Mortar Tests 24 months on St Astier Pure NHL
TESTS ON ST ASTIER 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			Norm/method used for test
	NHL 5	NHL 3.5	NHL 2	NHL 5	NHL 3.5	NHL 3.5	NHL 2	NHL 5	NHL 3.5	NHL 2	
						Doyeaux sand					
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	EN459-2 P.5.5.3
Set (beginning) h	4.3	5.3	8 3/4	3.3	6	6.15	9	3	6	9.3	EN196.2 P.6.2
Bulk density kg/m^3 (no curing)	2110	2110	2100	2115	2140	1975	2080	2105	2110	2100	EN459.2 P.5.8
Air content %	0	1.6	2	0	0	0	1	0	3	2	EN459.2 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											EN459.2
7 days	0.53	0.43	0.28	0.38	0.31	0.28	0.31	0.4	0.28	0.25	
28 days	0.9	0.73	0.74	0.8	0.48	0.45	0.73	0.66	0.65	0.72	
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											EN459-2 P.5.1
7 days	1.96	0.75	0.62	1	0.57	0.5	0.53	0.88	0.53	0.47	
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	
											Fr. Std. for one coat renders
Permeability at compl. carb gr. of air/m^2 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	0.17	0.59	0.75	0.13	0.44		0.6	0.15	0.25	0.51	
Water absorption l/hxm^2	3	4.5	10.5	3.2	7.3		12.1	5.5	9.4	15.4	at compl. Carbonation
Capillarity gr/cm^2 x$min^{1/2}$	0.88	1.18	3.05	2.54	4.7		7.84	4.61	6.3	8.7	at compl. Carbonation

NHL / Putty lime blends

	NHL 5/Putty/Sand			NHL 3.5/Putty/Sand			Test Norm/method used
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	
Water/binder ratio gr	1.2	1.07	1.03	1.04	1	0.95	
Penetration mm	7	10	11	8	12	13	EN459-2 P.5.5.3
Set (beginning) h	3.5	5.25	9.5	6.5	8.5	10	EN196-2 P.5.8
Bulk density kg/m^3 (no curing)	2105	2040	2030	2070	2040	2020	EN459-2 P.5.8
Air content %	0	0	3	3	4	6	EN 459-2 P. 5.7
Elast. Moduli Mpa							
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	
Flexural Strength N/mm^2							
7 days	0.4	0.35	0.32	0.38	0.5	0.26	AN459.2
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	
Compressive Strength N/mm^2							
7 days	0.82	0.66	0.42	0.76	0.76	0.22	EN459-2 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	
Permeability at complete Carb (vapour exchange) gr of air x m^2 x hour x mmHg	0.6	0.59	0.63	0.69	0.71	0.68	Fr. Std on one coat renders
Shrinkage at 28 days mm/m	0.25	0.6	0.84	0.35	0.67	0.89	
Water absorption l/hxm^2 at compl. Carbonation	10	12.3	18	11.2	15.6	19.3	
Capillarity gr/cm^2 x$min^{1/2}$ 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^3	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	EN459-2
12 months	22210	19700	
24 months	22150	19650	
Flexural Strength N/mm^2			
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^2			
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) gr of air x m2 x hour x mmHg	0.23	0.25	At complete carbonation French Std. for one coat renders
Shrinkage at 28 days mm/m	0.63	0.42	
Water absorption l/hxm^2 at compl. Carbonation	0.23	0.25	
Capillarity gr/cm^2 x$min^{1/2}$	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 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°C and 95% humidity.
- Water addition was made to obtain the same workability on all mortars.

NOTES:

Compressive strenght 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 and Douglas Johnston to whom we are grateful for their co-operation and suggestions.

For further Guidance, contact your St Astier Distributor.