-**TA**

CV CONSTRAINED HOOP



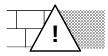


Wall to be retained

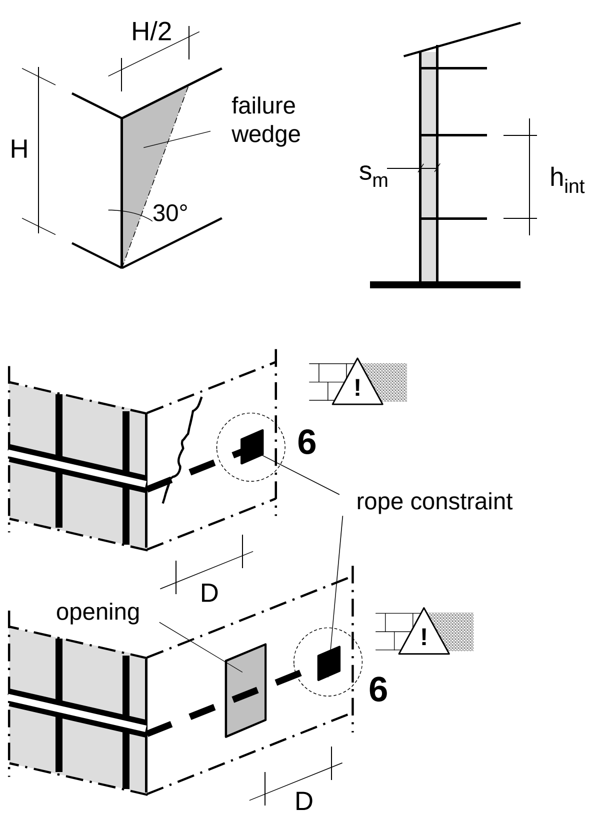
PRIMARY ZONE TO BE RETAINED:

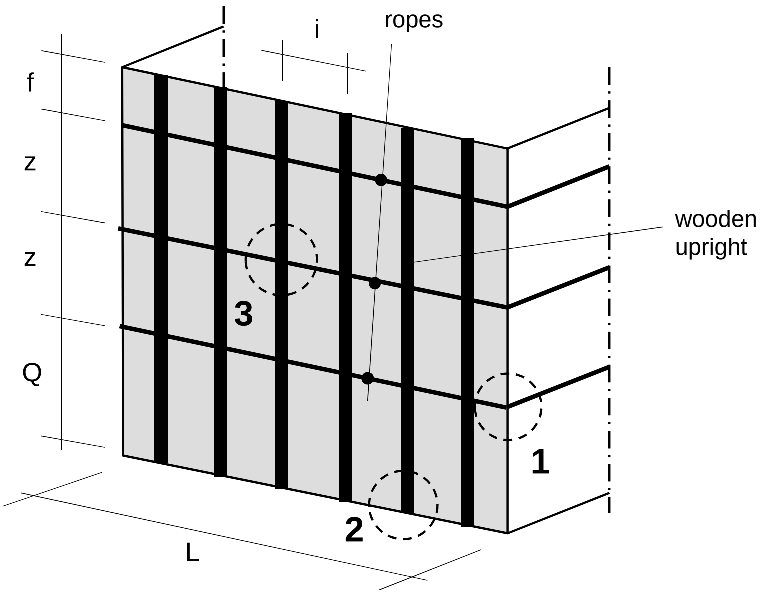
Rotation: upper half of the wall
Buckling: middle zone with larger bulging

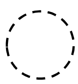
WARNING



This symbol means that this solution is allowed only if the anchorage is made in concrete or stone blocks or in tight masonry







Detail drawings are shown in the relevant sections

KEY

L = width of the wall to be restrained
H = height of the wall to be restrained
h_{int} = maximum space between two floors
s_m = average thickness of the masonry to be restrained
i = distance between uprights
z = distance between wire ropes
f = maximum extrusion of uprights over the top rope
D = minimum constraint distance
Q = bottom wire rope height

Definition of Q:
The bottom wire rope should be positioned at the same height as the failure wedge lower end (wall detachment crack beginning)
In case of full detachment it should be assumed Q = z

All the elements should be designed according to Tables 1 and 2

WARNING
The rope anchorage should always be placed beyond the failure wedge shown above

If evident cracks are present the wire rope anchorage should be placed at a distance longer or equal to D, measured from the detachment crack along the wire rope.
If the anchorage is placed beyond an opening, D should be measured from the internal edge of the opening.
In any case the anchorage should be placed beyond the failure wedge

STEEL WIRE ROPE HOOPS: design

Table 1

max L 10 m

CE

CP in opening

CP in hole

CV

SEISMIC CLASS A*					h_{int}: up to 3 m, S_m: up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m	3 - 4 m, S_m: up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m	4 - 5 m, S_m: up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m
L	up to 5 m	z	up to 1 m	Ø rope [mm]	12	12	14	14	12	12	14	14	12	12	14	14
				D min [m]	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
			1-2m	Ø rope [mm]	16	18	20	20	14	16	18	20	14	16	18	20
				D min [m]	2.2	1.9	1.8	1.7	2.0	1.8	1.7	1.6	1.9	1.7	1.6	1.6
	5-7m	z	up to 1 m	Ø rope [mm]	12	14	16	18	12	14	16	18	12	14	16	16
				D min [m]	1.6	1.4	1.3	1.2	1.4	1.3	1.2	1.1	1.3	1.2	1.1	1.1
			1-2m	Ø rope [mm]	18	20	22	24	18	20	22	24	16	20	22	24
				D min [m]	3.1	2.7	2.5	2.4	2.8	2.5	2.3	2.3	2.6	2.4	2.3	2.2
	7-10m	z	up to 1 m	Ø rope [mm]	16	18	20	20	14	16	18	20	14	16	18	20
				D min [m]	2.2	1.9	1.8	1.7	2.0	1.8	1.7	1.6	1.9	1.7	1.6	1.6
			1-2m	Ø rope [mm]	22	24	n.c.	n.c.	20	24	n.c.	n.c.	20	22	n.c.	n.c.
				D min [m]	4.4	3.9	3.6	3.4	4.0	3.6	3.4	3.2	3.7	3.4	3.2	3.1
z	up to 1 m	i	up to 1 m	upright section	10x10	10x10	10x10	13x13	10x10	10x10	10x10	13x13	10x10	10x10	10x10	10x10
				f max [m]	0.20	0.20	0.30	0.30	0.20	0.20	0.30	0.30	0.20	0.20	0.20	0.30
			1-1.5m	upright section	10x10	13x13	13x13	13x13	10x10	13x13	13x13	13x13	10x10	10x10	13x13	13x13
				f max [m]	0.30	0.20	0.20	0.40	0.20	0.30	0.30	0.40	0.20	0.30	0.30	0.40
			1.5-2m	upright section	13x13	13x13	15x15	15x15	10x10	13x13	13x13	15x15	10x10	13x13	13x13	15x15
				f max [m]	0.20	0.30	0.30	0.40	0.20	0.20	0.30	0.40	0.20	0.20	0.30	0.40
	1 - 2m	i	up to 1 m	upright section	13x13	13x13	15x15	15x15	13x13	13x13	15x15	15x15	13x13	13x13	15x15	15x15
				f max [m]	0.40	0.50	0.50	0.80	0.40	0.40	0.50	0.80	0.40	0.40	0.50	0.80
			1-1.5m	upright section	15x15	15x15	18x18	18x18	15x15	15x15	18x18	18x18	13x13	15x15	18x18	18x18
				f max [m]	0.40	0.50	0.50	0.80	0.40	0.50	0.50	0.80	0.40	0.50	0.50	0.80
			1.5-2m	upright section	15x15	18x18	20x20	2 15x15	15x15	18x18	20x20	2 15x15	15x15	18x18	18x18	20x20
				f max [m]	0.60	0.90	0.80	0.80	0.60	0.50	0.80	0.80	0.60	0.50	0.80	0.80

n.c. – solution not applicable (try other solutions)

Table 2

max L 10 m

CE

CP in opening

CP in hole

CV

SEISMIC CLASS B*					h_{int}: up to 3 m, S_m: up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m	3 - 4 m, S_m: up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m	4 - 5 m, S_m: up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m
L	up to 5 m	z	up to 1 m	Ø rope [mm]	12	12	12	12	12	12	12	12	12	12	12	12
				D min [m]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
			1-2m	Ø rope [mm]	14	14	16	18	12	14	16	18	12	14	16	16
				D min [m]	1.2	1.1	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	5-7m	z	up to 1 m	Ø rope [mm]	12	12	14	14	12	12	14	14	12	12	14	14
				D min [m]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
			1-2m	Ø rope [mm]	16	18	20	20	14	16	18	20	14	16	18	20
				D min [m]	1.7	1.5	1.4	1.3	1.5	1.4	1.3	1.2	1.4	1.3	1.2	1.2
	7-10m	z	up to 1 m	Ø rope [mm]	14	14	16	18	12	14	16	18	12	14	16	16
				D min [m]	1.2	1.1	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
			1-2m	Ø rope [mm]	18	20	22	24	18	20	22	24	16	20	22	24
				D min [m]	2.4	2.1	1.9	1.8	2.2	1.9	1.8	1.8	2.0	1.8	1.8	1.7
z	up to 1 m	i	up to 1 m	upright section	10x10	10x10	10x10	10x10	10x10	10x10	10x10	10x10	10x10	10x10	10x10	10x10
				f max [m]	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
			1-1.5m	upright section	10x10	10x10	10x10	13x13	10x10	10x10	10x10	13x13	10x10	10x10	10x10	13x13
				f max [m]	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
			1.5-2m	upright section	10x10	13x13	13x13	13x13	10x10	10x10	13x13	13x13	10x10	10x10	13x13	13x13
				f max [m]	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	1 - 2m	i	up to 1 m	upright section	13x13	13x13	13x13	15x15	13x13	13x13	13x13	13x13	10x10	13x13	13x13	13x13
				f max [m]	0.20	0.50	0.50	0.50	0.20	0.50	0.50	0.50	0.20	0.50	0.50	0.50
			1-1.5m	upright section	13x13	15x15	15x15	18x18	13x13	13x13	15x15	15x15	13x13	13x13	15x15	15x15
				f max [m]	0.40	0.30	0.50	0.50	0.40	0.30	0.30	0.50	0.40	0.30	0.30	0.50
			1.5-2m	upright section	15x15	15x15	18x18	18x18	13x13	15x15	18x18	18x18	13x13	15x15	18x18	18x18
				f max [m]	0.30	0.40	0.40	0.60	0.30	0.40	0.40	0.60	0.30	0.40	0.40	0.60

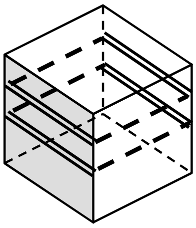
(*) For the seismic classes see Annex 1
If no Annex 1 is provided, seismic class A should be used

NOTE: the wire ropes have been sized with a safety factor to ultimate load equal to 2.5

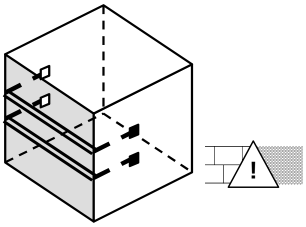
TRANSOM WITH SIDE HOOP: general recommendations

STOP-**TA**

TL TRANSOM WITH EXTERNAL SIDE WIRE ROPE



TV TRANSOM WITH CONSTRAINED SIDE WIRE ROPES

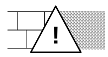


Wall to be retained

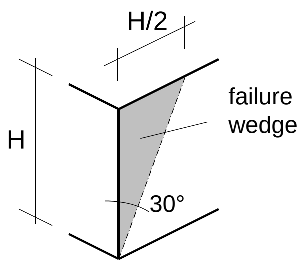
PRIMARY ZONE TO BE RETAINED:

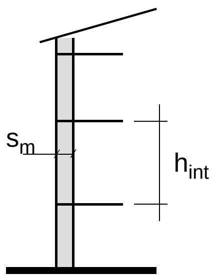
Rotation: upper half of the wall
Buckling: middle zone with larger bulging

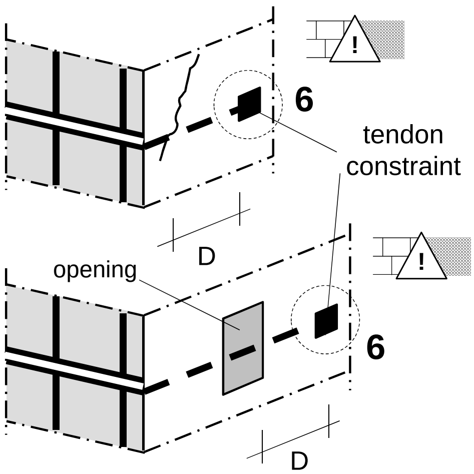
WARNING

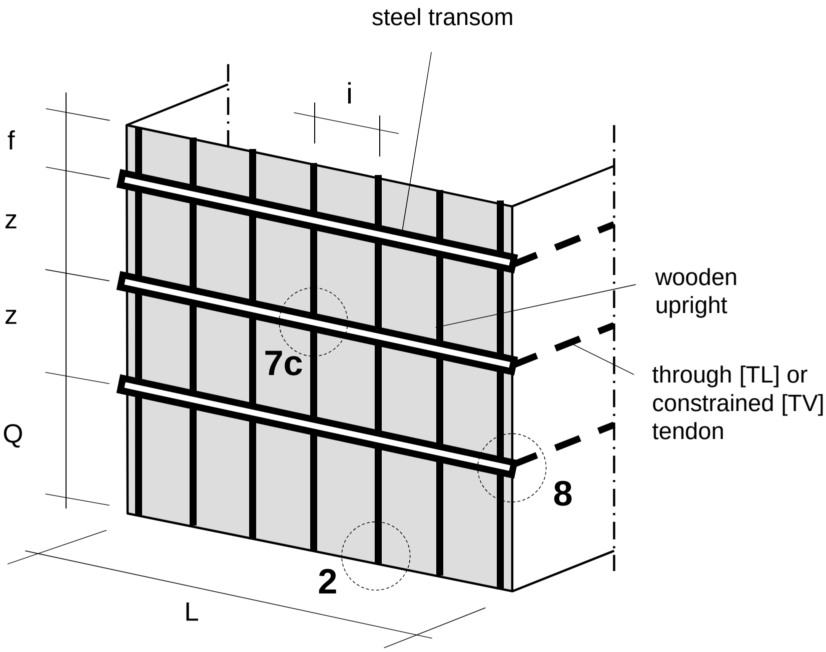


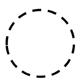
This symbol means that this solution is allowed only if the anchorage is made in concrete or stone blocks or in tight masonry











Detail drawings are shown in the relevant sections

WARNING
The wire rope anchorage should always be placed beyond the failure wedge shown above

If evident cracks are present the wire rope anchorage should be placed at a distance longer or equal to D, measured from the detachment crack along the rope.
If the anchorage is placed beyond an opening, D should be measured from the internal edge of the opening.
In any case the anchorage should be placed beyond the failure wedge

KEY

L = width of the wall to be restrained
H = height of the wall to be restrained
h_{int} = maximum space between two floors
s_m = average thickness of the masonry to be restrained
i = distance between uprights
z = distance between transoms
f = maximum extrusion of uprights over the top transom
D = minimum anchorage distance
Q = bottom transom height

Definition of Q:
The bottom transom should be positioned at the same height as the failure wedge lower end (wall detachment crack beginning)
In case of full detachment it should be assumed Q = z

All the elements should be designed according to Tables 3 and 4

TRANSOM WITH SIDE HOOP: design

STOP-**TA**

Table 3

max L 7 m

TL

TV

SEISMIC CLASS A*			z											
			up to 1.5 m				up to 3 m				up to 4 m			
			Sm				Sm				Sm			
			up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m	up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m	up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m
L	up to 5 m	Ø rope [mm]	14	16	16	18	18	20	24	n.c.	20	24	n.c.	n.c.
		transom	HEA140	HEA160	HEA160	HEA180	HEA200	HEA200	HEA220	n.c.	HEA200	HEA220	n.c.	n.c.
		D min [m]	1.3	1.1	1.0	1.0	2.5	2.2	2.0	n.c.	3.1	2.7	n.c.	n.c.
	5-7m	Ø rope [mm]	16	18	20	22	22	24	n.c.	n.c.	24	n.c.	n.c.	n.c.
		transom	HEA200	HEA200	HEA220	HEA240	HEA240	HEA260	n.c.	n.c.	HEA260	n.c.	n.c.	n.c.
		D min [m]	1.8	1.5	1.4	1.4	3.6	3.1	n.c.	n.c.	4.3	n.c.	n.c.	n.c.
i	up to 1 m	upright section	10x10	13x13	13x13	13x13	15x15	18x18	18x18	n.c.	18x18	20x20	n.c.	n.c.
		f max [m]	0.40	0.40	0.40	0.30	0.60	0.90	0.80	n.c.	0.90	1.10	n.c.	n.c.
	1-1.5 m	upright section	13x13	13x13	15x15	18x18	18x18	20x20	20x20	n.c.	20x20	2 18x18	n.c.	n.c.
		f max [m]	0.20	0.20	0.40	0.40	0.60	0.80	0.80	n.c.	0.90	1.10	n.c.	n.c.
	1.5 - 2 m	upright section	13x13	15x15	18x18	18x18	20x20	2 18x18	2 18x18	n.c.	2 18x18	2 20x20	n.c.	n.c.
		f max [m]	0.20	0.30	0.30	0.40	0.70	0.60	0.80	n.c.	0.90	1.10	n.c.	n.c.

Table 4

max L 7 m

TL

TV

SEISMIC CLASS B*			z											
			up to 1.5 m				up to 3 m				up to 4 m			
			Sm				Sm				Sm			
			up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m	up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m	up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m
L	up to 5 m	Ø rope [mm]	12	12	14	16	16	18	20	22	18	20	22	24
		transom	HEA140	HEA140	HEA140	HEA160	HEA160	HEA180	HEA200	HEA200	HEA180	HEA200	HEA220	HEA220
		D min [m]	1.0	1.0	1.0	1.0	1.8	1.6	1.5	1.4	2.2	1.9	1.8	1.8
	5-7m	Ø rope [mm]	14	16	16	18	18	20	24	n.c.	20	24	n.c.	n.c.
		transom	HEA160	HEA180	HEA200	HEA200	HEA220	HEA240	HEA240	n.c.	HEA220	HEA240	n.c.	n.c.
		D min [m]	1.3	1.1	1.0	1.0	2.5	2.2	2.0	n.c.	3.1	2.7	n.c.	n.c.
i	up to 1 m	upright section	10x10	10x10	10x10	13x13	13x13	15x15	18x18	18x18	18x18	18x18	20x20	20x20
		f max [m]	0.2	0.2	0.5	0.5	0.5	0.7	1.0	1.0	1.2	1.1	1.3	1.2
	1 - 1.5 m	upright section	10x10	13x13	13x13	15x15	15x15	18x18	18x18	20x20	18x18	20x20	2 18x18	2 18x18
		f max [m]	0.4	0.3	0.3	0.3	0.5	0.8	0.8	0.9	0.9	1.0	1.3	1.2
	1.5 - 2 m	upright section	13x13	13x13	15x15	18x18	18x18	18x18	20x20	2 18x18	20x20	2 18x18	2 20x20	2 20x20
		f max [m]	0.3	0.3	0.3	0.4	0.7	0.6	0.8	1.0	0.9	1.1	1.3	1.2

n.c. – solution not applicable (try other solutions)

(*) For the seismic classes see Annex 1
If no Annex 1 is provided, seismic class A should be used

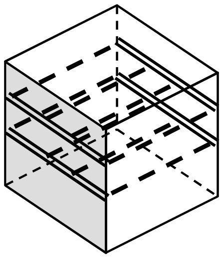
NOTE: the wire ropes have been sized with a safety factor to ultimate load equal to 2.5

WARNING:
when L > 7 m, this solution is applicable only if it is possible to make an anchorage at a distance < 7 m on an intermediate main inside wall.
In this case the tables should be applied considering L as the distance between the two anchorage tendons.

THROUGH INTERNAL DISTRIBUTED ROPES: general recommendations

STOP-**TA**

TI TRANSOM WITH THROUGH INTERNAL DISTRIBUTED WIRE ROPES

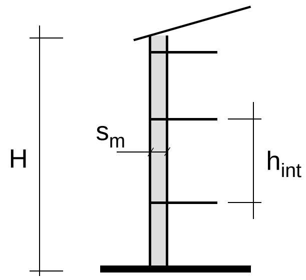


Wall to be retained

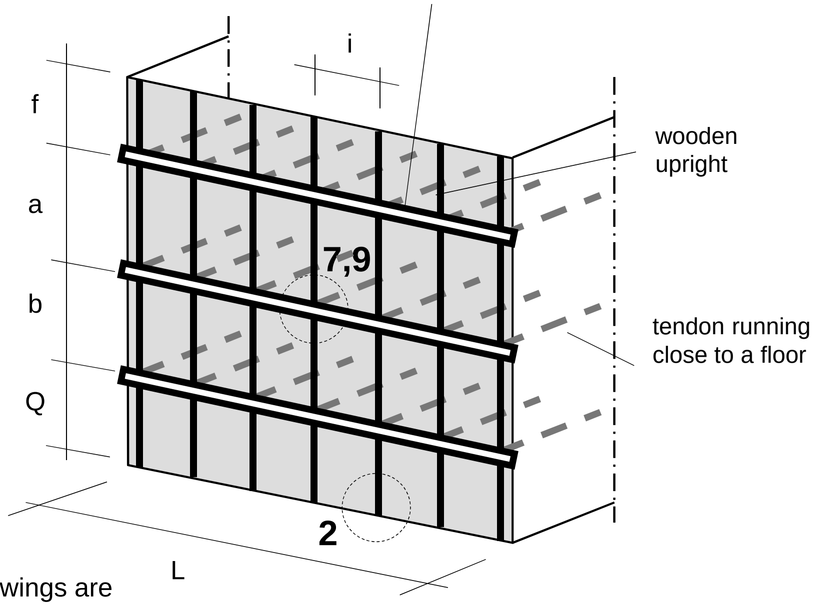
PRIMARY ZONE TO BE RETAINED:

Rotation: upper half of the wall
Buckling: middle zone with larger bulging

WARNING:
tendons may be positioned at floors soffit or extrados.
In case of wooden floors, tendons should be positioned close to the main girders.
When the scaffolding is perpendicular to the tendons, make sure that the planking can provide a spacer function. If not, spacing elements should be positioned beside the tendons.



$z = \max(a,b) = h_{int}$



Detail drawings are shown in the relevant section

KEY

L = width of the wall to be restrained
H = height of the wall to be restrained
h_{int} = maximum space between two floors
s_m = average thickness of the masonry to be restrained
i = distance between uprights
z = reference design distance (equal to the maximum distance between floors)
f = maximum extrusion of uprights over the top transom
Q = bottom transom height

Definition of Q:
The bottom transom should be positioned at the same height as the first damaged floor.
In case of full detachment, the bottom transom should be placed close to the first floor.

All the elements should be designed according to Tables 5 and 6

THROUGH INTERNAL DISTRIBUTED ROPES: design

Table 5

TI

SEISMIC CLASS A*			h_{int}											
			up to 3 m				3 - 4 m				4 - 5 m			
			S_m				S_m				S_m			
			up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m	up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m	up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m
	up to 1 m	Ø rope [mm]	12	14	16	16	14	16	16	18	14	16	18	20
	up to 1 m	wooden transom	15x15	18x18	20x20	20x20	18x18	20x20	2 15x15	2 18x18	18x18	20x20	2 18x18	2 18x18
	up to 1 m	steel transom	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160
	up to 1 m	upright section	13x13	15x15	18x18	18x18	15x15	18x18	20x20	2 18x18	18x18	20x20	2 18x18	2 20x20
	up to 1 m	f max [m]	0.6	0.5	0.8	0.7	0.9	1.1	1.0	1.3	1.2	1.5	1.5	1.5
i	1 - 1.5 m	Ø rope [mm]	14	16	18	20	16	18	20	n.c.	18	20	n.c.	n.c.
i	1 - 1.5 m	wooden transom	18x18	2 15x15	2 18x18	2 18x18	20x20	2 18x18	2 18x18	n.c.	2 15x15	2 18x18	n.c.	n.c.
i	1 - 1.5 m	steel transom	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	n.c.	2UPN160	2UPN160	n.c.	n.c.
i	1 - 1.5 m	upright section	15x15	18x18	18x18	20x20	18x18	20x20	2 18x18	n.c.	20x20	2 20x20	n.c.	n.c.
i	1 - 1.5 m	f max [m]	0.4	0.6	0.7	0.9	0.8	1.1	1.3	n.c.	1.2	1.4	n.c.	n.c.
	1.5 - 2 m	Ø rope [mm]	16	18	20	n.c.	18	20	n.c.	n.c.	20	n.c.	n.c.	n.c.
	1.5 - 2 m	wooden transom	2 18x18	2 18x18	2 20x20	n.c.	2 18x18	2 20x20	n.c.	n.c.	2 18x18	n.c.	n.c.	n.c.
	1.5 - 2 m	steel transom	2UPN160	2UPN160	2UPN160	n.c.	2UPN160	2UPN160	n.c.	n.c.	2UPN160	n.c.	n.c.	n.c.
	1.5 - 2 m	upright section	18x18	18x18	20x20	n.c.	20x20	2 18x18	n.c.	n.c.	2 18x18	n.c.	n.c.	n.c.
	1.5 - 2 m	f max [m]	0.5	0.6	0.8	n.c.	0.7	1.1	n.c.	n.c.	1.2	n.c.	n.c.	n.c.

Table 6

TI

SEISMIC CLASS B*			h_{int}											
			up to 3 m				3 - 4 m				4 - 5 m			
			S_m				S_m				S_m			
			up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m	up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m	up to 0.4 m	0.4-0.6m	0.6-0.8m	0.8-1m
	up to 1 m	Ø rope [mm]	12	12	12	14	12	12	14	16	12	14	16	16
	up to 1 m	wooden transom	13x13	15x15	18x18	18x18	15x15	18x18	18x18	20x20	15x15	18x18	20x20	2 15x15
	up to 1 m	steel transom	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160
	up to 1 m	upright section	13x13	13x13	15x15	18x18	15x15	18x18	18x18	20x20	18x18	18x18	20x20	2 18x18
	up to 1 m	f max [m]	0.5	0.7	0.7	1.0	0.8	1.1	1.0	1.2	1.2	1.4	1.5	1.5
i	1 - 1.5 m	Ø rope [mm]	12	14	16	16	14	16	18	18	14	16	18	20
i	1 - 1.5 m	wooden transom	15x15	18x18	20x20	2 15x15	18x18	20x20	2 15x15	2 18x18	18x18	2 15x15	2 18x18	2 20x20
i	1 - 1.5 m	steel transom	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160
i	1 - 1.5 m	upright section	13x13	15x15	18x18	18x18	18x18	18x18	20x20	2 18x18	18x18	2 18x18	2 18x18	2 20x20
i	1 - 1.5 m	f max [m]	0.5	0.8	0.7	0.9	0.9	1.0	1.3	1.2	1.1	1.4	1.5	1.5
	1.5 - 2 m	Ø rope [mm]	14	16	18	20	16	18	20	n.c.	16	20	n.c.	n.c.
	1.5 - 2 m	wooden transom	18x18	20x20	2 18x18	2 18x18	20x20	2 18x18	2 18x18	n.c.	2 18x18	2 18x18	n.c.	n.c.
	1.5 - 2 m	steel transom	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	2UPN160	n.c.	2UPN160	2UPN160	n.c.	n.c.
	1.5 - 2 m	upright section	15x15	18x18	18x18	20x20	18x18	20x20	2 18x18	n.c.	20x20	2 18x18	n.c.	n.c.
	1.5 - 2 m	f max [m]	0.4	0.6	0.8	1.0	0.7	1.1	1.0	n.c.	1.2	1.4	n.c.	n.c.

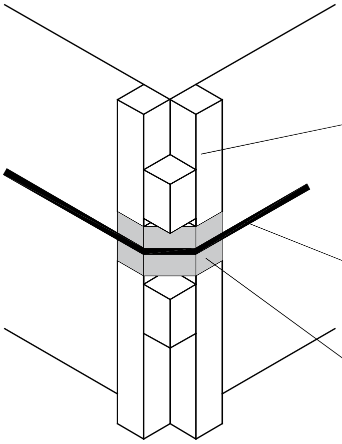
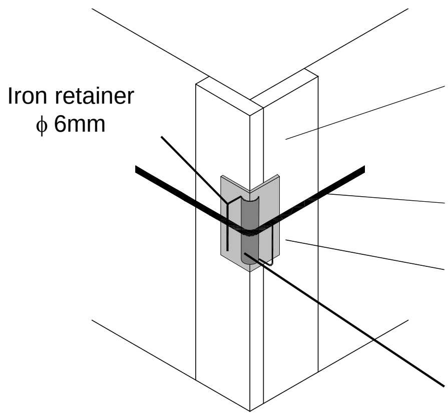
n.c. – solution not applicable (try other solutions)

(*) For the seismic classes see Annex 1

If no Annex 1 is provided, seismic class A should be used

NOTE: the wire ropes have been sized with a safety factor to ultimate load equal to 2.5

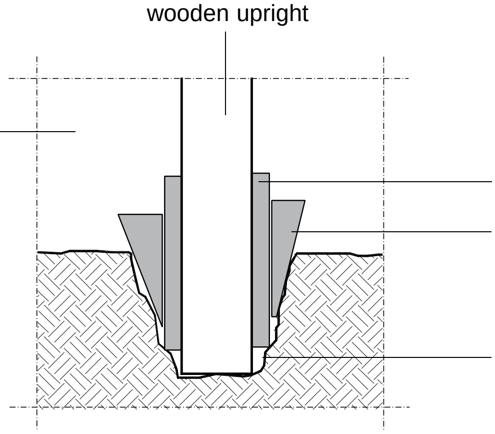
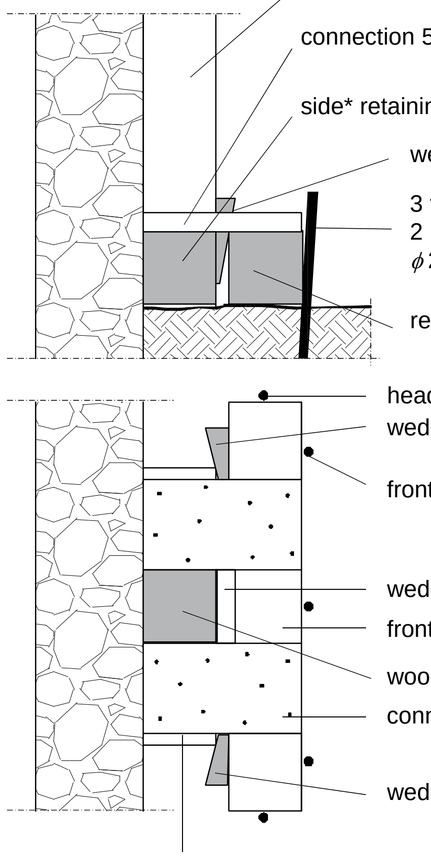
STEEL TENDONS: construction details | STOP-**TA**

Detail 1	WIRE ROPE DEFLECTION ON MASONRY CORNER
a BEAMS AND STEEL SHEET MASONRY CORNER ANGULAR	
b PLANKS AND ROUNDED PLATE MASONRY CORNER ANGULAR	

NOTE: a, b are alternative solutions

STEEL TENDONS: construction details

STOP-**TA**

Detail 2	**UPRIGHT BASE**
a IN GROUND BASE ANCHOR	
b ABOVE GROUND BASE ANCHOR	

(*) the side retaining elements and the front retaining beam should have the same dimensions as the vertical uprights

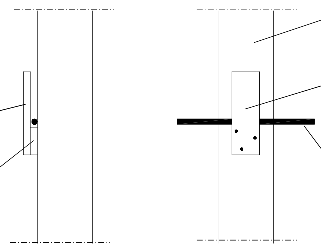
STEEL TENDONS: construction details

STOP-**TA**

Detail 3 — WIRE ROPE-UPRIGHT CROSSING

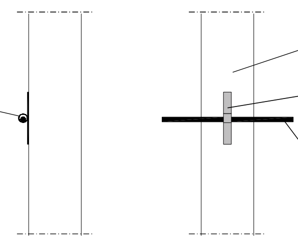
a

WOODEN SADDLE SUPPORT



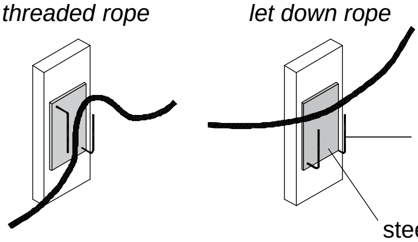
b

STEEL SLOT SUPPORT



c

STEEL PLATE AND RETAINERS SUPPORT



Each element should be held in place by or anchored to the wall in order to avoid the collapse of the system in case of rope loosening

NOTE: a, b and c are equivalent and alternative solutions

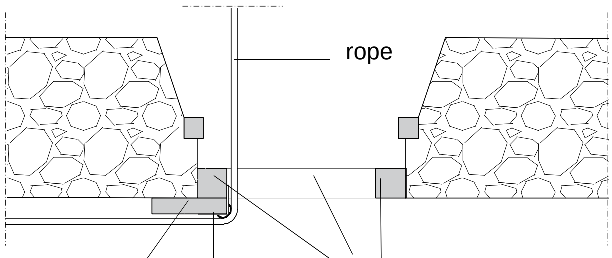
STEEL TENDONS: construction details | STOP-**TA**

Detail 4 — WIRE ROPE DEFLECTION ON EDGE OF OPENING

a

ROPE DEFLECTION
ON OPENING EDGE

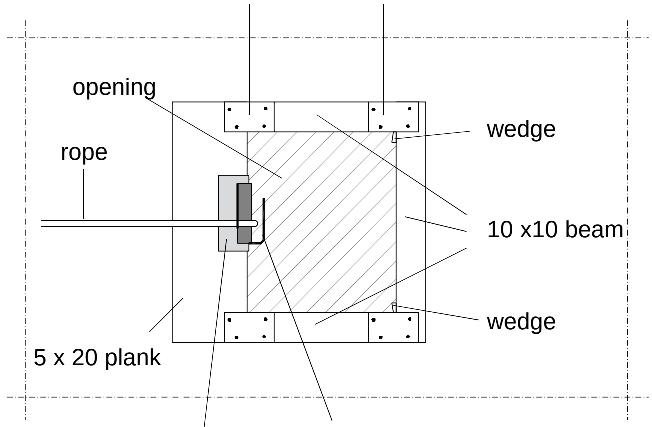
HORIZONTAL SECTION



deflection steel plate made from a half metal tube
welded on the edge and aimed at increasing the bend radius

FRONT VIEW

connecting gusset made from planks 2.5 cm thick



iron retainer ϕ 6 mm

deflection steel plate made from a half metal tube
welded on the edge and aimed at increasing the bend radius

STEEL TENDONS: construction details

Detail 5 — WIRE ROPE PASSING THROUGH A HOLE

a

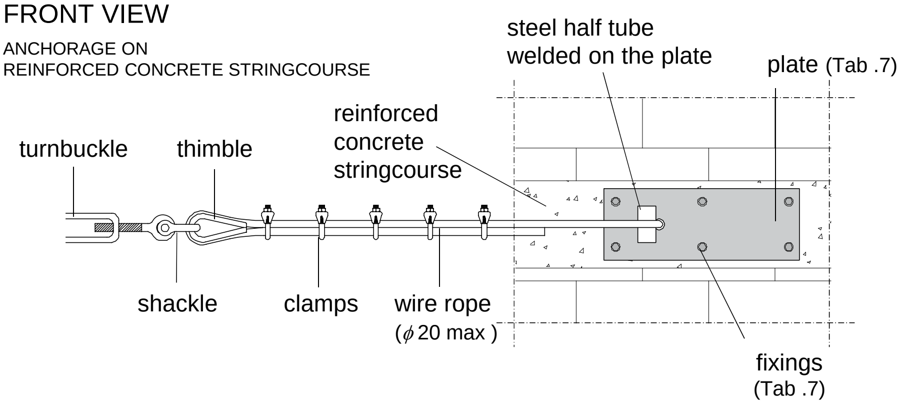
ROPE DEFLECTION PASSING THROUGH A MASONRY HOLE

WARNING

this solution is allowed only if the anchorage is made in concrete or stone blocks or in tight masonry

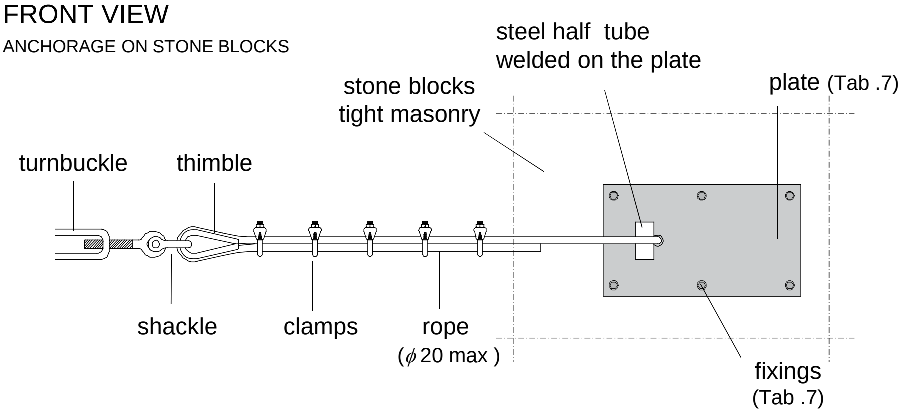
FRONT VIEW

ANCHORAGE ON REINFORCED CONCRETE STRINGCOURSE

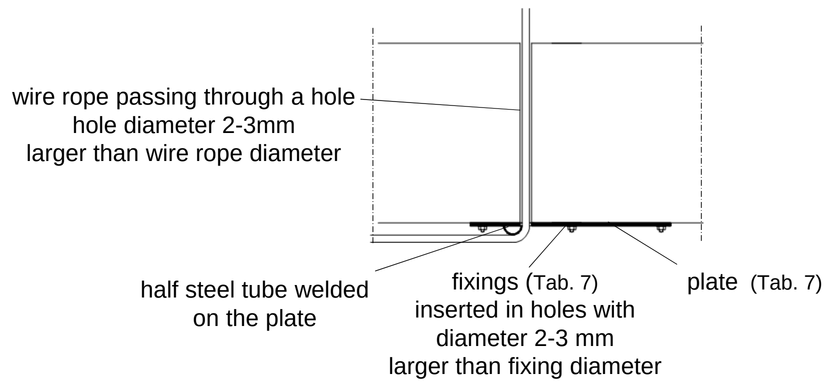


FRONT VIEW

ANCHORAGE ON STONE BLOCKS



HORIZONTAL SECTION



NOTE: for the wire rope assembly details see page 19/22

WARNING: if the anchorage is made on stone blocks, the fixings should be inserted to incorporate more blocks

STEEL TENDONS: construction details

STOP-**TA**

Detail 6

WIRE ROPE ANCHORAGE

a

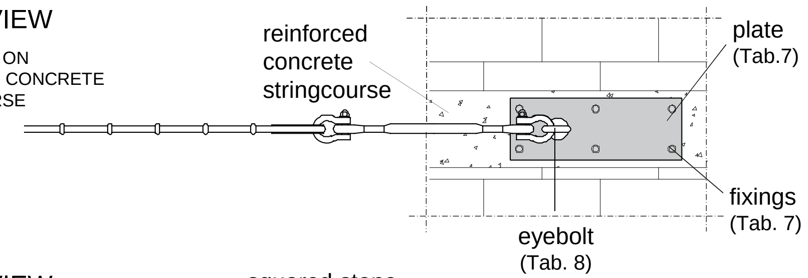
DOUBLE PLATE WITH THROUGH BAR ANCHORAGE

WARNING

this solution is allowed only if the anchorage is made in concrete or stone blocks or in tight masonry

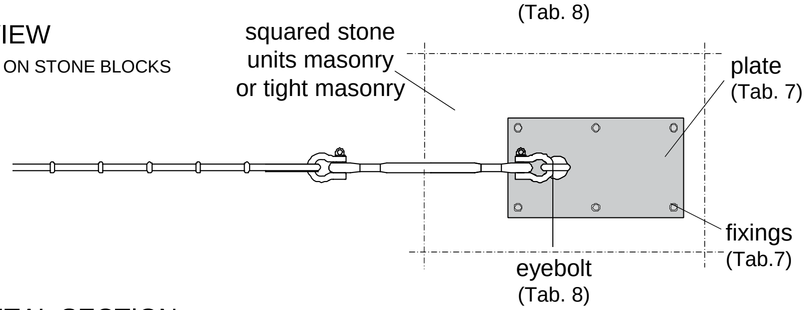
FRONT VIEW

ANCHORAGE ON REINFORCED CONCRETE STRINGCOURSE

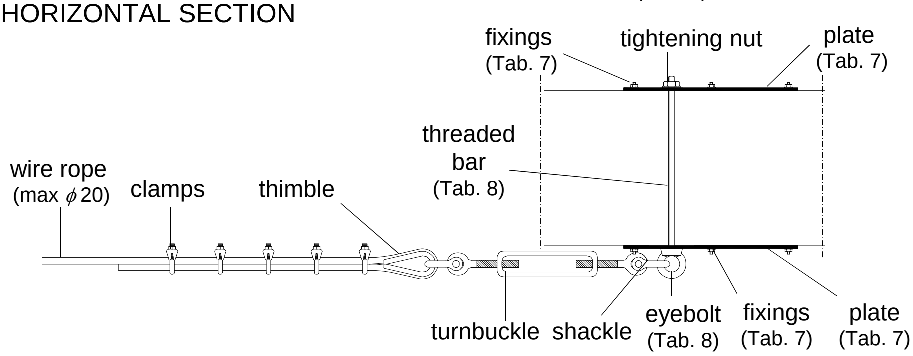


FRONT VIEW

ANCHORAGE ON STONE BLOCKS



HORIZONTAL SECTION



b

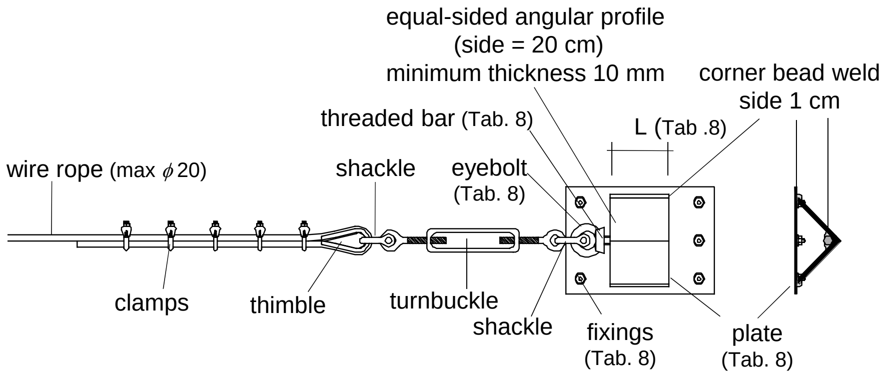
SINGLE PLATE WITH BAR ON ANGULAR SECTION ANCHORAGE

WARNING

this solution is allowed only if the anchorage is made in concrete or stone blocks or in tight masonry

FRONT VIEW

SECTION



WARNING: this solution should be used only in cases where positioning an internal back-plate (solution a) is not feasible.

see next page

WARNING: if the anchorage is made on stone blocks, the fixings should be inserted to incorporate more blocks

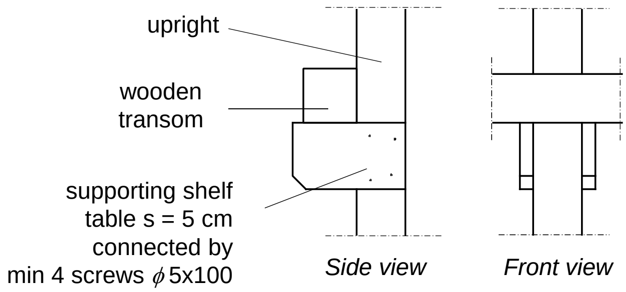
STEEL TENDONS: constructional details

STOP-**TA**

Detail 7 — TRANSOM-UPRIGHT CROSSING

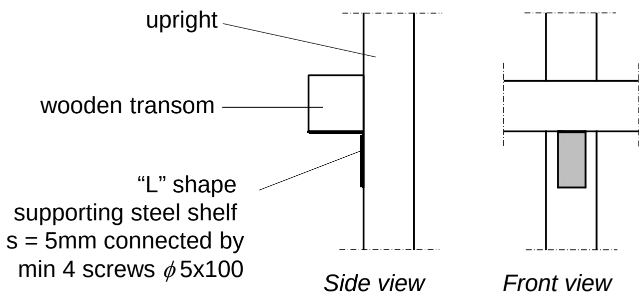
a

WOODEN TRANSOM SUPPORT WITH WOODEN SHELVES



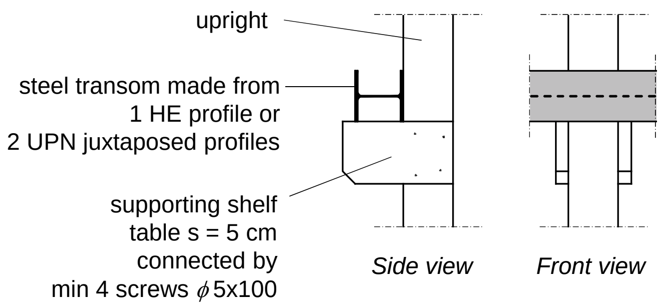
b

WOODEN TRANSOM SUPPORT WITH STEEL SHELVES



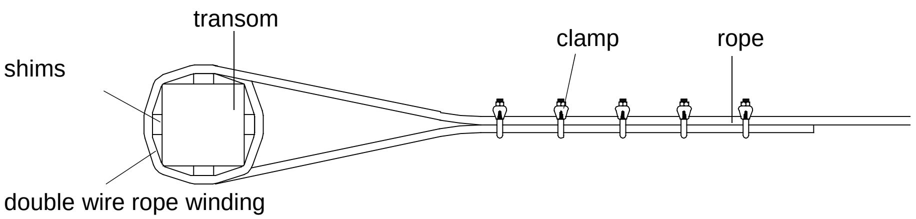
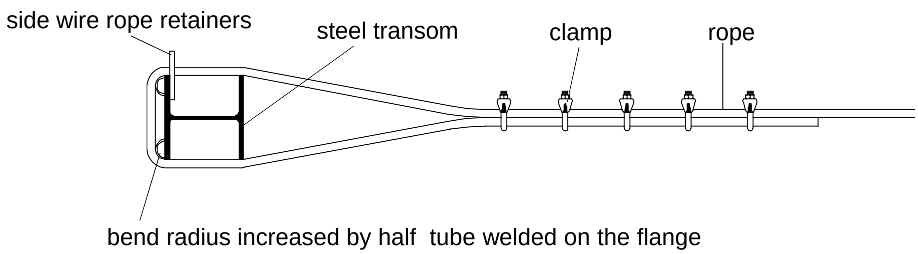
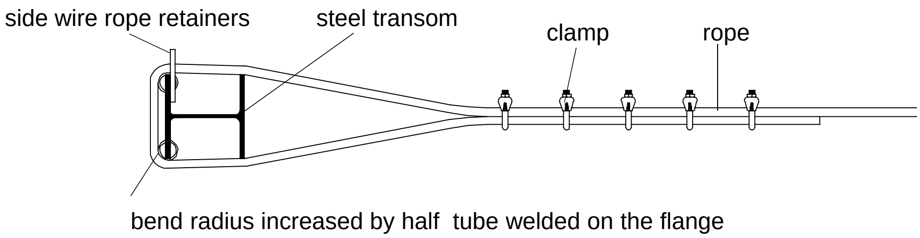
c

STEEL TRANSOM SUPPORT WITH STEEL SHELVES



NOTE: a, b and c are equivalent and alternative solutions

STEEL TENDONS: constructional details

Detail **8**	**TRANSOM-TENDON CROSSING**
a WINDING ON WOODEN TRANSOM	
b WINDING ON SINGLE STEEL TRANSOM	 Alternative choice: 

STEEL TENDONS: constructional details | STOP-**TA**

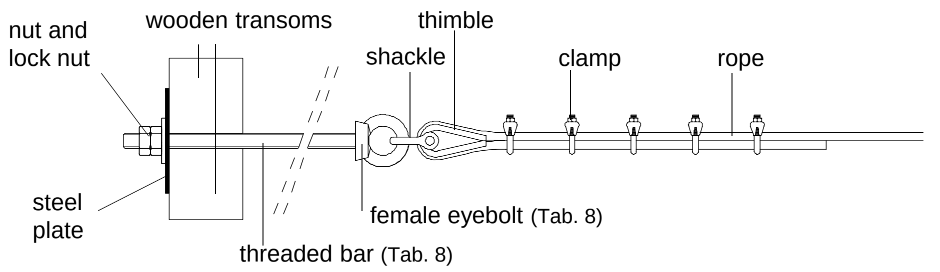
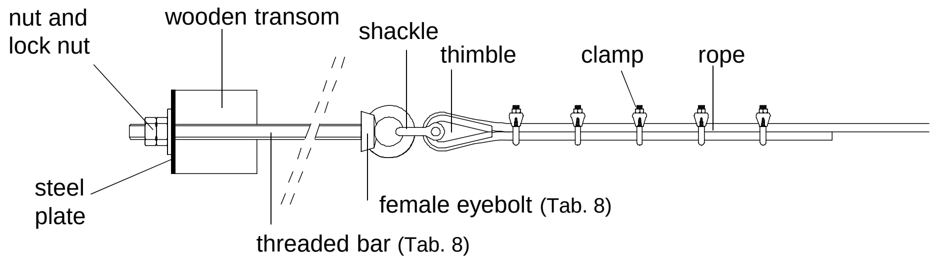
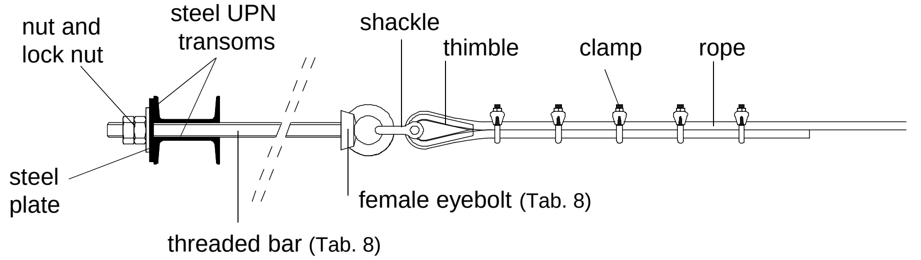
Detail 9	TRANSOM-TENDON CROSSING
a BOLTED PLATE LAID ON DOUBLE WOODEN TRANSOM	
b BOLTED PLATE LAID ON WOODEN TRANSOM WITH THROUGH HOLE	
c BOLTED PLATE LAID ON COUPLED STEEL UPN TRANSOMS	

Table 7 – Direction for designing details 5 and 6a

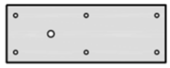
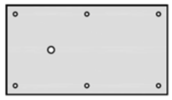
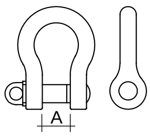
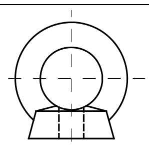
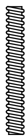
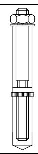
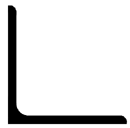
material	rope (mm)	plate dimensions (cm x cm)	plate thickness (cm)	fixing number and diameter	typical scheme
concrete	ϕ 12 – 20	55 x 20	1.0	6 ϕ 12 mm	
squared stone blocks or tight masonry	ϕ 12 – 20	55 x 30	1.0	6 ϕ 12 mm	

Table 8 – Directions for designing details 6b and 9

details 6b e 9						detail 6b		
steel rope type S10 ZN	shackle		female eyebolt		bar	rectangular plate	fixings	equal-"L" shape angular
								
diameter (mm)	A (mm)	WLL (*)	ISO thread	WLL (*)	diameter	dimensions (cm x cm)	number and diameter (mm)	length L (cm)
ϕ 12 -14	A26	3.25T o 3 1/4T	M30	3.6T	ϕ 30			15
ϕ 16 - 18	A31	4.75T o 4 3/4T	M36	5.1T	ϕ 36	50 x 35	5 ϕ 12 mm	15
ϕ 20	A36	6.50T o 6 1/2T	M42	7.0T	ϕ 42			20

(*) WWL is a code stamped on the elements. When elements having the WWL code reported in this table are not available, elements with higher WWL code may be used.

WARNINGS

The figures reported in Tables 7 and 8 have been defined referring to the Hilti HDA-P M12 mechanical anchoring (masonry hole ϕ 22 mm),
or
Würth W-HAZ M12 mechanical anchoring (masonry hole ϕ 18 mm)

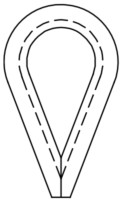
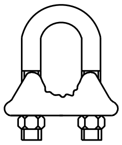
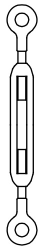
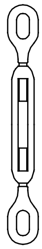
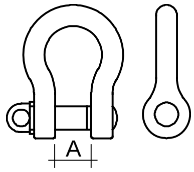
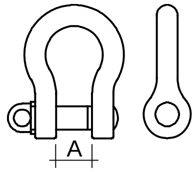
Other anchoring types may be used provided that their performances are equivalent or higher*.

When drilling holes, a minimum distance of 30 mm should be foreseen between the hole axis and the plate edge.

(*) When chemical plugs are used, in order to assure the same tensile and shear resistance as the mechanical steel plugs defined in Tables 7 and 8, information should be sought from the plug manufacturer in regard to masonry quality, bar diameter, steel class.

STEEL TENDONS: constructional details

Table 9 – Coordination between assembly elements (global safety factor equal to 2.5)

Steel rope type S10 Zn		Zinc plated RL thimble	CAV type clamp	O-O type turnbuckle	II B type turnbuckle	Omega shackle for O-O type turnbuckle		Omega shackle for II – B type turnbuckle	
						 A		 A	
Diameter (mm)	Capacity (t) (**) (S.F. = 2.5)	Dimensions	Marking	ISO thread	ISO thread	A (mm)	WLL(*)	A (mm)	WLL(*)
ϕ 12	3.52	12 A18	marked 13	M22	A27	22	2.00T o 2 T	26	3.25T or 3 1/4T
ϕ 14	4.78	16 A23.5	marked 14	M24	A30	26	3.25T o 3 1/4T	31	4.75T or 4 3/4T
ϕ 16	6.24	16 A23.5	marked 16	M27	A33	26	3.25T o 3 1/4T	31	4.75T or 4 3/4T
ϕ 18	7.92	20 A29.5	marked 18	M33	A36	31	4.75T o 4 3/4T	36	6.50T or 6 1/2T
ϕ 20	9.76	20 A29.5	marked 19	M36	A39	36	6.50T o 6 1/2T	36	6.50T or 6 1/2T
ϕ 22	11.78	22 A32	marked 22	M39	A45	36	6.50T o 6 1/2T	43	8.50T or 8 1/2T
ϕ 24	14.02	24 A35	marked 26	-	A52	-	-	43	8.50T or 8 1/2T

(*) WWL is a code stamped on the elements. When elements having the WWL code reported in this table are not available, elements with higher WWL code may be used.

(**) these figures refer to the TECI ® catalogue 2009. However, ropes and ancillary elements from other manufacturers may be used provided that their performances are not lower than those reported in the table.

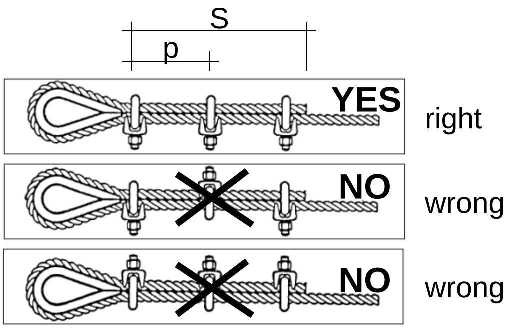


Table 10 – Directions for rope tightening with clamps

ϕ rope (mm)	CAV clamp marking	N clamps	step p (cm)	overlapping S (cm)
12	13	5	7.5	35
14	14	5	8.5	40
16	16	5	10.0	45
18	18	5	11.0	50
20	19	5	12.0	55
22	22	7	13.0	85
24	26	7	14.5	95

Data and figures taken from TECI ® catalogue 2009

STEEL TENDONS: precautions and warnings

STOP-**TA**

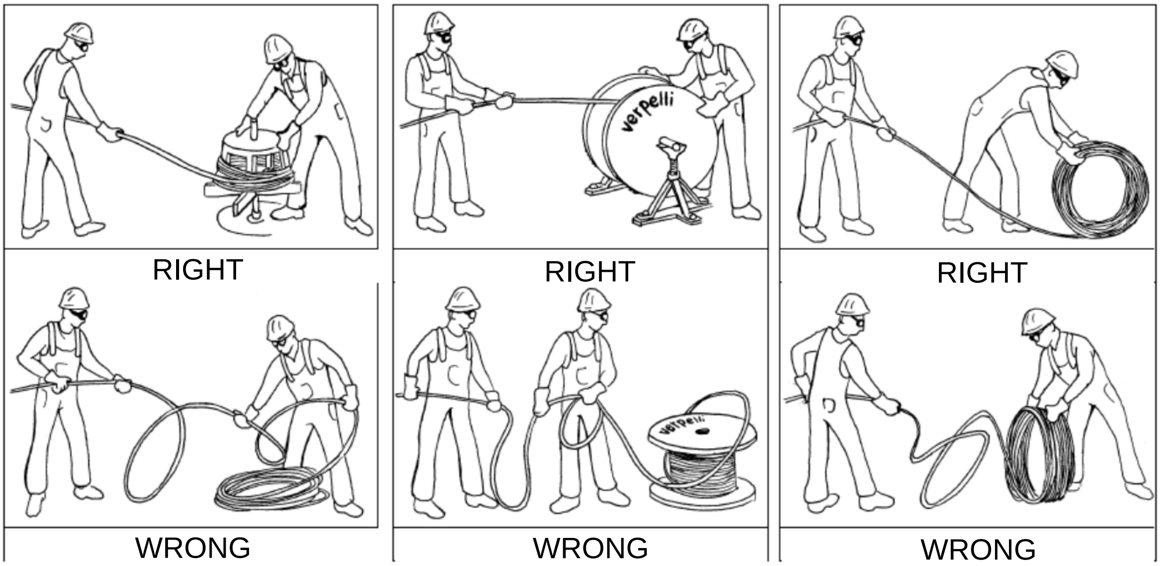


Figure taken from the website www.verpelli.it

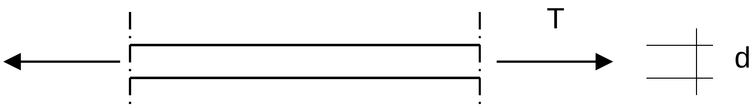
Tendons should never be loaded in exceedance of their capacity.

Tendons should always be inspected prior to their use.
Damaged tendons should never be used.
Tendons should never be bent close to sleeves, splices, cable terminals.

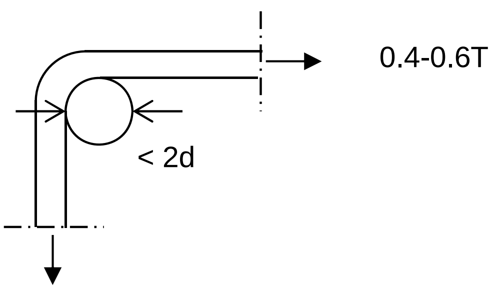
Steel ropes shall not be bent around small pins.
If, for example, a rope is bent around a pin whose diameter is equal to twice the rope one, the rope ultimate load is decreased from **40 to 60%**, thus reducing and loosing its capacity.

Consequently, in these cases, the use of suitable protections such as **thimbles and edge protectors** is advised.

WARNING
Ropes bending around small-radius elements should be avoided



When ropes are bent around small-radius elements (less than twice the rope diameter), the capacity should be reduced to 40-60% of the nominal one



USE OF STEEL ROPES AND THEIR ANCILLARY ELEMENTS

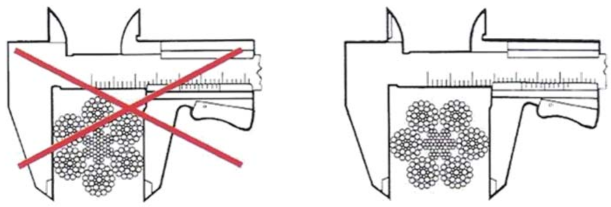
General directions

The choice should be made taking into account design instructions as well as assembling conditions of cables.

When “comfortable” working conditions are present, long cables may be used (50, 100, 200 m) thus limiting the discontinuity points.
When “uncomfortable” working conditions are present, short cables may be used (10, 20, 30 m) thus increasing the discontinuity points.

Preliminary checks

The preliminary cable check only consists of examining its length and the nominal cable diameter as well as the solidity and strength of ancillary elements. The cable should not show any signs of damage, severe wear or wires bending at any point. The rope diameter should be measured by a gauge, positioned as shown in figure.



ERRATO / INCORRECT   CORRETTO / CORRECT

Figure taken from the Teci ® catalogue 2009

Extremity eyelets assembly

The eyelet should be made as shown in figure, the first clamp should be placed as close as possible to the eyelet and the others spaced by 5-6 times the rope diameter (see Table 8).

The junction between two cables should be done by mutually inserting a turnbuckle and two omega shackles (cable – eyelet – shackle – turnbuckle –shackle – eyelet – cable).

Tensioning

The cable may be tensioned in two phases: the first one consists in closing the cable as a ring or fastening it to fixed points using suitable devices (Tirfor, small tackles, etc.) providing large displacements of the extremities; the second one consists in tensioning the cable by operating all the turnbuckles, possibly in an even manner.

STEEL ROPES TENDONS AND HOOPS

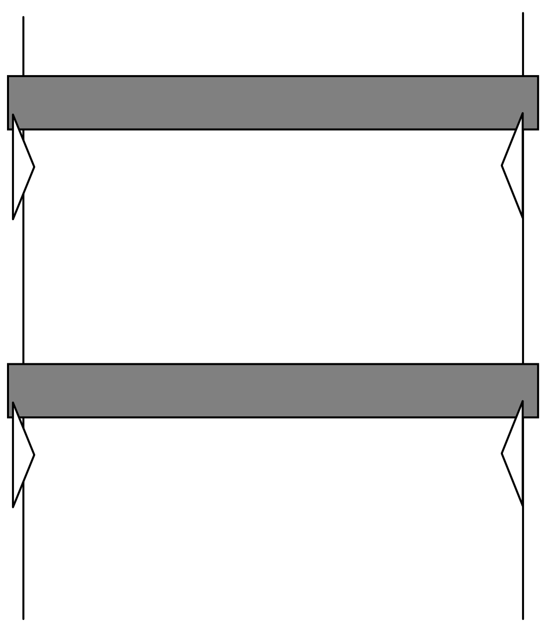
Field of application:
Tendons and hoop systems applied to buildings damaged by earthquakes.

General assumptions
The measures described in this procedure are intended to restrain load bearing walls with a thickness up to 1 m.
At page 1/22 several solutions aimed at protecting the ongoing damage are shown. The various schemes are coded and explained in terms of applicability and for each of them the design parameters are pointed out.
Once the most suitable solution for a particular case has been defined, reference should be made to the relevant section for the chosen solution code.
For each solution, the assembly conditions are shown and the reference geometrical design parameters are defined.
After the evaluation of the geometrical parameters for a particular case, and taking into account the seismic class (see Annex 1), the elements dimensions should be selected according to the relevant tables.
The details shown in the diagrams that are in dashed circles can be found on the relevant pages from 9/22 to 17/22.
During the assembly of elements and the laying operations, the additional directions given in pages 18/22, 19/22, 20/22 e 21/22 apply.

WARNING
All the dimensional figures (rope and ancillary elements) and the proposed assembly solutions have been defined so that a minimum safety factor equal to 2.5 is assured for single elements and for the whole system.
All the dimensional figures given in this procedure should be intended as minimum design values.
In the execution phase, sections with larger dimensions or elements with higher capacity than prescribed may be used.

VADEMECUM STOP

BRACING OF COLUMNS WITH POLYESTER RATCHET STRAPS



ABRUZZO EARTHQUAKE 2009
COORDINATION TEAM FOR TEMPORARY WORKS

WORKING GROUP FOR THE VADEMECUM STOP
under the supervision of Sergio Basti - Central director for emergency and urgent technical rescue
manual licensed by note no. EM3064/5001-11 dated 2009-06-15

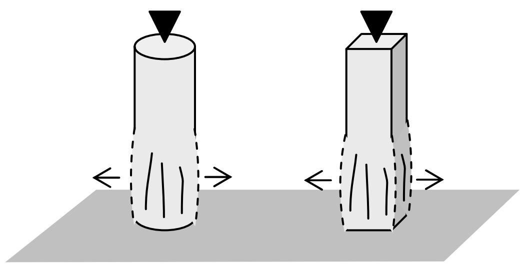
S.Grimaz (coordinator)
L.Munaro, M.Cavriani, E.Mannino, C.Bolognese, M.Caciolai, L.Ponticelli,
M.Bellizzi, A. D'Odorico, A.Maiolo

With the contribute of:
F.Barazza, P.Malisan, A.Moretti

Translated by:
L. Ponticelli, S. La Mendola, E. Gissi
and
Keith Bellamy
Section Leader, Urban Search & Rescue
Hampshire Fire and Rescue Service, UK

BRACING OF COLUMNS WITH POLYESTER RATCHET STRAPS: general recommendations STOP-**CP**

Forces to constrain: crushing

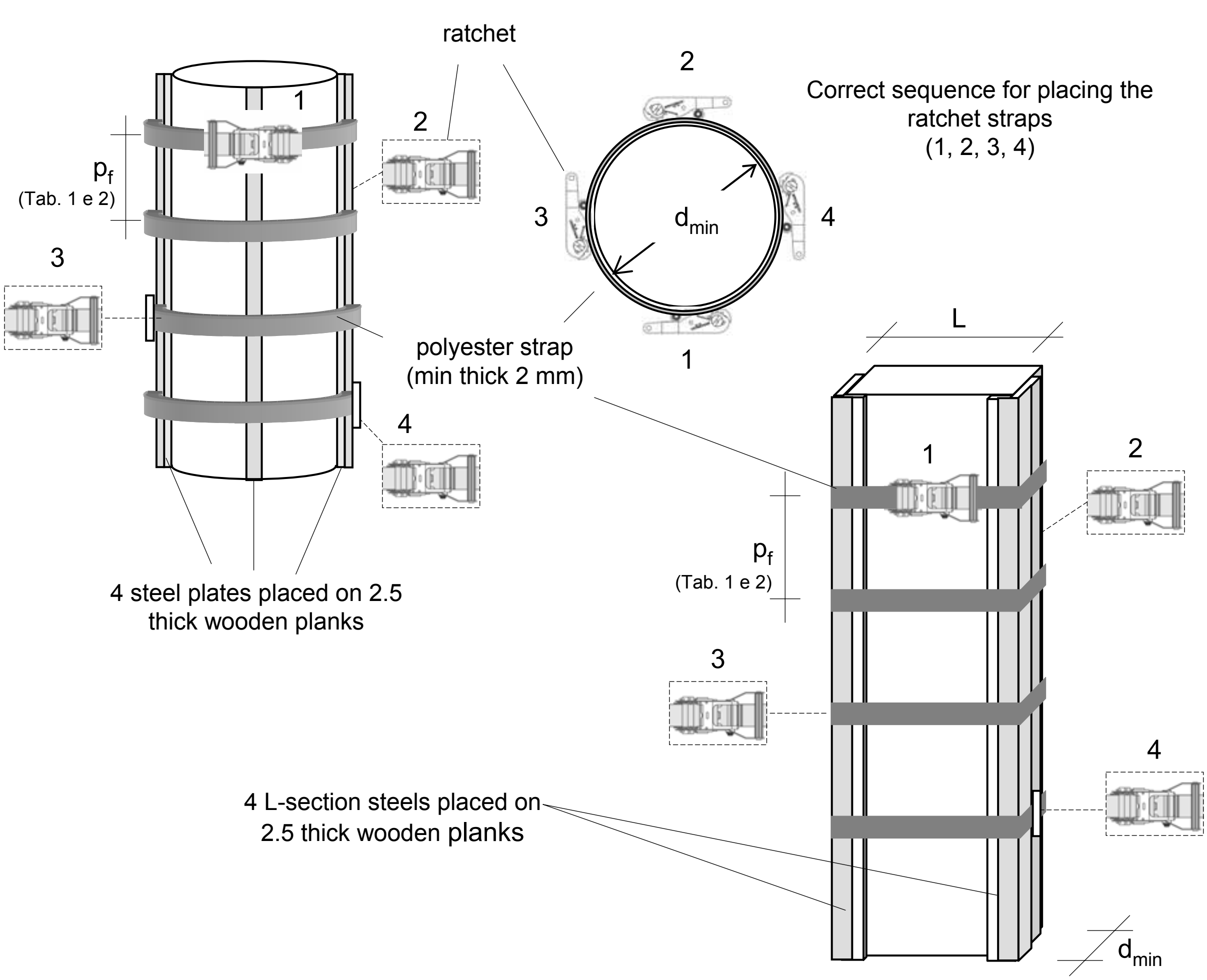


Description
Excessive vertical loads can provoke the buckling of columns with transverse deformations, cracks and expulsion of materials.

Warning
This procedure cannot be used for concrete columns.

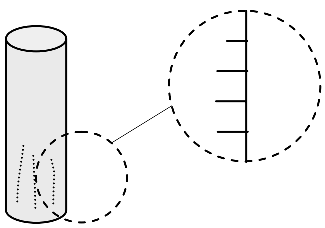
Function of the ratchet straps: to contain the transverse deformation of the column improving at the same time the resistance to vertical loads.

CONSTRUCTIONAL DIAGRAMS



LEVEL OF DAMAGE

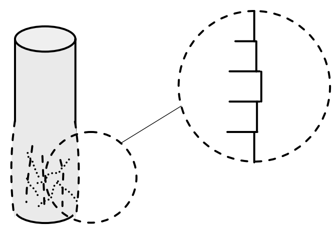
I level



Evidence of vertical cracks

If no perceptible roughness is felt by a hand on the surface of the column

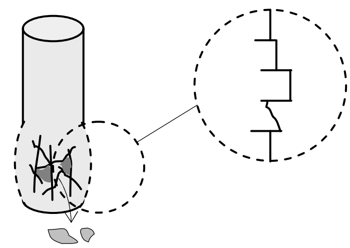
II level



Evidence of vertical and horizontal cracks and displacement of stones

If a perceptible roughness is felt by a hand on the surface of the column (mm)

III level



Evidence of vertical and horizontal cracks and expulsion of stones

Evidence is present on the surface of the expulsion of stones and the roughness is felt (cm). Presence of Stones on the ground

Table 1 –Spacing distance between the straps. Width of the straps: 50 mm

Width of the straps: 50 mm (thickness min.: 2 mm)		
Level of damage	Spacing distance between the straps: p_f (cm) (and maximum dimension of the column: d_{min})	
	d_{min} Circular cross section	d_{min} L Rectangular cross section $L/d_{min} \le 2$
I	45 ($d_{min} \le$ 90 cm)	40 ($d_{min} \le$ 90 cm)
II	40 ($d_{min} \le$ 90 cm)	20 ($d_{min} \le$ 70 cm)
III	15 ($d_{min} \le$ 70 cm)	15 ($d_{min} \le$ 30 cm)

Table 2 – Spacing distance between the straps. Width of the straps: 75 mm

Width of the straps: 75 mm (thickness min.: 2 mm)		
Level of damage	Spacing distance between the straps: p_f (cm) (and maximum dimension of the column: d_{min})	
	d_{min} Circular cross section	d_{min} L Rectangular cross section $L/d_{min} \le 2$
I	45 ($d_{min} \le$ 90 cm)	40 ($d_{min} \le$ 90 cm)
II	40 ($d_{min} \le$ 90 cm)	25 ($d_{min} \le$ 70 cm)
III	20 ($d_{min} \le$ 70 cm)	15 ($d_{min} \le$ 40 cm)

BRACING OF COLUMNS WITH POLYESTER STRAPS

Field of application

The use of this procedure is allowed only on masonry rectangular or circular columns that are within the prescribed measurements stated above. (diameter for the circular columns and the narrowest side for the rectangular columns) less than 90 cm and with a ratio between the sides less than 2.

General assumptions

The aim of the intervention is to increase the load bearing resistance of a column by the reduction of its transverse displacements.
Before placing the polyester ratchet straps clean all the surfaces of the columns but don't remove structural elements.
Rounded L-section steel is preferred to avoid cutting the straps. All the L-section steel must be placed on 2.5 cm thick planks to absorb the irregularities of the surfaces.
Light colour antioxidant protective paint for the L-section steel is preferred to reduce the solar heating.
The ratchets must be placed according to the correct sequence as shown on page 1/3.
Tighten the ratchet straps by hand.

Guidance for bracing columns with polyester straps

After evaluating the level of the damage, it is possible to define the maximum spacing between the polyester straps following tables 1 and 2 on page 2/3.
Steel plates are necessary to distribute the transverse loads.
To improve the effectiveness of the system it is possible to use more steels. For rectangular columns, the steels placed on the sides must be thickened.

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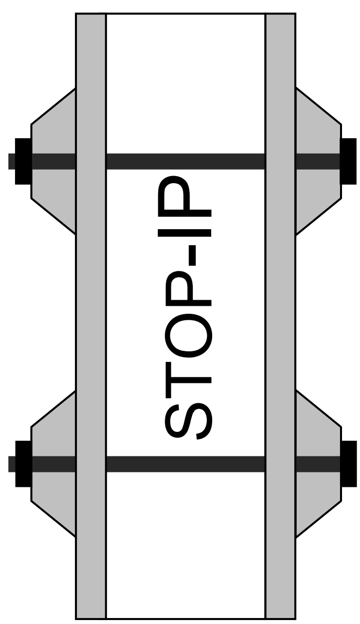
VADEMECUM STOP

INTERLOCKED PACKING OF WALLS



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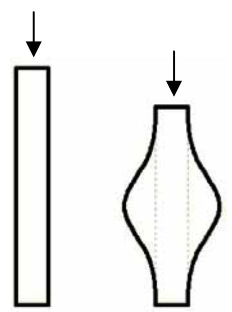
INTERLOCKED PACKING OF WALLS: general recommendations

STOP-**IP**

Movement to constrain: buckling of walls



Description

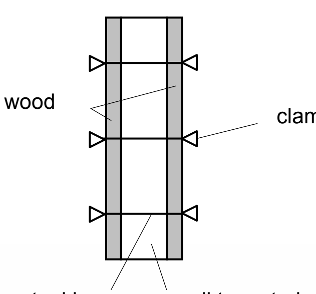
Excessive vertical loads can provoke the buckling of walls with transverse deformations.

Warning

This procedure <u>cannot</u> be used for concrete walls and can only be implemented after evaluation of the damage has taken place to ensure a safe work site.

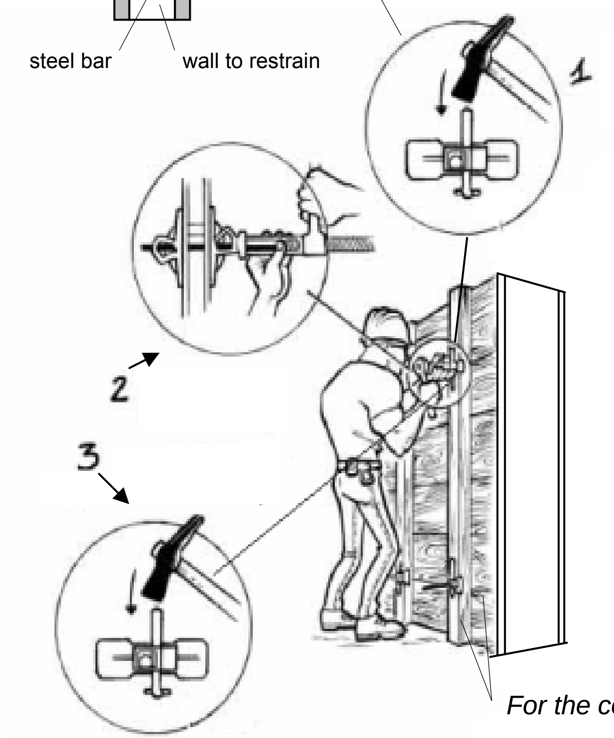
Function of the interlocked packing: to contain the transverse deformation of the wall improving at the same time the resistance of the wall to vertical loads.

PACKING OF THE WALL WITH THE “RAPID” SYSTEM



“RAPID” clamp

“RAPID” tensioner



The procedure for installing the “RAPID” system

a. Lock a clamp to one end of the steel bar (nr. 1 in the sketch).
b. Tension the steel bar using clamp and tensioner on the other side of the wall (nr. 2 in the sketch).
c. Lock the second clamp (nr. 3 in the sketch).
d. Remove the tensioner and start on a new steel bar.

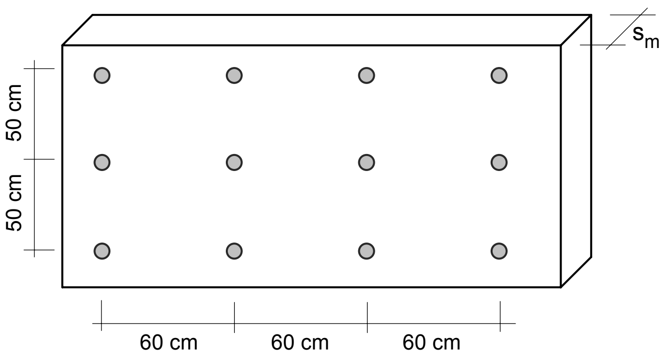
For the correct spacings see page 2/3

Images downloaded by the web site: “www.comated.com/web2004/default.asp”

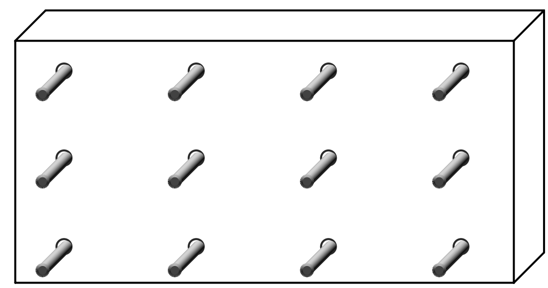
INTERLOCKED PACKING OF WALLS: Placement and spacing

STOP-**IP**

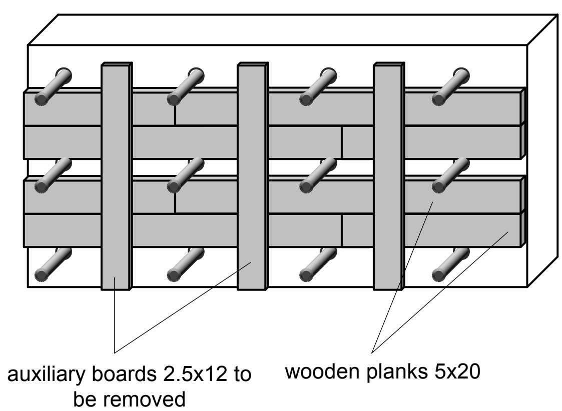
A) Drilling the wall. Diameter of the holes: $Ø_{bar}$ + 2mm



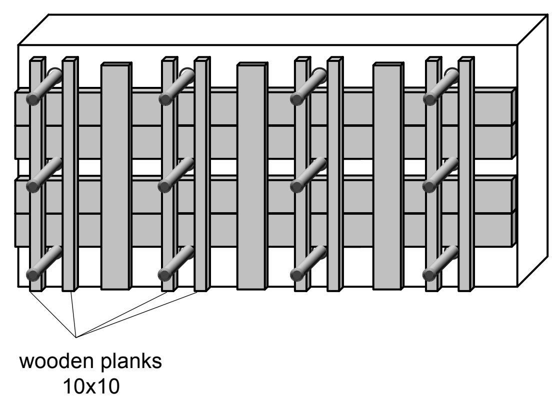
B) Insertion of the steel bars with diameter as in Table 1: $Ø_{bar}$



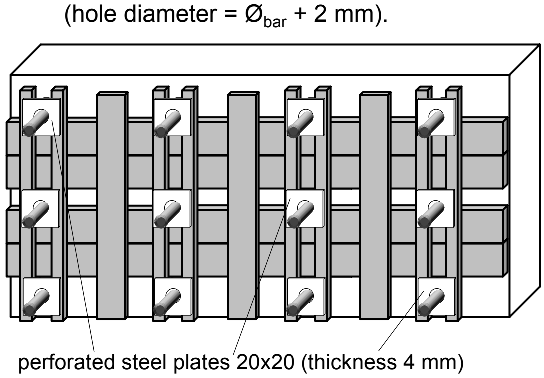
C) Place 5x20 wooden planks as shown on both the sides of the wall. The steel bars can be in contact with the wooden planks to support them.



D) Place two 10x10 wooden planks on both the sides of the steels vertically and on both the sides of the wall.



E) Place steel plate (thickness 4 mm) on both the sides of the wall on every steel bar (hole diameter = $Ø_{bar}$ + 2 mm).



F) Tensioning of the bars with the “RAPID” system showed on page 1/3

Table 1 – Sizing of the ribbed steel bars

Thickness of the wall (s_m)	Ribbed bars: minimum diameter ($Ø_{bar}$) (mm)
$s_m \leq 50$ cm	Ø6
50 cm < $s_m \leq 80$ cm	Ø8

INTERLOCKED PACKING OF WALLS

Field of application
The use of this procedure is only allowed on masonry walls less than 80 cm thick.

General assumptions
The aim of the intervention is to increase the load bearing resistance of a wall by the reduction of its transverse displacements. The tensioning of the steel bars must be done on the side of the wall nearer to the exit route of the building. For the safety of the operators this intervention is not allowed on heavily damaged walls.
Before stiffening the wall it is necessary to shore the ceiling slabs to reduce the loads on the wall. The shore can be removed at the end to transfer the loads to the reinforced wall.
Don't cut the steel bars but bend them when finished. It might be necessary to re-tension them in the future.

Instructions for the interlocked packing system
Based on the thickness of the wall (s_m), it is possible to calculate the diameter of the steel bar required using table 1 on page 2/3. Erect the wooden system as shown on page 2/3 and then tension the steel bars as shown on page 1/3.

PROHIBITIONS	1. Don't drill in to walls of heritage buildings or similar if not authorized. 2. The use of this procedure is not allowed on heavily damaged masonry walls.
DANGERS	1. Before drilling into the wall check for the presence of utilities (such as gas, power cables, water, etc.). 2. Remove any damaged or loose items that could fall from height before drilling in to the wall.

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