SUPPLEMENTAL MATERIALS

ASCE *Practice Periodical on Structural Design and Construction*

Comparing In-Plane Equivalent Shear Stiffness of Timber Diaphragms Retrofitted with Light and Reversible Wood-Based Techniques

Michele Mirra, Geert Ravenshorst, and Jan-Willem van de Kuilen

DOI: 10.1061/(ASCE)SC.1943-5576.0000602

www.ascelibrary.org

Supplemental material: detailed overview of diaphragms properties

In this document, the properties of the analysed floors are reported to provide the Readers with a detailed overview of them, and may constitute a useful database for future studies. In the tables, the diaphragms are distinguished between original *(O)* and strengthened *(S)*.

Table S1. Characteristics of the as-built and strengthened floors tested by Valluzzi et al. (2008) and values of their in-plane stiffness.

Test configuration		Vertical, 1/4 of the floor, with 1 point of application of load			
Specimen name		*FMSB (F1.M; O)*	*FM (F2.M; O)*	*FM+45°SP(A) (S)*	*FM+45°SP(B) (S)*
Floor dimensions					
Orthogonal to load	[mm]	2120	2120	2120	2120
Parallel to load	[mm]	2120	2120	2120	2120
Total thickness	[mm]	160	160	185	200
Properties of main beams					
Width	[mm]	120	120	120	120
Height	[mm]	140	140	140	140
Length	[mm]	2420	2420	2420	2420
Heart-to-heart distance	[mm]	500	500	500	500
Material		Spruce wood	Spruce wood	Spruce wood	Spruce wood
Properties of planking					
Width	[mm]	135	135	135	135
Thickness	[mm]	20	20	20	20
Length	[mm]	2120	2120	2120	2120
Material		Spruce wood	Spruce wood	Spruce wood	Spruce wood
Other characteristics		Straight-edged planks	Tongue-and-groove planks	Straight-edged planks	Tongue-and-groove planks
Beams-planks connections					
Fastener type		Nails	Nails	Nails	Nails
Diameter	[mm]	2.75	2.75	2.75	2.75
Length	[mm]	60	60	60	60
Other characteristics		2 nails for each beam-plank intersection	2 nails for each beam-plank intersection	2 nails for each beam-plank intersection	2 nails for each beam-plank intersection
Properties of strengthening					
Type of strengthening		Not applicable (as-built sample)	Not applicable (as-built sample)	Second layer of planks at an angle of 45˚	Second layer of planks at an angle of 45˚
Width	[mm]	-	-	150	150
Thickness	[mm]	-	-	25	40
Length	[mm]	-	-	Variable	Variable
Material		-	-	Spruce wood	Spruce wood
Other characteristics		-	-	Straight-edged planks	Tongue-and-groove planks
Fastener type		-	-	Screws	Screws
Diameter	[mm]	-	-	6	6
Length	[mm]	-	-	100	120
Other characteristics		-	-	2 screws at each new plank-beam intersection	2 screws at each new plank-beam intersection
In-plane stiffness					
Value reported in the publication	[kN/mm]	0.08	0.29	1.18	1.25
Value at 0.1% drift	[kN/mm]	0.15	0.31	2.06	2.13
Value at 1.0% drift	[kN/mm]	0.04	0.06	0.71	0.72
Value at yielding (and drift)	[kN/mm]	0.10 (0.12%)	0.33 (0.12%)	1.89 (0.3%)	1.89 (0.3%)
Equivalent shear stiffness					
Value calculated from publication	[N/mm]	81	288	1176	1247
Value at 0.1% drift	[N/mm]	152	313	2065	2128
Value at 1.0% drift	[N/mm]	43	62	707	719
Value at yielding	[N/mm]	100	330	1890	1890

Table S2. Characteristics of the as-built and strengthened floors tested by Corradi et al. (2006) and values of their in-plane stiffness.

Test configuration		Horizontal, half of the floor, with 1 point of application of load		
Specimen name		*01-T2-OR (O)*	*02-T6-OR (O)*	*03-T4-T6 (S)*
Floor dimensions				
Orthogonal to load	[mm]	3000	3000	3000
Parallel to load	[mm]	3000	3000	3000
Total thickness	[mm]	288	288	316
Properties of main beams				
Width	[mm]	180	180	180
Height	[mm]	180	180	180
Length	[mm]	3100	3100	3100
Heart-to-heart distance	[mm]	1100	1100	1100
Material		Chestnut wood	Chestnut wood	Chestnut wood
Properties of secondary beams				
Width	[mm]	80	80	80
Height	[mm]	80	80	80
Length	[mm]	1100	1100	1100
Heart-to-heart distance	[mm]	300	300	300
Material		Chestnut wood	Chestnut wood	Chestnut wood
Properties of planking				
Width	[mm]	125	125	125
Thickness	[mm]	28	28	28
Length	[mm]	600	600	600
Material		Chestnut wood	Chestnut wood	Chestnut wood
Other characteristics		Notched planks	Notched planks	Notched planks
Beams-planks connections				
Fastener type		Nails	Nails	Nails
Diameter	[mm]	Not mentioned	Not mentioned	Not mentioned
Length	[mm]	Not mentioned	Not mentioned	Not mentioned
Other characteristics		1 nail at planks' ends	3 nails at planks' ends	2 nails at planks' ends
Properties of strengthening				
Type of strengthening		Not applicable (as-built sample)	Not applicable (as-built sample)	Second layer of planks at an angle of 90˚
Width	[mm]	-	-	125
Thickness	[mm]	-	-	28
Length	[mm]	-	-	600
Material		-	-	Chestnut wood
Other characteristics		-	-	Notched planks
Fastener type		-	-	Nails
Diameter	[mm]	-	-	Not mentioned
Length	[mm]	-	-	Not mentioned
Other characteristics		-	-	2 nails at planks' ends and 2 in their middle
In-plane stiffness				
Value reported in the publication	[kN/mm]	0.47	0.28	1.71
Value at 0.1% drift	[kN/mm]	0.71	0.77	2.19
Value at 1.0% drift	[kN/mm]	0.13	0.20	0.40
Value at yielding (and drift)	[kN/mm]	0.23 (0.07%)	0.26 (0.08%)	2.19 (0.1%)
Equivalent shear stiffness				
Value calculated from publication	[N/mm]	470	280	1710
Value at 0.1% drift	[N/mm]	710	771	2190
Value at 1.0% drift	[N/mm]	128	204	400
Value at yielding	[N/mm]	230	255	2190

Table S3. Characteristics of the as-built and strengthened floors tested by Branco et al. (2015) and values of their in-plane stiffness.

Test configuration		Vertical, 1/4 of the floor, with 1 point of application of load	
Specimen name		*S (O)*	*SS (S)*
Floor dimensions			
Orthogonal to load	[mm]	2125	2125
Parallel to load	[mm]	2125	2125
Total thickness	[mm]	180	200
Properties of main beams			
Width	[mm]	100	100
Height	[mm]	160	160
Length	[mm]	2420	2420
Heart-to-heart distance	[mm]	500	500
Material		C24 timber	C24 timber
Properties of planking			
Width	[mm]	125	125
Thickness	[mm]	20	20
Length	[mm]	2125	2125
Material		*Andira Vermifuga* wood	*Andira Vermifuga* wood
Other characteristics		Straight-edged planks	Straight-edged planks
Beams-planks connections			
Fastener type		Nails	Nails
Diameter	[mm]	2.50	2.50
Length	[mm]	60	60
Other characteristics		2 nails for each intersection between beam and plank	2 nails for each intersection between beam and plank
Properties of strengthening			
Type of strengthening		Not applicable (as-built sample)	Superposition of a second layer of planks arranged at 90°
Width	[mm]	-	125
Thickness	[mm]	-	20
Length	[mm]	-	2125
Material		-	*Andira Vermifuga* wood
Other characteristics		-	Straight-edged planks
Fastener type		-	Nails
Diameter	[mm]	-	2.50
Length	[mm]	-	60
Other characteristics		-	2 nails at each intersection of the new planks with the existing ones
In-plane stiffness			
Value reported in the publication	[kN/mm]	0.05	0.13
Value at 0.1% drift	[kN/mm]	0.15	0.61
Value at 1.0% drift	[kN/mm]	0.05	0.16
Value at yielding	[kN/mm]	0.16 (at 0.14% drift)	0.61 (at 0.1% drift)
Equivalent shear stiffness			
Value calculated from publication	[N/mm]	55	132
Value at 0.1% drift	[N/mm]	153	609
Value at 1.0% drift	[N/mm]	53	165
Value at yielding	[N/mm]	165	609

Table S4. Characteristics of the as-built and strengthened floors tested by Gubana and Melotto (2018) and values of their in-plane stiffness.

Test configuration		Vertical, half of the floor, with 1 point of application of load		
Specimen name		*UR-2 (O)*	*OSB90-R-2 (S)*	*OSB0-S-2 (S)*
Floor dimensions				
Orthogonal to load	[mm]	3160	3160	3160
Parallel to load	[mm]	3000	3000	3000
Total thickness	[mm]	183	208	208
Properties of main beams				
Width	[mm]	160	160	160
Height	[mm]	160	160	160
Length	[mm]	3160	3160	3160
Heart-to-heart distance	[mm]	500	500	500
Material		GL24h timber	GL24h timber	GL24h timber
Properties of planking				
Width	[mm]	145	145	145
Thickness	[mm]	23	23	23
Length	[mm]	3160	3160	3160
Material		C24 timber	C24 timber	C24 timber
Other characteristics		Straight-edged planks	Straight-edged planks	Straight-edged planks
Beams-planks connections				
Fastener type		Nails	Nails	Nails
Diameter	[mm]	2.50	2.50	2.50
Length	[mm]	65	65	65
Other characteristics		2 nails at beam-plank intersection	2 nails at beam-plank intersection	2 nails at beam-plank intersection
Properties of strengthening				
Type of strengthening		Not applicable (as-built sample)	Overlay of OSB panels arranged orthogonal to joists	Overlay of OSB panels arranged parallel to joists
Width	[mm]	-	1000	1000
Thickness	[mm]	-	25	25
Length	[mm]	-	3160	3160
Fastener type		-	Nails	Screws
Diameter	[mm]	-	2.80	6.0
Length	[mm]	-	90	160
Other characteristics		-	100 mm spacing along panels' perimeter, in correspondence of the joists	150 mm spacing in correspondence of the joists
In-plane stiffness				
Value reported in the publication	[kN/mm]	0.53	1.77	1.97
Value at 0.1% drift	[kN/mm]	0.55	2.55	5.05
Value at 1.0% drift	[kN/mm]	0.09	0.57	1.19
Value at yielding (and drift)	[kN/mm]	0.55 (0.1%)	3.12 (0.07%)	4.27 (0.13%)
Equivalent shear stiffness				
Value calculated from publication	[N/mm]	560	1870	2080
Value at 0.1% drift	[N/mm]	582	2691	5320
Value at 1.0% drift	[N/mm]	97	606	1259
Value at yielding	[N/mm]	582	3290	4496

Table S5. Characteristics of the as-built and strengthened floors tested by Peralta et al. (2004) and different values of their in-plane stiffness.

Test configuration		Horizontal, whole floor, with 2 points of application of load		
Specimen name		*MAE-2 (O)*	*MAE-2B (S)*	*MAE-2C (S)*
Floor dimensions				
Orthogonal to load	[mm]	7320	7320	7320
Parallel to load	[mm]	3660	3660	3660
Total thickness	[mm]	254	264	264
Properties of main beams				
Width	[mm]	38	38	38
Height	[mm]	235	235	235
Length	[mm]	3660	3660	3660
Heart-to-heart distance	[mm]	406	406	406
Material		Pine wood	Pine wood	Pine wood
Properties of planking				
Width	[mm]	140	140	140
Thickness	[mm]	19	19	19
Length	[mm]	From 1630 to 3660	From 1630 to 3660	From 1630 to 3660
Material		Pine wood	Pine wood	Pine wood
Other characteristics		Straight-edged planks	Straight-edged planks	Straight-edged planks
Beams-planks connections				
Fastener type		Nails	Nails	Nails
Diameter	[mm]	3.50	3.50	3.50
Length	[mm]	76	76	76
Other characteristics		2 or 3 nails at beam-plank intersection	2 or 3 nails at beam-plank intersection	2 or 3 nails at beam-plank intersection
Properties of strengthening				
Type of strengthening		Not applicable (as-built sample)	Unblocked plywood panels overlay	Blocked plywood panels overlay
Width	[mm]	-	1200	1200
Thickness	[mm]	-	9.5	9.5
Length	[mm]	-	2400	2400
Fastener type		-	Nails	Nails
Diameter	[mm]	-	3.50	3.50
Length	[mm]	-	76	76
Other characteristics		-	152 mm spacing on supported edges, 305 mm spacing along intermediate joists	51 mm spacing at the diaphragm boundaries, 76 mm spacing on panel edges; additional toe-nailing 38x89 mm boards between the joists below panel edges
In-plane stiffness				
Value reported in the publication	[kN/mm]	1.80	8.40	11.30
Value at 0.1% drift	[kN/mm]	5.84	10.96	17.96
Value at 1.0% drift	[kN/mm]	1.42	2.34 [(a)]	5.22 [(a)]
Value at yielding (and drift)	[kN/mm]	5.84 (0.1%)	7.76 (0.12%)	13.93 (0.18%)
Equivalent shear stiffness				
Value calculated from publication	[N/mm]	600	2800	3767
Value at 0.1% drift	[N/mm]	1949	3653	5990
Value at 1.0% drift	[N/mm]	475	780	1743
Value at yielding	[N/mm]	1949	2400	4644

[(a)] Values obtained from an extrapolation of the experimental curve and not directly from it, because the test was stopped slightly before this drift value.

Table S6. Characteristics of the as-built and strengthened floors tested by Brignola et al. (2012) and different values of their in-plane stiffness.

Test configuration		Horizontal, whole floor, with 2 points of application of load	
Specimen name		*AB-1 (O)*	*R-1 (S)*
Floor dimensions			
Orthogonal to load	[mm]	4000	4000
Parallel to load	[mm]	3000	3000
Total thickness	[mm]	275	294
Properties of main beams			
Width	[mm]	50	50
Height	[mm]	250	250
Length	[mm]	4000	4000
Heart-to-heart distance	[mm]	500	500
Material		Radiata pine wood	Radiata pine wood
Properties of planking			
Width	[mm]	150	150
Thickness	[mm]	25	25
Length	[mm]	1000, 2000	1000, 2000
Material		Pine wood	Pine wood
Other characteristics		Straight-edged planks	Straight-edged planks
Beams-planks connections			
Fastener type		Nails	Nails
Diameter	[mm]	3.15	3.15
Length	[mm]	75	75
Other characteristics		2 or 4 nails for each intersection between beam and plank	2 or 4 nails for each intersection between beam and plank
Properties of strengthening			
Type of strengthening		Not applicable (as-built sample)	Plywood panels overlay
Width	[mm]	-	1200
Thickness	[mm]	-	19
Length	[mm]	-	2400
Fastener type		-	Screws
Diameter	[mm]	-	4.2
Length	[mm]	-	50 (120 in correspondence of joists)
Other characteristics		-	150 mm spacing along both panel edges and joists
In-plane stiffness			
Value reported in the publication	[kN/mm]	1.36	6.65
Value at 0.1% drift	[kN/mm]	3.06	14.70
Value at 1.0% drift	[kN/mm]	1.16	5.20
Value at yielding	[kN/mm]	3.02 (at 0.18% drift)	12.4 (at 0.16% drift)
Equivalent shear stiffness			
Value calculated from publication	[N/mm]	340	1665
Value at 0.1% drift	[N/mm]	769	3675
Value at 1.0% drift	[N/mm]	290	1300
Value at yielding	[N/mm]	756	3102

Table S7. Characteristics of the as-built and strengthened floors tested by Giongo et al. (2013) and values of their in-plane stiffness.

Test configuration		Horizontal, whole floor, with 4 points of application of load	
Specimen name		*26_B_asB (O)*	*35_B_Plyw (S)*
Floor dimensions			
Orthogonal to load	[mm]	9600	9600
Parallel to load	[mm]	4700	4700
Total thickness	[mm]	322	331
Properties of main beams			
Width	[mm]	50	50
Height	[mm]	300	300
Length	[mm]	4800	4800
Heart-to-heart distance	[mm]	450	450
Material		Rimu wood	Rimu wood
Properties of planking			
Width	[mm]	130	130
Thickness	[mm]	22	22
Length	[mm]	2350, 4700	2350, 4700
Material		Matai wood	Matai wood
Other characteristics		Tongue-and-groove planks	Tongue-and-groove planks
Beams-planks connections			
Fastener type		Nails	Nails
Diameter	[mm]	Not mentioned	Not mentioned
Length	[mm]	Not mentioned	Not mentioned
Other characteristics		2 nails for each intersection between beam and plank	2 nails for each intersection between beam and plank
Properties of strengthening			
Type of strengthening		Not applicable (as-built sample)	Plywood panels overlay
Width	[mm]	-	1200
Thickness	[mm]	-	9
Length	[mm]	-	2400
Fastener type		-	Screws
Diameter	[mm]	-	3.5 (4.2 along floor's perimeter)
Length	[mm]	-	30 (60 along floor's perimeter)
Other characteristics		-	150 mm spacing along panel edges, 300 mm spacing on the whole panels' area, 100 mm spacing along floor's perimeter
In-plane stiffness			
Value at 0.1% drift	[kN/mm]	1.16	10.70
Value at 1.0% drift	[kN/mm]	0.65	3.69
Value at yielding	[kN/mm]	1.00 (at 0.25% drift)	10.70 (at 0.1% drift)
Equivalent shear stiffness			
Value at 0.1% drift	[N/mm]	302	2783
Value at 1.0% drift	[N/mm]	169	961
Value at yielding	[N/mm]	260	2783

Table S8. Characteristics of the as-built and strengthened floors tested by Wilson et al. (2014) and values of their in-plane stiffness.

Test configuration		Horizontal, whole floor, 4 load points		Horizontal, whole floor, 2 load points	
Specimen name		*1a-PARA (O)*	*1b-PARA (S)*	*1a-PERP (O)*	*1b-PERP (S)*
Floor dimensions					
Orthogonal to load	[mm]	10400	10400	5500	2120
Parallel to load	[mm]	5500	5500	10400	2120
Total thickness	[mm]	308	323	308	323
Properties of main beams					
Width	[mm]	45	45	45	45
Height	[mm]	290	290	290	290
Length	[mm]	5500	5500	5500	5500
Heart-to-heart distance	[mm]	400	400	400	400
Material		MSG8 timber	MSG8 timber	MSG8 timber	MSG8 timber
Properties of planking					
Width	[mm]	135	135	135	135
Thickness	[mm]	18	18	18	18
Length	[mm]	1600-5200	1600-5200	1600-5200	1600-5200
Material		MSG8 timber	MSG8 timber	MSG8 timber	MSG8 timber
Other characteristics		Straight-edged planks	Straight-edged planks	Straight-edged planks	Straight-edged planks
Beams-planks connections					
Fastener type		Nails	Nails	Nails	Nails
Diameter	[mm]	3.15	3.15	3.15	3.15
Length	[mm]	75	75	75	75
Other characteristics		2 or 4 nails for each beam-plank intersection	2 or 4 nails for each beam-plank intersection	2 or 4 nails for each beam-plank intersection	2 or 4 nails for each beam-plank intersection
Properties of strengthening					
Type of strengthening		Not applicable (as-built sample)	Plywood panels overlay	Not applicable (as-built sample)	Plywood panels overlay
Width	[mm]	-	1200		1200
Thickness	[mm]	-	15		15
Length	[mm]	-	2400		2400
Other characteristics		-	Metal straps stapled on panel edges; blocking and chords on long floor edges		Metal straps stapled on panel edges; blocking on long floor edges
Fastener type		-	Nails		Nails
Diameter	[mm]	-	3.15		3.15
Length	[mm]	-	75		75
Other characteristics		-	300 mm spacing along joists, 100 at floor's edges		300 mm spacing along joists, 100 at floor's edges
In-plane stiffness					
Value reported in the publication	[kN/mm]	0.64	14.52	1.61	22.41
Value at 0.1% drift	[kN/mm]	2.06	19.55	5.34	30.89
Value at 1.0% drift	[kN/mm]	0.47	3.66	1.54	7.15
Value at yielding (and drift)	[kN/mm]	2.06 (0.1%)	15.00 (0.15%)	3.75 (0.14%)	30.89 (0.1%)
Equivalent shear stiffness					
Value calculated from publication	[N/mm]	198	4459	134	1864
Value at 0.1% drift	[N/mm]	637	3294	441	1402
Value at 1.0% drift	[N/mm]	148	1140	128	595
Value at yielding	[N/mm]	637	2533	313	1402

Table S9. Characteristics of the as-built and strengthened floors tested by Mirra et al. (2020) in the direction parallel to the joists, and values of their in-plane stiffness.

Test configuration		Vertical, half of the floor, 1 point of application of load			
Specimen name		*DFpar-1 (O)*	*DFpar-2 (O)*	*DFpar-1s (S)*	*DFpar-2s (S)*
Floor dimensions					
Orthogonal to load	[mm]	2400	2400	2400	2400
Parallel to load	[mm]	3800	3960	3800	3960
Total thickness	[mm]	148	154	166	172
Properties of main beams					
Width	[mm]	60	60	60	60
Height	[mm]	130	130	130	130
Length	[mm]	3800	3960	3800	3960
Heart-to-heart distance	[mm]	650	650	650	650
Material		C24 timber	C24 timber	C24 timber	C24 timber
Properties of planking					
Width	[mm]	165	165	165	165
Thickness	[mm]	18	24	18	24
Length	[mm]	2400	2400	2400	2400
Material		C24 timber	C24 timber	C24 timber	C24 timber
Other characteristics		Tongue-and-groove planks	Tongue-and-groove planks	Tongue-and-groove planks	Tongue-and-groove planks
Beams-planks connections					
Fastener type		Nails	Nails	Nails	Nails
Diameter	[mm]	3.0	3.0	3.0	3.0
Length	[mm]	65	65	65	65
Other characteristics		2 nails for each beam-plank intersection	2 nails for each beam-plank intersection	2 nails for each beam-plank intersection	2 nails for each beam-plank intersection
Properties of strengthening					
Type of strengthening		Not applicable (as-built sample)	Not applicable (as-built sample)	Plywood panels overlay	Plywood panels overlay
Width	[mm]	-	-	600	600
Thickness	[mm]	-	-	18	18
Length	[mm]	-	-	1200	1200
Other characteristics		-	-	Improvement of shear transfer with additional fasteners on top	Improvement of shear transfer with additional fasteners on top
Fastener type		-	-	Screws	Screws
Diameter	[mm]	-	-	4.5 (5.0 on top)	5.0
Length	[mm]	-	-	40 (70 on top)	60 (70 on top)
Other characteristics		-	-	100 mm spacing along the panels' perimeter	100 mm spacing along the panels' perimeter
In-plane stiffness					
Value at 0.1% drift	[kN/mm]	0.74	0.86	5.45	6.32
Value at 1.0% drift	[kN/mm]	0.36	0.47	2.02	2.83
Value at yielding (and drift)	[kN/mm]	0.48 (0.28%)	0.57 (0.16%)	5.70 (0.09%)	5.61 (0.15%)
Equivalent shear stiffness		Size-dependent (flexural response)			
Value at 0.1% drift	[N/mm]	467	521	3441	3832
Value at 1.0% drift	[N/mm]	227	285	1277	1717
Value at yielding	[N/mm]	303	345	3600	3403

Table S10. Characteristics of the as-built and strengthened floors tested by Mirra et al. (2020) in the direction perpendicular to the joists, and different values of their in-plane stiffness.

Test configuration		Vertical, half of the floor, 1 point of application of load			
Specimen name		*DFper-3 (O)*	*DFper-4 (O)*	*DFper-3s (S)*	*DFper-4s (S)*
Floor dimensions					
Orthogonal to load	[mm]	2300	2300	2300	2300
Parallel to load	[mm]	3800	3800	3800	3800
Total thickness	[mm]	128	128	146	146
Properties of main beams					
Width	[mm]	50	50	60	60
Height	[mm]	110	110	130	130
Length	[mm]	2300	2300	3800	3960
Heart-to-heart distance	[mm]	750	750	650	650
Material		C24 timber	C24 timber	C24 timber	C24 timber
Properties of planking					
Width	[mm]	165	165	165	165
Thickness	[mm]	18	18	18	24
Length	[mm]	3800	3800	2400	2400
Material		C24 timber	C24 timber	C24 timber	C24 timber
Other characteristics		Tongue-and-groove planks	Tongue-and-groove planks	Tongue-and-groove planks	Tongue-and-groove planks
Beams-planks connections					
Fastener type		Nails	Nails	Nails	Nails
Diameter	[mm]	3.0	3.0	3.0	3.0
Length	[mm]	65	65	65	65
Other characteristics		2 nails for each beam-plank intersection	2 nails for each beam-plank intersection	2 nails for each beam-plank intersection	2 nails for each beam-plank intersection
Properties of strengthening					
Type of strengthening		Not applicable (as-built sample)	Not applicable (as-built sample)	Plywood panels overlay	Plywood panels overlay
Width	[mm]	-	-	600	600
Thickness	[mm]	-	-	18	18
Length	[mm]	-	-	1200	1200
Other characteristics		-	-	-	Improvement of shear transfer with timber blocks on top
Fastener type		-	-	Screws	Screws
Diameter	[mm]	-	-	5.0	5.0
Length	[mm]	-	-	60	60
Other characteristics		-	-	100 mm spacing along the panels' perimeter	100 mm spacing along the panels' perimeter
In-plane stiffness					
Value at 0.1% drift	[kN/mm]	0.33	0.21	1.88	5.28
Value at 1.0% drift	[kN/mm]	0.11	0.10	1.21	2.93
Value at yielding (and drift)	[kN/mm]	0.25 (0.15%)	0.21 (0.1%)	1.56 (0.45%)	4.11 (0.26%)
Equivalent shear stiffness		Size-dependent (flexural response)			
Value at 0.1% drift	[N/mm]	200	127	1136	3196
Value at 1.0% drift	[N/mm]	67	60	735	1773
Value at yielding	[N/mm]	151	127	946	2488

Table S11. Characteristics of the as-built and strengthened roof tested by Mirra et al. (2020) and different values of its in-plane stiffness.

Test configuration		Vertical, one roof pitch, 1 point of application of load	
Specimen name		*DRpar-5 (O)*	*DRpar-5s (S)*
Floor dimensions			
Orthogonal to load	[mm]	2730	2730
Parallel to load	[mm]	3800	3800
Total thickness	[mm]	148	148 (same thickness because panels are placed in between the purlins)
Properties of main beams (rafters)			
Width	[mm]	50	50
Height	[mm]	105	105
Length	[mm]	2730	2730
Heart-to-heart distance	[mm]	925	925
Material		C24 timber	C24 timber
Properties of secondary beams (purlins)			
Width	[mm]	60	60
Height	[mm]	35	35
Length	[mm]	3800	3800
Heart-to-heart distance	[mm]	820	820
Material		C24 timber	C24 timber
Properties of planking			
Width	[mm]	165	165
Thickness	[mm]	18	18
Length	[mm]	2730	2400
Material		C24 timber	C24 timber
Other characteristics		Tongue-and-groove planks	Tongue-and-groove planks
Beams-planks connections			
Fastener type		Nails	Nails
Diameter	[mm]	3.0	3.0
Length	[mm]	55	55
Other characteristics		2 nails for each beam-plank intersection	2 nails for each beam-plank intersection
Properties of strengthening			
Type of strengthening		Not applicable (as-built sample)	Plywood panels overlay
Width	[mm]	-	600
Thickness	[mm]	-	18
Length	[mm]	-	1200
Other characteristics		-	Improvement of connection and shear transfer with steel angles at bottom (wall plate)
Fastener type		-	Screws
Diameter	[mm]	-	4.5 (6.0 for steel angle)
Length	[mm]	-	40 (70 for steel angle)
Other characteristics		-	100 mm spacing along the panels' perimeter
In-plane stiffness			
Value at 0.1% drift	[kN/mm]	0.15	3.42
Value at 1.0% drift	[kN/mm]	0.06	1.31
Value at yielding (and drift)	[kN/mm]	0.15 (0.1%)	2.57 (0.4%)
Equivalent shear stiffness			
Value at 0.1% drift	[N/mm]	108	2457
Value at 1.0% drift	[N/mm]	41	940
Value at yielding	[N/mm]	108	1848

References

Branco, J. M., M. Kekeliak, and P.B. Lourenço. 2015. “In-Plane Stiffness of Timber Floors Strengthened with CLT.” *Eur. J. Wood Wood Prod.* 73, 313-323.

Brignola, A., S. Pampanin, and S. Podestà. 2012. “Experimental Evaluation of the In-Plane Stiffness of Timber Diaphragms.” *Earthquake Spectra* 28(4), 1–23.

Corradi, M., E. Speranzini, A. Borri, and A. Vignoli. 2006. “In-Plane Shear Reinforcement of Wood Beam Floors With FRP.” *Composites: Part B* 37, 310-319.

Giongo, I., D. Dizhur, R. Tomasi, and J. M. Ingham. 2013. “In-plane assessment of existing timber diaphragms in URM buildings via quasi-static and dynamic in-situ tests.” *Advanced Materials Research* 778, 495-502.

Gubana, A., and M. Melotto. 2018. “Experimental tests on wood-based in-plane strengthening solutions for the seismic retrofit of traditional timber floors.” *Constr. Build. Mater.* 191, 290–299.

Mirra, M., G.J.P. Ravenshorst, J.W.G. van de Kuilen. 2020. “Experimental and analytical evaluation of the in-plane behaviour of as-built and strengthened traditional wooden floors”. *Eng. Struct.* 211 https://doi.org/10.1016/j.engstruct.2020.110432

Peralta, D.F., M.J. Bracci, and M.B.D. Hueste. 2004. “Seismic Behavior of Wood Diaphragms in Pre-1950s Unreinforced Masonry Buildings.” *J. Struct. Eng.* 130 (12), https://doi.org/10.1061/(ASCE)0733-9445(2004)130:12(2040).

Valluzzi, M. R., E. Garbin, M. Dalla Benetta, and C. Modena. 2008. “Experimental Assessment and Modelling of In-Plane Behaviour of Timber Floors.” 6th International Conference on Structural Analysis of Historical Constructions, Bath, U.K., CRC-Press, Balkema, 755-762.

Valluzzi, M. R., E. Garbin, M. Dalla Benetta, and C. Modena. 2010. “In-Plane Strengthening of Timber Floors For The Seismic Improvement Of Masonry Buildings.” World Conference on Timber Engineering, Riva del Garda, Italy.

Wilson, A., P. J. H. Quenneville, and J. M. Ingham. 2014. “In-plane orthotropic behavior of timber floor diaphragms in unreinforced masonry buildings.” *J. Struct. Eng.* 140 (1): 04013038. https://doi.org/10.1061/(ASCE)ST.1943-541X.0000819.