

## Test Report

# Testing of four Lime Mortars according to EN 998-1 "Specification for mortar for masonry-Rendering and plastering mortar"

**Project:** Testing\_Limeplaster\_Est

**Project-No:** 16027

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Testing of Lime Plasters according to EN 998-1 "Rendering and plastering mortar"

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## 1 Aims and Objectives

The client requires the testing of its lime plasters to German and European standards. Overall four different plasters have to be tested, for which the following abbreviations are used in this report:

- 16027\_LP\_0.5      Manufacturer description: "Lime Plaster- Fine Finish 0-0.5"
- 16027\_LP\_1        Manufacturer description: "Lime Plaster- Fine Finish 0-1"
- 16027\_LP\_2        Manufacturer description: "Lime Plaster- Finish 0-2"
- 16027\_LP\_4        Manufacturer description: "Lime Plaster- Base Coat 0-4"

All test results listed below refer exclusively to the material sent in February by the contracting authority and the specimens produced from them.

Documented in this report tests include the following testing services:

Tests / Materials	16027_LP_0.5	16027_LP_1	16027_LP_2	16027_LP_4
Dry bulk density	x	x	x	x
Compressive strength	x	x	x	x
Adhesion strength	x	x	x	x
Capillary water absorption	x	x	x	x
Fire Behaviour	x	x	x	x

Table 1: Overview of commissioned tests for lime plasters

Due to the lime plasters do not contain flammable ingredients they can be declared as non-flammable building materials (fire class A1 according to DIN 4201) like usual for pure mineral products and products with organic content  $\leq 1$  mass or volume percent (higher value relevant).

The tests were carried out in the laboratory of Ziegert | Seiler Ingenieure GmbH, Schlesische Straße 26, Staircase A, 10997 Berlin, Germany.

## 2 Tests

The tests for the lime plasters were done corresponding to EN 998-1:2011-02: "Specification for mortar for masonry-rendering and plastering mortar". For evaluating the results requirements defined in the standard were taken as a basis.

All test protocols containing single values and averages are included in

**Appendix 1.**

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## 2.1 Dry Bulk Density

### 2.1.1 Requirements

Requirements for this test are defined in [DIN EN 1015-10:1999-08] "Methods of test for mortar for masonry - Part 10: Determination of dry bulk density of hardened mortar".

### 2.1.2 Testing Procedure

For measuring the density three prisms of each plaster, which are made in plastic stage, were dried at 60 °C up to constant mass first. Than dimensions were measured with calliper and prisms were weighted. Density has to be determined by putting prisms masses in relation to outer volumes.

### 2.1.3 Results

The average density of the tested lime plasters are listed in the following Chart 1.

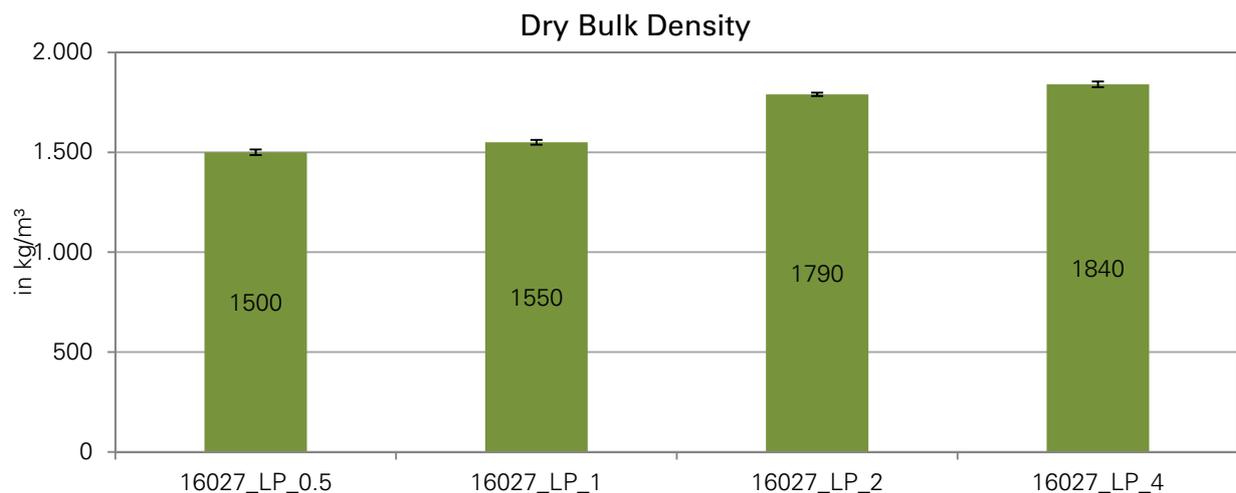


Chart 1: overview of measured dry bulk densities

The dry density of tested lime plasters is between 1500 kg/m<sup>3</sup> for 16027\_LP\_0.5 and 1840 kg/m<sup>3</sup> for 16027\_LP\_4. As expected the bulk density increases with increasing maximum grain size of the lime plasters.

Based on the determined densities the thermal capability for the lime plasters is classified after [DIN EN 1745:2012-07] as shown in table 3. A test to determine the coefficient of water vapor diffusion resistance according to [DIN EN 1015-19:2005-01] has not taken place.

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Properties	16027_LP_0.5	16027_LP_1	16027_LP_2	16027_LP_4
Dry Bulk Density in kg/m <sup>3</sup>	1500	1550	1790	1840
Thermal capability $\lambda$ in W/m·K (tabulated average, P = 50 %)	0.61	0.61	0.82	0.82

Table 2: Classification of thermal conductivity based on the density

## 2.2 Compressive Strength

### 2.2.1 Requirements

For this test requirements corresponding to [DIN EN 1015-11:2007-05] apply. Classification to strength classes will be done analogue to specification in [DIN EN 998-1:2010-12] shown in Table 3 at a glance.

Strength class	Compressive Strength after 28 days in N/mm <sup>2</sup>
CS I	0.4 up to 2.5
CS II	1.5 up to 5.0
CS III	3.5 up to 7.5
CS IV	≥ 6

Table 3: Strength classes of plaster mortars corresponding to [DIN EN 998-1:2010-12]

### 2.2.2 Testing Procedure

The compressive strength of the prisms conditioned under standard climate (20°C/65% air humidity) was tested with material testing machine type Zwick/Röll Z010. Number of samples was doubled because both pieces of halved in length prisms were used. The minimum number of three samples was guaranteed that way.

During the test load speed (in N/s) was adapted to strength properties that way that failure happens at minimum 30 up to maximum 90 seconds according to [DIN EN 1015-11:2007-05].

### 2.2.3 Results

The average compressive strength of the lime plasters is shown in the following Chart 2.

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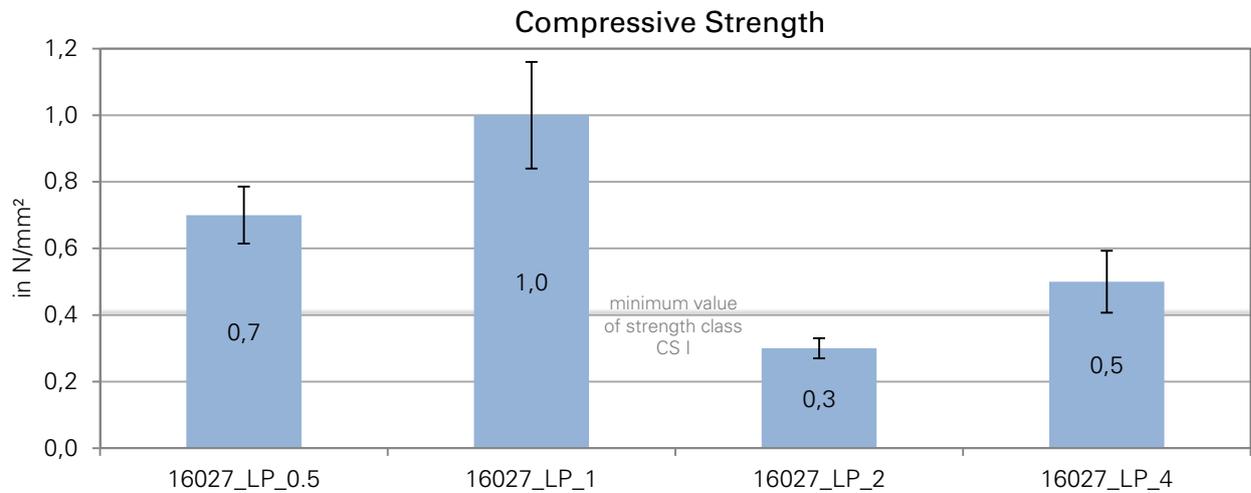


Chart 2: overview of measured compressive strength of the four tested lime plasters in comparison to the minimum value of strength class CS I corresponding to [DIN EN 998-1:2010-12]

The compressive strength tested 28 days after sample production of lime plaster is between 0.3 N/mm<sup>2</sup> for 16027\_LP\_2 and 1.0 N/mm<sup>2</sup> for 16027\_LP\_1. The two fine plasters 16027\_LP\_0.5 and 16027\_LP\_1 contain cellulose fibers, according to manufacturer to improve water retention. The strengths of the fine plasters are significantly higher than the two exclusively lime-based plasters 16027\_LP\_2 and 16027\_LP\_4.

The compressive strength of the 16027\_LP\_2 tested after 28 days confirming to standard lies with 0.3 N/mm<sup>2</sup> under the minimum value of strength class CS I of [DIN EN 998-1:2010-12]. The manufacturer's experience shows, however, the suitability for use of lime plaster 16027\_LP\_2 also when used as exterior plaster. For this reason, additional prisms were made to determine the compressive strength using the manufacturer specifications to the gauging water and for use 24 hours after mixing. A test series was examined after 28 days, the other after 56 days, to estimate the strength development. The test results are summarized in the chart below.

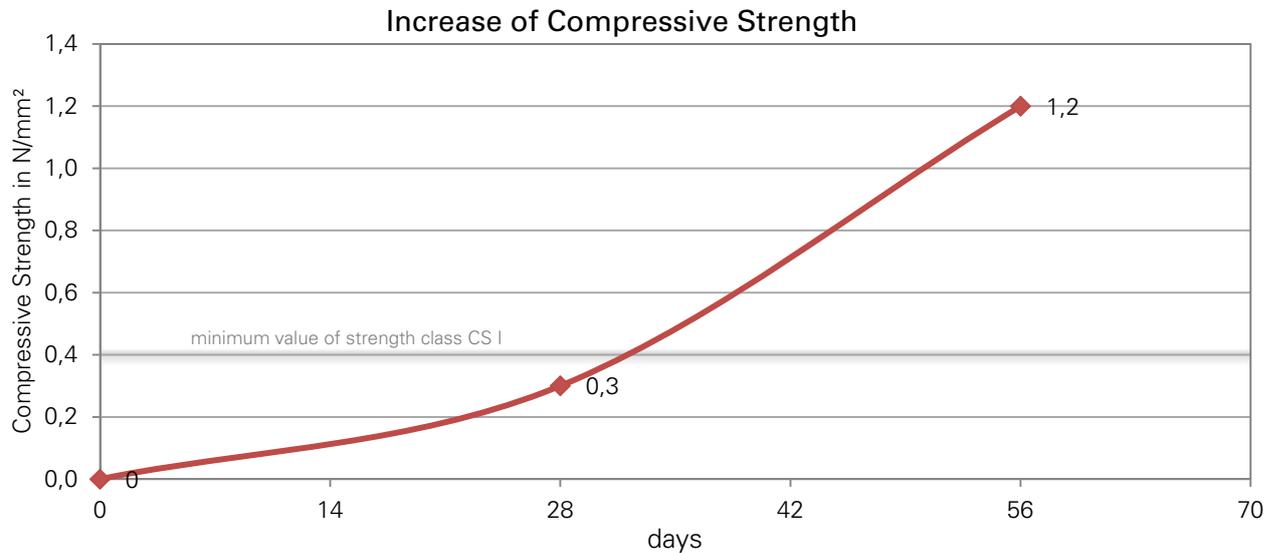


Chart 3: determined development of strength with time

The average compressive strength after 28 days was with 0.3 N/mm<sup>2</sup> as large as in the first series of tests and was thus slightly below the minimum level of strength class CS I. After 56 days was the compressive strength due to the progressive carbonation already 1.2 N/mm<sup>2</sup>. A final classification of the lime plaster 16027\_LP\_2 in the strength category CS I is accordingly justifiable.

## 2.3 Adhesion Strength

### 2.3.1 Requirements

For this test requirements corresponding to [DIN EN 1015-12:2000-06] apply. Diameter of test samples was 50 mm.

### 2.3.2 Testing Procedure

The lime plasters were prepared in plastic stage and applied on concrete slaps according to [DIN EN 1015-12:2000-06]. Test was done with the adhesion tester of the company Dynatest (Type: DTEpico 500 dc) after 28 days of storing the samples under standard climate (20 °C/65 % air humidity).

### 2.3.3 Results

The average adhesion strength of the different lime plasters is illustrated in Chart 4.

The adhesive strengths of the two fine plasters are with 0.25 N/mm<sup>2</sup> for 16027\_LP\_0.5 and 0.75 N/mm<sup>2</sup> for 16027\_LP\_1 higher than usual for lime plasters. The high adhesive strengths can possibly be attributed on the cellulose constituents contained in the plasters.

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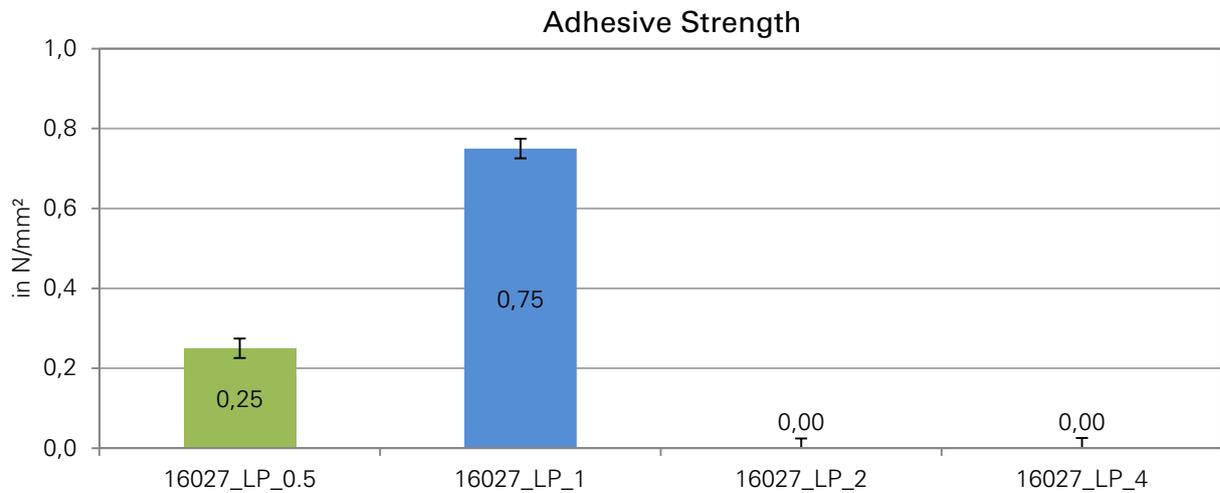


Chart 4: overview of measured adhesion strength of the four tested lime plasters

For the other two lime plasters 16027\_LP\_2 und 16027\_LP\_4, none or not enough adhesion tensile strength values could be determined, because the plaster broke already while cutting free the test specimen from the underground, or before the adhesion device had displayed a value.

The laboratory results for the two lime plasters 16027\_LP\_2 and 16027\_LP\_4 contradict producer's experience that there had been no problems with the adhesion strength in the application. As for a CE marking according to [DIN EN 998-1:2010-12] an indication of the adhesion strength is imperative that adhesion could be repeated to substrates usual for plasters. A corresponding deviation from the standard ground "concrete slab" is described in the [DIN EN 1015-12: 2000-06] for plasters, which are designed for a different substrate.

## 2.4 Capillary Water absorption

### 2.4.1 Requirements

In the standard [DIN EN 998-1:2010-12] a capillary water absorption is required for normal mortar, corresponding to the category W0 to W2. The associated values are summarized in the following Table 4.

Category	Capillary Water absorption in $\text{kg}/(\text{m}^2 \cdot \text{min}^{0,5})$
W0	not specified
W1	$C \leq 0.40$
W2	$C \leq 0.20$

Table 4: Capillary water absorption classes of plaster mortars corresponding to [DIN EN 998-1:2010-12]

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## 2.4.2 Testing Procedure

The coefficient of capillary water absorption is determined using prismatic mortar test under prescribed conditions at atmospheric pressure. After drying to constant mass an area of the specimen is first immersed 5 mm to 10 mm deep in water over a fixed period of time. Subsequently, the increase in mass is determined.

## 2.4.3 Results

The two plasters 16027\_LP\_0.5 and 16027\_LP\_4 had a capillary water absorption of 1.3 or 1.2 kg / (m<sup>2</sup> \* min<sup>0.5</sup>), after which they are to be classified in the category W0. The two plasters 16027\_LP\_1 and 16027\_LP\_2, however, are classified in the category W1 as their capillary water absorption corresponds to the maximum value for this category. The results are shown in the Chart 5.

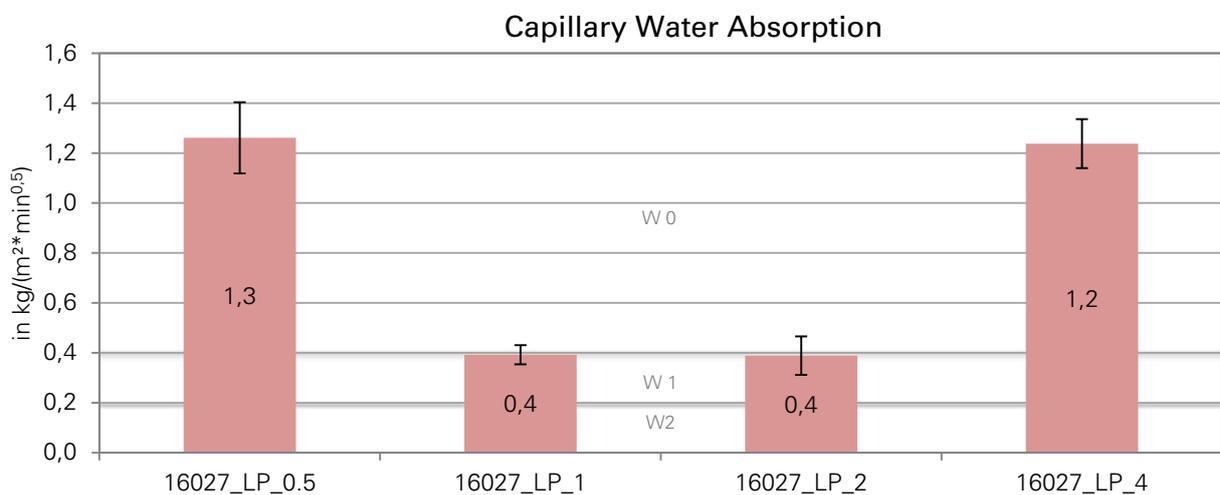


Chart 5: overview of measured capillary water absorption of the four tested lime plasters

## 2.5 Fire Behaviour / Building Material Class

### 2.5.1 Requirements

The classification in the building material class A1 according to [DIN EN 998-1:2010-12] without examination is only possible for pure mineral lime plasters or lime plasters containing organic aggregates, which accounts for less than 1% of mass or volume, the larger value is decisive.

### 2.5.2 Testing Procedure

The classification of purely mineral plaster can be done without prior examination.

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### 2.5.3 Results

Since the content of cellulose fibres in the two fine plasters 16027\_LP\_0.5 and 16027\_LP\_1 is less than 1% of mass or volume, and the two lime plasters 16027\_LP\_2 and 16027\_LP\_4 are purely mineral, all can be classified without testing in the building material class A1.

## 3 Summary of Results

The results obtained in the above tests (Chapter 2) are summarized in the following table.

Properties	16027_LP_0.5	16027_LP_1	16027_LP_2	16027_LP_4
Range of Values of Bulk Density in kg/m <sup>3</sup>	1490-1520	1530-1560	1780-1800	1820-1850
1850Compressive strength in N/mm <sup>2</sup> / Category	0.7 / CS I	1.0 / CS I	0.3 / CS I* <sup>1</sup>	0.5 / CS I
Adhesion strength in N/mm <sup>2</sup> / appearance of fracture	0.25 / B	0.75 / B	<i>no values to determine</i>	<i>no values to determine</i>
Capillary water absorption	W 0	W 1	W 1	W 0
Fire Behaviour	A1	A1	A1	A1

Figure 1: Overview of results, \*<sup>1</sup> Classification at the discretion of the testing institute

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## 4 Recommendation for Declaration

The particulars to be provided for a CE conformity marking properties of plaster mortars are specified in [DIN EN 998-1:2010-12] and exemplarily shown in Annex ZA.1.

The declaration recommendations made here are made with the principle that the values are reliably maintained. The declaration recommendations below made by the signatories are issued on the basis of the experimental results and to the best of our knowledge. These recommendations are to be checked by the manufacturer and, if necessary, taking into account possible adapt from the manufacturing process resulting fluctuations.

One value that is to be determined for a complete declaration for plasters used in exterior components yet is the coefficient of water vapor permeability according to DIN EN 1015-19.

For the investigated lime plaster listed below declarations are recommended:

16027\_LP\_0.5

Manufacturer description: "Lime Plaster- Fine Finish 0-0.5"

*Number of European Standard:*

EN 998-1:2010

*Description of the product:*

**Normal plaster  
for interior and exterior**

*Information on properties which are subject to legal provisions:***Fire Behaviour:** A 1**Adhesion Strength:** 0.15 N/mm<sup>2</sup>**Appearance of fracture:** B**Water Absorption:** W 0**Coefficient of water vapour permeability  $\mu$ :** *to be determined***Thermal conductivity ( $\lambda_{10, dry}$ ):** 0.61 W/mK (tabulated average, P = 50 %)**Durability (frost resistance):** Assessment under the rules at the intended place of use of the plaster mortar*Further values for declaration:*Range of Values of Bulk Density in kg/m<sup>3</sup>:

1450-1550

Compressive Strength (category):

C I

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**16027\_LP\_1**

Manufacturer description: "Lime Plaster- Fine Finish 0-1"

*Number of European Standard:***EN 998-1:2010***Description of the product:***Normal plaster  
for interior and exterior***Information on properties which  
are subject to legal provisions:***Fire Behaviour: A 1****Adhesion Strength: 0.65 N/mm<sup>2</sup>****Appearance of fracture: B****Water Absorption: W 1****Coefficient of water vapour permeability  $\mu$ : *to be determined*****Thermal conductivity ( $\lambda_{10,dry}$ ): 0.61 W/mK (tabulated average,  
P = 50 %)****Durability (frost resistance):** Assessment under the rules at the intended place of use of the plaster mortar*Further values for declaration:*Range of Values of Bulk Density in kg/m<sup>3</sup>: 1500-1600

Compressive Strength (category): C I

**16027\_LP\_2**

Manufacturer description: "Lime Plaster- Finish 0-2"

*Number of European Standard:***EN 998-1:2010***Description of the product:***Normal plaster  
for interior and exterior***Information on properties which  
are subject to legal provisions:***Fire Behaviour: A 1****Adhesion Strength: *no values to determine*****Appearance of fracture: A****Water Absorption: W 1****Coefficient of water vapour permeability  $\mu$ : *to be determined*****Thermal conductivity ( $\lambda_{10,dry}$ ): 0.82 W/mK (tabulated average,  
P = 50 %)****Durability (frost resistance):** Assessment under the rules at the intended place of use of the plaster mortar*Further values for declaration:*Range of Values of Bulk Density in kg/m<sup>3</sup>: 1750-1850

Compressive Strength (category): C I

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16027\_LP\_4

Manufacturer description: "Lime Plaster- Base Coat 0-4"

Number of European Standard:

EN 998-1:2010

Description of the product:

**Normal plaster**  
**for interior and exterior**

Information on properties which  
 are subject to legal provisions:

**Fire Behaviour:** A 1**Adhesion Strength:** *no values to determine***Appearance of fracture:** A**Water Absorption:** W 0**Coefficient of water vapour permeability  $\mu$ :** *to be determined***Thermal conductivity ( $\lambda_{10, dry}$ ):** 0.82 W/mK (tabulated average,  
P = 50 %)**Durability (frost resistance):** Assessment under the rules at the intended place of use of the plaster mortar

Further values for declaration:

Range of Values of Bulk Density in kg/m<sup>3</sup>: 1800-1900

Compressive Strength (category): C I

It's recommended to repeat the adhesion strength tests for the 16027\_LP\_2 and 16027\_LP\_4 on substrates usual for these plasters, to have all values necessary for a CE marking according to [DIN EN 998-1:2010-12].

## 5 Lists

### 5.1 Literature

- [DIN EN 998-1:2010-12] Deutsches Institut für Normung (Ed.): Specification for mortar for masonry - Rendering and plastering mortar, issue: December 2010
- [DIN EN 1015-1:2007] Deutsches Institut für Normung (Ed.): DIN EN 1015-1:2007-05 Methods of test for mortar for masonry. Determination of particle size distribution (by sieve analysis), issue: May 2007
- [DIN EN 1015-10:1999-08] Deutsches Institut für Normung (Ed.): DIN EN 1015-10:1999-08 Methods of test for mortar for masonry - Determination of dry bulk density of hardened mortar, issue: August 1999
- [DIN EN 1015-11:2007-05] Deutsches Institut für Normung (Ed.): DIN EN 1015-11:2007-05 Methods of test for mortar for masonry - Determination of flexural and compressive strength of hardened mortar, issue: May 2007

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- [DIN EN 1015-12:2000-06]      Deutsches Institut für Normung (Ed.): DIN EN 1015-12:2000-06 Methods of test for mortar for masonry - Determination of adhesive strength of hardened rendering and plastering mortars on substrates, issue: June 2000
- [DIN EN 1015-19:2005-01]      Deutsches Institut für Normung (Ed.): DIN EN 1015-19:2005-01 Methods of test for mortar for masonry - Determination of water vapour permeability of hardened rendering and plastering mortars, issue: January 2005
- [DIN EN 1745:2012-07]      Deutsches Institut für Normung (Ed.): Masonry and masonry products - Methods for determining thermal properties, issue: July 2012

## 5.2      Tables

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## 6 Formal Aspects

### 6.1 Copyright

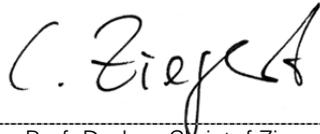
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### 6.2 Scale

This report consists of 15 pages of text including cover page and table of contents and 9 pages of appendixes including cover page thus, the document amounts to 24 pages in total.

Berlin, 13. July 2016



Prof. Dr.-Ing. Christof Ziegert



Caroline Kaiser, M. Eng.



## Test Report

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"Specification for mortar for masonry-Rendering and  
plastering mortar"

**Project:** Testing\_Limeplaster\_Est

**Project-No:** 16027

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## APPENDIX

Appendix 1: printouts of test results

Measure of shrinkage, Density and Compressive Strength according to EN 1015-10 and DIN EN 1015-11

Material	Sample No.	Lime mortar 0-0.5 mm					
		1		2		3	
Date of Production		23.02.2016					
Consistency		plastic					
Slump	mm	168 X 173					
Storing in formwork	Days	7					
Storing stripped out	Days	21					
Date of Test		22.03.2016					
Days after Production	Days						
Test Temperature/Humidity	°C / %	23/50					
Storing under Test Climate	h						
Length (with Moisture of Production)	mm	160.0	160.0	160.0	160.0	160.0	160.0
Length (with balancing humidity)	mm	158.3	157.9	159.3	159.3	159.3	159.3
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Measure of Shrinkage	%	1.1	1.3	0.4	0.4	0.4	0.4
<b>Measure of Shrinkage (Average)</b>	<b>%</b>	<b>0.9</b>					
Standard Deviation	%	0.45					
Deviation from the Average	%	13	40	53	53	53	53
Width (with balancing humidity)	mm	39.1	39.0	39.2	39.2	39.2	39.2
Height (with balancing humidity)	mm	39.4	39.2	39.4	39.4	39.4	39.4
Mass (with balancing humidity)	g	364.3	367.1	368.9	368.9	368.9	368.9
Volume	cm <sup>3</sup>	243.87	241.40	246.04	246.04	246.04	246.04
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Density (single values/ with balancing humidity)	kg/m <sup>3</sup>	1490	1520	1500	1500	1500	1500
<b>Density (average/ with balancing humidity)</b>	<b>kg/m<sup>3</sup></b>	<b>1500</b>					
Standard Deviation	kg/m <sup>3</sup>	14					
Deviation from the Average	%	0	1	0	0	0	0
Half of the prism		1_a	1_b	2_a	2_b	3_a	3_b
Breaking Load Compression Test F	N	952	950	1110	1010	1270	1350
Compression Area	mm <sup>2</sup>	1564	1560	1568	1568	1568	1568
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Compressive Strength (Single Values)	N/mm <sup>2</sup>	0.60	0.60	0.70	0.65	0.80	0.85
<b>Compressive Strength (Average)</b>	<b>N/mm<sup>2</sup></b>	<b>0.7</b>					
Standard Deviation	N/mm <sup>2</sup>	0.1					
Deviation from the Average	%	13	13	2	8	16	23

Measure of shrinkage, Density and Compressive Strength according to EN 1015-10 and DIN EN 1015-11

Material	Sample No.	Lime mortar 0-1 mm					
		1		2		3	
Date of Production		23.02.2016					
Consistency		plastic					
Slump	mm	170 x 173					
Storing in formwork	Days	7					
Storing stripped out	Days	21					
Date of Test		22.03.2016					
Days after Production	Days	28					
Test Temperature/Humidity	°C / %	23/50					
Storing under Test Climate	h						
Length (with Moisture of Production)	mm	160.0	160.0	160.0	160.0	160.0	160.0
Length (with balancing humidity)	mm	159.5	158.2	159.5	159.5	159.5	159.5
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Measure of Shrinkage	%	0.3	1.1	0.3	0.3	0.3	0.3
<b>Measure of Shrinkage (Average)</b>	<b>%</b>	<b>0.6</b>					
Standard Deviation	%	0.47					
Deviation from the Average	%	46	93	46	46	46	46
Width (with balancing humidity)	mm	38.3	38.3	38.7	38.7	38.7	38.7
Height (with balancing humidity)	mm	39.6	39.6	40.5	40.5	40.5	40.5
Mass (with balancing humidity)	g	374.6	373.4	383.2	383.2	383.2	383.2
Volume	cm <sup>3</sup>	241.91	239.94	249.99	249.99	249.99	249.99
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Density (single values/ with balancing humidity)	kg/m <sup>3</sup>	1550	1560	1530	1530	1530	1530
<b>Density (average/ with balancing humidity)</b>	<b>kg/m<sup>3</sup></b>	<b>1550</b>					
Standard Deviation	kg/m <sup>3</sup>	12					
Deviation from the Average	%	0	0	1	1	1	1
Half of the prism		1_a	1_b	2_a	2_b	3_a	3_b
Breaking Load Compression Test F	N	1840	1920	1470	1390	1470	1400
Compression Area	mm <sup>2</sup>	1532	1532	1548	1548	1548	1548
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Compressive Strength (Single Values)	N/mm <sup>2</sup>	1.20	1.25	0.95	0.90	0.95	0.90
<b>Compressive Strength (Average)</b>	<b>N/mm<sup>2</sup></b>	<b>1.0</b>					
Standard Deviation	N/mm <sup>2</sup>	0.2					
Deviation from the Average	%	20	25	4	9	5	10

Measure of shrinkage, Density and Compressive Strength according to EN 1015-10 and DIN EN 1015-11

Material	Sample No.	Lime mortar 0-2 mm					
		1		2		3	
Date of Production		04.05.2016					
Consistency		plastic					
Slump	mm	150 x 146					
Storing in formwork	Days	7					
Storing stripped out	Days	21					
Date of Test		29.06.2016					
Days after Production	Days	56					
Test Temperature/Humidity	°C / %	23/50					
Storing under Test Climate	h	1176					
Length (with Moisture of Production)	mm	160.0	160.0	160.0	160.0	160.0	160.0
Length (with balancing humidity)	mm	160.2	160.1	160.1	160.1	160.1	160.1
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Measure of Shrinkage	%	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
<b>Measure of Shrinkage (Average)</b>	<b>%</b>	<b>-0.1</b>					
Standard Deviation	%	0.04					
Deviation from the Average	%	50	25	25	25	25	25
Width (with balancing humidity)	mm	39.2	40.1	39.2	40.1	39.2	40.1
Height (with balancing humidity)	mm	39.8	40.1	39.7	40.1	39.7	40.1
Mass (with balancing humidity)	g	463.5	457.4	458.8	457.4	458.8	458.8
Volume	cm <sup>3</sup>	249.94	257.44	249.15	257.44	249.15	257.44
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Density (single values/ with balancing humidity)	kg/m <sup>3</sup>	1850	1780	1840	1780	1840	1840
<b>Density (average/ with balancing humidity)</b>	<b>kg/m<sup>3</sup></b>	<b>1820</b>					
Standard Deviation	kg/m <sup>3</sup>	42					
Deviation from the Average	%	2	2	1	2	1	1
Half of the prism		1_a	1_b	2_a	2_b	3_a	3_b
Breaking Load Compression Test F	N	2040	2090	1690	1780	1670	1870
Compression Area	mm <sup>2</sup>	1568		1604		1568	
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Compressive Strength (Single Values)	N/mm <sup>2</sup>	1.30	1.35	1.05	1.10	1.05	1.20
<b>Compressive Strength (Average)</b>	<b>N/mm<sup>2</sup></b>	<b>1.2</b>					
Standard Deviation	N/mm <sup>2</sup>	0.1					
Deviation from the Average	%	8	11	12	8	11	1

Measure of shrinkage, Density and Compressive Strength according to EN 1015-10 and DIN EN 1015-11

Material	Sample No.	Lime mortar 0-2 mm					
		1		2		3	
Date of Production		04.05.2016					
Consistency		plastic					
Slump	mm	150 x 146					
Storing in formwork	Days	7					
Storing stripped out	Days	21					
Date of Test		01.06.2016					
Days after Production	Days	28					
Test Temperature/Humidity	°C / %	23/50					
Storing under Test Climate	h	504					
Length (with Moisture of Production)	mm	160.0	160.0	160.0	160.0	160.0	160.0
Length (with balancing humidity)	mm	159.8	160.2	160.0	160.0	160.0	160.0
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Measure of Shrinkage	%	0.1	-0.1	0.0	0.0	0.0	0.0
<b>Measure of Shrinkage (Average)</b>	<b>%</b>	<b>0.0</b>					
Standard Deviation	%	0.12					
Deviation from the Average	%						
Width (with balancing humidity)	mm	39.2	39.5	39.5	39.5	39.5	39.5
Height (with balancing humidity)	mm	39.9	39.5	39.5	39.5	39.6	39.6
Mass (with balancing humidity)	g	477.2	501.5	510.4	510.4	510.4	510.4
Volume	cm <sup>3</sup>	249.94	249.95	250.27	250.27	250.27	250.27
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Density (single values/ with balancing humidity)	kg/m <sup>3</sup>	1910	2010	2040	2040	2040	2040
<b>Density (average/ with balancing humidity)</b>	<b>kg/m<sup>3</sup></b>	<b>1980</b>					
Standard Deviation	kg/m <sup>3</sup>	68					
Deviation from the Average	%	4	1	3	3	3	3
Half of the prism		1_a	1_b	2_a	2_b	3_a	3_b
Breaking Load Compression Test F	N	766	758	371	372	332	316
Compression Area	mm <sup>2</sup>	1568	1580	1580	1580	1580	1580
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Compressive Strength (Single Values)	N/mm <sup>2</sup>	0.50	0.50	0.25	0.25	0.20	0.20
<b>Compressive Strength (Average)</b>	<b>N/mm<sup>2</sup></b>	<b>0.3</b>					
Standard Deviation	N/mm <sup>2</sup>	0.1					
Deviation from the Average	%	63	61	22	22	30	33

Measure of shrinkage, Density and Compressive Strength according to EN 1015-10 and DIN EN 1015-11

Material	Sample No.	Lime mortar 0-2 mm					
		1		2		3	
Date of Production		02.03.2016					
Consistency		plastic					
Slump	mm	183 x 183					
Storing in formwork	Days	7					
Storing stripped out	Days	21					
Date of Test		31.03.2016					
Days after Production	Days	28					
Test Temperature/Humidity	°C / %	23/50					
Storing under Test Climate	h	168					
Length (with Moisture of Production)	mm	160.0	160.0	160.0	160.0	160.0	160.0
Length (with balancing humidity)	mm	160.0	160.0	160.0	160.0	159.8	159.8
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Measure of Shrinkage	%	0.0	0.0	0.0	0.0	0.1	0.1
<b>Measure of Shrinkage (Average)</b>	<b>%</b>	<b>0.0</b>					
Standard Deviation	%	0.07					
Deviation from the Average	%	100	100	100	100	200	200
Width (with balancing humidity)	mm	38.8	38.6	38.8	38.6	38.9	38.9
Height (with balancing humidity)	mm	40.0	40.2	40.0	40.2	39.7	39.7
Mass (with balancing humidity)	g	442.3	443.9	442.3	443.9	443.7	443.7
Volume	cm <sup>3</sup>	248.32	248.28	248.32	248.28	246.78	246.78
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Density (single values/ with balancing humidity)	kg/m <sup>3</sup>	1780	1790	1780	1790	1800	1800
<b>Density (average/ with balancing humidity)</b>	<b>kg/m<sup>3</sup></b>	<b>1790</b>					
Standard Deviation	kg/m <sup>3</sup>	8					
Deviation from the Average	%	0	0	0	0	0	0
Half of the prism		1_a	1_b	2_a	2_b	3_a	3_b
Breaking Load Compression Test F	N	381	362	412	369	478	781
Compression Area	mm <sup>2</sup>	1552	1544	1552	1544	1556	1556
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Compressive Strength (Single Values)	N/mm <sup>2</sup>	0.25	0.25	0.25	0.25	0.30	0.50
<b>Compressive Strength (Average)</b>	<b>N/mm<sup>2</sup></b>	<b>0.3</b>					
Standard Deviation	N/mm <sup>2</sup>	0.0					
Deviation from the Average	%	18	22	11	20	2	67

Measure of shrinkage, Density and Compressive Strength according to EN 1015-10 and DIN EN 1015-11

Material	Sample No.	Lime mortar 0-4 mm					
		1		2		3	
Date of Production		02.03.2016					
Consistency		plastic					
Slump	mm	179 x 181					
Storing in formwork	Days	7					
Storing stripped out	Days	21					
Date of Test		31.03.2016					
Days after Production	Days	29					
Test Temperature/Humidity	°C / %	23/50					
Storing under Test Climate	h	168					
Length (with Moisture of Production)	mm	160.0	160.0	160.0	160.0	160.0	160.0
Length (with balancing humidity)	mm	160.0	160.0	160.0	160.0	159.9	159.9
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Measure of Shrinkage	%	0.0	0.0	0.0	0.0	0.1	0.1
<b>Measure of Shrinkage (Average)</b>	<b>%</b>	<b>0.0</b>					
Standard Deviation	%	0.04					
Deviation from the Average	%	100	100	100	100	200	200
Width (with balancing humidity)	mm	38.8	38.8	38.8	38.8	38.1	38.1
Height (with balancing humidity)	mm	39.8	39.8	39.6	39.6	39.7	39.7
Mass (with balancing humidity)	g	450.2	452.8	452.8	452.8	447.5	447.5
Volume	cm <sup>3</sup>	247.08	245.84	245.84	245.84	241.86	241.86
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Density (single values/ with balancing humidity)	kg/m <sup>3</sup>	1820	1840	1840	1840	1850	1850
<b>Density (average/ with balancing humidity)</b>	<b>kg/m<sup>3</sup></b>	<b>1840</b>					
Standard Deviation	kg/m <sup>3</sup>	14					
Deviation from the Average	%	1	0	0	0	1	1
Half of the prism		1_a	1_b	2_a	2_b	3_a	3_b
Breaking Load Compression Test F	N	584	803	848	974	856	578
Compression Area	mm <sup>2</sup>	1552	1552	1552	1552	1524	1524
Should value be used for calculating the average?		<input checked="" type="checkbox"/>					
Compressive Strength (Single Values)	N/mm <sup>2</sup>	0.40	0.50	0.55	0.65	0.55	0.40
<b>Compressive Strength (Average)</b>	<b>N/mm<sup>2</sup></b>	<b>0.5</b>					
Standard Deviation	N/mm <sup>2</sup>	0.1					
Deviation from the Average	%	25	3	9	26	12	24

## Determination of Adhesion corresponding to EN 1015-12

Project: 16027\_Testing\_Limeplaster\_Est

Date of testing: 24.03. and 27.04.2016

## Adhesion

Sample		M1 after 10 min. in g	M2 after 90 min. in g	Coefficient of capillary water absorption in kg/m <sup>2</sup> min <sup>0,5</sup>	Note
Lime 0-0.5	la	166.00	176.14	1.01	wet spot on the surface at the end
Lime 0-0.5	lb	211.36	224.62	1.33	wet spot on the surface at the end
Lime 0-0.5	IIa	188.99	201.11	1.21	wet spot on the surface at the end
Lime 0-0.5	IIb	202.20	214.02	1.18	
Lime 0-0.5	IIIa	194.28	208.53	1.43	
Lime 0-0.5	IIIb	193.42	207.48	1.41	
<b>Average:</b>				<b>1.3</b>	→ <i>Category W0</i>
Lime 0-1	la	192.36	196.54	0.42	after 90 min. not water saturated
Lime 0-1	lb	204.02	208.38	0.44	after 90 min. not water saturated
Lime 0-1	IIa	189.65	193.54	0.39	after 90 min. not water saturated
Lime 0-1	IIb	216.42	219.61	0.32	after 90 min. not water saturated
Lime 0-1	IIIa	192.34	196.50	0.42	after 90 min. not water saturated
Lime 0-1	IIIb	214.05	217.80	0.38	after 90 min. not water saturated
<b>Average:</b>				<b>0.39</b>	→ <i>Category W1</i>
Lime 0-2	la	226.23	231.08	0.49	after 90 min. not water saturated
Lime 0-2	lb	226.51	231.05	0.45	after 90 min. not water saturated
Lime 0-2	IIa	222.44	226.40	0.40	after 90 min. not water saturated
Lime 0-2	IIb	229.10	232.41	0.33	after 90 min. not water saturated
Lime 0-2	IIIa	224.78	228.90	0.41	after 90 min. not water saturated
Lime 0-2	IIIb	226.24	228.78	0.25	after 90 min. not water saturated
<b>Average:</b>				<b>0.39</b>	→ <i>Category W1</i>
Lime 0-4	la	230.24	243.14	1.29	
Lime 0-4	lb	215.01	226.66	1.17	
Lime 0-4	IIa	219.23	231.82	1.26	
Lime 0-4	IIb	246.42	260.36	1.39	
Lime 0-4	IIIa	218.92	229.72	1.08	
Lime 0-4	IIIb	224.99	237.36	1.24	
<b>Average:</b>				<b>1.24</b>	→ <i>Category W0</i>

## Determination of Adhesion corresponding to EN 1015-12

Project: 16027\_Testing\_Limeplaster\_Est

Date of testing: 24.03. and 27.04.2016

## Adhesion

Sample		Adhesion value in kN	$\Phi$ Area of Fracture in mm	Adhesion strength, in N/mm <sup>2</sup>	Note Adhesion Fraction: Fracture between mortar and subsoil Cohesion Fraction: Fracture in mortar or subsoil
Lime 0-0.5	1	0.49	49.2	0.25	Cohesion Fraction
Lime 0-0.5	2	0.38	49.5	0.20	Cohesion Fraction
Lime 0-0.5	3	0.43	49.2	0.25	Cohesion Fraction
Lime 0-0.5	4	0.57	49.5	0.30	Cohesion Fraction
Lime 0-0.5	5	0.54	49.6	0.30	Cohesion Fraction
<b>Average:</b>				<b>0.25</b>	
Lime 0-1	1	1.20	47.6	0.65	Cohesion Fraction
Lime 0-1	2	1.42	47.9	0.80	Cohesion Fraction
Lime 0-1	3	1.28	47.4	0.75	Cohesion Fraction
Lime 0-1	4	1.62	48.6	0.85	Cohesion Fraction
Lime 0-1	5	1.26	48.9	0.65	Cohesion Fraction
<b>Average:</b>				<b>0.75</b>	
Lime 0-2	1	/	/	/	Adhesion Fraction
Lime 0-2	2	0.10	47.5	0.05	Adhesion Fraction
Lime 0-2	3	/	/	/	Cohesion Fraction
Lime 0-2	4	/	/	/	Adhesion Fraction
Lime 0-2	5	0.08	47.7	0.05	Adhesion Fraction
<b>Average:</b>				<b>0.05</b>	
Lime 0-4	1	/	/	/	Adhesion Fraction
Lime 0-4	2	/	/	/	Adhesion Fraction
Lime 0-4	3	/	/	/	Adhesion Fraction
Lime 0-4	4	/	/	/	Adhesion Fraction
Lime 0-4	5	/	/	/	Adhesion Fraction
<b>Average:</b>					