

# Mortar Tests 24 hours

## TESTS ON PURE NHL MORTARS

Note: performance figures will vary using different sands. For example see figures on NHL 3.5 tested using a 3mm - 0.075 well graded common sand (Doyeaux).

		1:2			1:2.5				1:3			
		NHL 5	NHL 3.5	NHL 2	NHL 5	NHL 3.5	NHL 3.5 Doyeaux sand	NHL 2	NHL 5	NHL 3.5	NHL 2	Norm/method used for test
Water content	gr.	225	226	228	215	220	250	214	208	211	206	
Water/binder ratio		0.67	0.88	1.07	0.79	1.07	1.21	1.27	0.92	1.23	1.47	
Penetration	mm	8	9.5	11	7.5	9	10	8.5	7	8.5	9.5	EN 459-2 Pr. 5.5.3
Set (beginning)	h	4.3	5.3	8 3/4	3.3	6	6.15	9	3	6	9.3	EN 196.2 P. 6.2
Bulk density (no curing)	kg/m <sup>3</sup>	2110	2110	2100	2115	2140	1975	2080	2105	2110	2100	EN 459.2 P. 5.8
Air content	%	0	1.6	2	0	0	0	1	0	3	2	EN 459.2 P. 5.7
Elast. Moduli	Mpa											
	28 days	10800	9010	9025	11000	9000	8600	9800	10000	8970	9000	French Std. on one coat renders
	6 months	18000	16250	12600	17050	13505	12050	12030	16900	12450	11800	
	12 months	18510	15280	12515	17280	13620		12030	16150	13150	11900	
	24 months	21500	17480	13375	18020	13785		12000	17540	13670	11750	
Flexural Strength	Mpa											
	7 days	0.53	0.43	0.28	0.38	0.31	0.28	0.31	0.4	0.28	0.25	as above
	28 days	0.9	0.73	0.74	0.8	0.48	0.45	0.73	0.66	0.65	0.72	as above
	6 months	2.2	2.18	1.28	1.75	1.7	1.3	1.2	1.55	1.38	1.08	
	12 months	2.4	2.25	1.3	2.2	2.05		1.25	1.8	1.5	1.05	
	24 months	2.51	2.6	1.41	2.3	2		1.15	2.05	1.53	1.05	
Compressive Strength	MPa											
	7 days	1.96	0.75	0.62	1	0.57	0.5	0.53	0.88	0.53	0.47	EN459-2 P. 5.1
	28 days	2.2	1.88	1.48	2	1.47	1.3	1.36	1.5	1.34	1.25	
	6 months	7.31	7.1	3.84	5.91	5.34	4.02	3	5.31	3.94	2.88	
	12 months	9.28	7.5	4	8.44	5.9		2.9	6.5	3.9	2.9	
	24 months	10.81	8.63	4.25	8.81	6		3	7.8	3.97	2.75	
Permeability @ complete carb.												Fr. Std. for one coat renders
(gr. of air x m <sup>2</sup> x hour x mmHg)		0.55	0.64	0.68	0.5	0.65		0.71	0.52	0.72	0.71	
Shrinkage at 28 days	mm.m <sup>1</sup>	0.17	0.59	0.75	0.13	0.44		0.6	0.15	0.25	0.51	
Water absorption	l.h.m <sup>2</sup>	3	4.5	10.5	3.2	7.3		12.1	5.5	9.4	15.4	
Capillarity	g.min	0.88	1.18	3.05	2.54	4.7		7.84	4.61	6.3	8.7	

NHL / Putty lime blends

		NHL 5/Putty/Sand			NHL 3.5/Putty/Sand			Norm/method used for test	
		Blend ratio	0.9/0.1/3	0.7/0.3/3	0.5/0.5/3	0.9/0.1/3	0.7/0.3/3	0.5/0.5/3	
<b>Water/binder ratio</b>	<b>gr</b>		1.2	1.07	1.03	1.04	1	0.95	
<b>Penetration</b>	<b>mm</b>		7	10	11	8	12	13	EN459-2 P. 5.5.3
<b>Set (beginning)</b>	<b>h</b>		3.5	5.25	9.5	6.5	8.5	10	EN 196-2 P. 5.8
<b>Bulk density (no curing)</b>	<b>kg/m<sup>3</sup></b>		2105	2040	2030	2070	2040	2020	EN 459-2 P. 5.8
<b>Air content</b>	<b>%</b>		0	0	3	3	4	6	EN 459-2 P. 5.7
<b>Elast. Moduli</b>	<b>Mpa</b>								
	28 days		11000	10020	8000	8400	8050	7510	French Std. on one coat renders
	6 months		16000	14000	13000	13200	12600	11000	
	12 months		16510	14320	13020	13410	12900	11050	
	24 months		16500	13950	13220	14520	13010	10850	
<b>Flexural Strength</b>	<b>N/mm<sup>2</sup></b>								
	7 days		0.4	0.35	0.32	0.38	0.5	0.26	As above
	28 days		0.67	0.65	0.45	0.6	0.52	0.38	
	6 months		1.15	1.13	0.83	1.33	1.05	0.65	
	12 months		1.75	1.15	0.85	1.5	1.2	0.8	
	24 months		1.55	1.2	0.8	1.56	1.26	0.84	
<b>Compressive Strength</b>	<b>N/mm<sup>2</sup></b>								
	7 days		0.82	0.66	0.42	0.76	0.76	0.22	EN 459-2 P. 5.1
	28 days		1.4	1.1	0.6	1.3	1.1	0.75	
	6 months		4.8	3.95	2.97	3.9	3.63	2	
	12 months		5.3	4.1	2.8	4.8	4.4	3.75	
	24 months		5.25	4.31	2.85	4.75	4.55	2.65	
<b>Permeability at complete Carb. (vapour exchange)</b>									
	(gr of air x m <sup>2</sup> x hour x mmHg)		0.6	0.59	0.63	0.69	0.71	0.68	Fr. Std. on one coat renders
<b>Shrinkage at 28 days</b>	<b>mm.m<sup>1</sup></b>		0.25	0.6	0.84	0.35	0.67	0.89	
<b>Water absorption</b>	<b>l.h.m<sup>2</sup></b>	at compl. Carbonation	10	12.3	18	11.2	15.6	19.3	
<b>Capillarity</b>	<b>g.min</b>	at compl. Carbonation	4.41	8.72	12.94	9.95	10.2	13.75	

CEMENT / HYDRATED LIME / SAND

Blends			1:1:6	1:2:9	Norm/method used for test	
Water content	gr.		200	200		
Water/binder ratio			0.72	0.65		
Penetration	mm		7	7	EN459-2 p. 5.5.3	
Set (beginning)	h		1.3	1	EN459-2 P. 6.2	
Bulk density (no curing)	kg/m <sup>3</sup>		2100	2100	EN459-2 P.5.8	
Air content	%		0	0	EN459-2 P. 5.7	
Elast. Moduli	Mpa				French Std. for one coat renders	
28 days			16200	15595		
6months			22010	19300		As above
12 months			22210	19700		
24 months			22150	19650		
Flexural Strength	N/mm <sup>2</sup>					
7 days			2.05	1.65		
28 days			1.95	1.55	EN459-2 P. 5.1	
6 months			2.1	1.5		
12 months			2.2	1.7		
24 months			2.2	1.75		
Compressive Strength	N/mm <sup>2</sup>					
7 days			5.02	4.96		
28 days			7.7	5.56		
6 months			8.1	5.75		
12 months			8.7	6.05		
24 months			8.5	5.95		
Permeability (Vapour exch. hour x mmHg)	Gr of air x m <sup>2</sup> x		0.23	0.25	At complete carb	
Shrinkage at 28 days	mm.m <sup>1</sup>		0.63	0.42	French Std. for one coat renders	
Water absorption	l.h.m <sup>2</sup>	at compl. Carbonation	0.23	0.25		
Capilarity	g.min	at compl. Carbonation	1.08	6.86		

# St.Astier Mortar tests : 24 months results

## September 2000

Enclosed the final results as follows:

Sheet 1 : Test on NHL/Sand mixes (1:2 1:2.5 1:3)

Sheet 2 : Tests on NHL/Putty /Sand blends (NHL blended with Putty@ 10% 30% 50%)

Sheet 3 : Test on Cement/lime/sand mixes (1:1:6 1:2:9)

- The proposed EU norms are conducted on mortars prepared with a binder/sand ratio of approx. 1:1.3. and Standard EU laboratory sand (ISO 679).
- The tests below reflect the performance of mortars made with the same sand but with volumetric mixes that are commonly used.
- Proctors air cured have been stored at constant 15 degrees C and 95% humidity.
- Water addition was made to obtain the same workability on all mortars.

### NOTES:

Compressive strength in NHL mortars is achieved gradually, allowing for movement. This is due to the lack of cement. In cementitious mixes the hardening is much faster and mostly complete within 28 days.

Elasticity, which is so important to achieve joint free construction, is by far better in NHL mortars than cementitious mixes. Shrinkage, capillarity and vapour exchange (permeability to air) also show better values than cementitious mixes.

The test on NHL/Putty blends shows the significant performance alteration that takes place. Although this does not signify that these blends cannot be used, we think that the specifier should be aware of the related performance.

The initial set up of these test was done in consultation with Mrs. J. M. Teutonico of English Heritage, Mrs. P. Gibbons of The Scottish Lime Centre, Prof John Ashurst, Douglas Johnston and Arch. Stafford Holmes to whom we are grateful for their co-operation and suggestions.

**For further Guidance, contact your St Astier Distributor.**

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