

Session EE9-3 Performance of Glass Fiber Lath

PERFORMANCE OF GLASS FIBER LATH AS A PLASTER BASE WITH EXTERIOR CEMENT PLASTER (STUCCO)

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ABSTRACT

Metal or wire lath has been the primary type of plaster base used with Exterior Cement Plaster (Stucco) for many years. Due in part to recent technology that enables glass fiber to be woven as a three dimensional material, Glass Fiber Lath is available as an alternative material to metal or wire lath. Compared to existing materials, Glass Fiber Lath offers many benefits in terms of application as well as performance. It is available in various configurations and is currently used with traditional Exterior Cement Plaster (Stucco) as well as One Coat Stucco and Masonry Veneer Stone.

The paper will discuss the evolution of Glass Fiber Lath technology including lessons learned during the development process. It will also review key application features as well as performance properties including testing completed to show compliance with the International Building³ and Residential Codes⁴. Also discussed will be on going ASTM Standards development work as well as a summary of research completed at the University of Florida that compares attributes of Glass Fiber Lath to existing materials used in both Exterior Cement Plaster (Stucco) as well as One Coat Stucco.

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INTRODUCTION

Stucco, as it's commonly known, is an above grade, exterior wall cladding that comprises a significant market share in both the residential as well as commercial siding markets. It is widely popular for a variety of reasons such as durability, low initial cost, availability and appearance particularly since the system can be adapted to a wide range of construction styles¹.

Stucco is typically described as being one of two types which are traditional, Exterior Portland Cement Plaster as described in ASTM C 926⁸ or One Coat Stucco are proprietary mixtures provided by stucco manufacturers. Stucco consists of a base coat layer followed by a finish coat layer. The base coat layer can be comprised of various materials such as cement, lime, aggregates, sand, water, fibers, admixtures or other proprietary ingredients. The base coat, which is spray or trowel applied, can vary in thickness depending on factors such as building code requirements, substrate type, and manufacturer's instructions with the range generally minimum 10 mm (3/8 inch) for One Coat Stucco up to 19 mm (3/4 inch) for Exterior Portland Cement Plaster.

With either type of stucco, a cementitious or non-cementitious finish coat that varies in thickness from 1.5 mm (1/16 inch) to 3 mm (1/8 inch) is applied, usually by trowel or spray, to the cured base coat. Cementitious finishes generally use ingredients similar to those in base coats while the non-cementitious finish coats are typically factory mixed, integrally colored products comprised of proprietary ingredients. Ingredients for base as well as finish coats will vary due to many factors such as project specifications, local practices, raw material availability, user preferences, building code requirements, type mix (field or factory), desired appearance and performance, project type, etc.

Stucco systems are applied directly to a plaster base which can be a solid substrate such as unit masonry, cast in place, precast concrete, etc. or, in the case of framed construction, to a stucco lath or netting. On framed/sheathed construction and other surfaces which may not enable an adequate bond of the stucco to the substrate. The plaster base serves a number of purposes including reinforcement and more importantly a mechanical key or attachment mechanism for the stucco.

Originally, plaster bases were created from wood lath or strips. Towards the end of the 19th century metal lath began to be used in the United States and it eventually replaced wood lath due to limitations such as high cost of labor to produce and install, difficulty to accommodate various wall geometries, plus possible adverse effects due to moisture. Additionally, the steel used to fabricate metal lath contained many more spaces which increased the keying and ability to keep the plaster in place.

Currently, most plaster bases are fabricated from metal although plastic lath is also available. Metal plaster bases are available in various configurations, weights and types which are commonly referred to as diamond mesh metal, high rib lath, flat rib lath, expanded metal, woven or welded wire lath. Since only material or manufacturing specifications exist for most if not all metal products, determining which product to use is generally based on local building codes and practices. For stucco applied to vertical, exterior walls, diamond or expanded metal mesh and woven or welded wire are the most commonly used types of metal plaster bases. For exterior applications, galvanized coatings are available to provide a higher level of corrosion resistance

and stainless steel lath is available to maximize protection in coastal and other corrosive environments. As far as packaging, the wire products are typically supplied in 0.91 m wide by 45.7 m (36 inch by 150 foot) long rolls while products such as expanded lath, diamond metal mesh, etc. are generally available in 0.71 m by 2.4 m (28 inch by 96 inch) sheets that are supplied in bundles and shipped on pallets.

Technology now available in the glass fiber industry has enabled development of Glass Fiber Lath which serves as a non-metallic plaster base. The significance of this material is that it addresses some of the recognized limitations of metal plaster base products. Specific improvements from Glass Fiber Lath materials can include enhanced speed/ease of application and handling, corrosion resistance, and safety during application. Additionally, unlike metal products which are manufactured to material standards or specifications, glass fiber lath is generally based on performance or end use testing. Glass Fiber Lath results in few, if any changes to types/spacing of lath fasteners, detailing, trim accessories, etc. that are commonly used with metal lath. This paper will provide insight on the product development from initial concept through testing as well as insight into potential features and benefits.

GLASS FIBER LATH

The Owens-Corning Fiberglass Corporation initially commercialized the production of continuous filament glass fibers in the late 1930's. By the middle 1940's, woven fabrics and non-woven mats made from these glass fibers were already being produced, largely for the Fiberglass Reinforced Plastics Industry (FRP).

Today, glass reinforcing fabrics are used in a variety of ways in the composites, construction and industrial markets. In the Exterior Insulation Finish System (EIFS) market, which is a type of exterior wall cladding system used on commercial and residential structures, woven fiberglass fabric or meshes have been used in the United States since the late 1960's to reinforce cement based matrices that make up the external coating of the system.

The reinforcing mesh used with EIFS is an open weave construction to allow for encapsulation within the cement matrix. Open weave fabrics are made by using "leno weave" or "knit" fabric formation methods which help stabilize the geometry of the mesh. The mesh is also saturated with a polymeric coating to further stabilize the mesh, protect it from damage due to handling and installation, and impart alkali resistance. Normally it is desirable to minimize the thickness of the mesh so that it can be easily embedded within the cement matrix. The mesh serves a variety of functions including prevention of cracking of the exterior lamina due to thermal expansion and contraction as well as provides impact resistance to the system. Figure 1 shows an EIFS with woven glass fiber mesh



Figure 1 EIFS with woven fiberglass mesh

The idea to develop a non-metallic plaster base came about to address recognized limitations of metal lath and wire products used with stucco wall systems. As a result, PermaLath and subsequently PermaLath 1000 Glass Fiber Lath were developed and introduced to the market.

PermaLath (Figure 2) is a three dimensional, glass fiber lath (weight 150 g/m^2) (4.5 oz/yd^2) that serves as an alternative to wire or metal lath in one coat stucco. PermaLath 1000 is a heavier (weight 300 g/m^2) (9 oz/yd^2), stiffer product designed for traditional three coat, one coat stucco and as a base for what's referred to as a scratch coat in masonry stone veneer applications. A three dimensional profile is induced into the fiberglass fabric to provide enhanced keying as well as for it to be self furred rather than mechanically furred with strips or the like since most, if not all building codes, require lath to be furred or held away from the substrate to provide a keying mechanism.



Figure 2 PermaLath Glass Fiber Lath

PRODUCT DEVELOPMENT....PHASE 1

The objective of the initial development phase was to develop a non-metallic lath suitable for use with One Coat Stucco Systems. Although various non-metallic materials were initially considered for the lath, fiberglass was the material of choice for the lath in part for the following reasons:

- High tensile strength and modulus: the strength-to-weight ratio of fiberglass makes it stronger than steel in some applications and the fibers are able to bear high loads without significant deformation which is key for reinforcement of cement based matrices;
- Heat and fire properties: it is able to withstand elevated temperatures due to its high softening point;
- Chemical resistance: fiberglass is not attacked by most chemicals nor is it adversely affected by fungus, bacteria or insect attack;
- Moisture resistance: fiberglass is not absorbent and therefore not prone to swell, stretch, corrode or disintegrate;
- Linear expansion: fiberglass has a low coefficient of thermal linear expansion;
- Availability: the materials are widely available from a variety of manufacturers. There is also a wide range of glass yarn yields available for virtually every design need;
- Fabric forming options: continuous fiberglass yarn can be formed into useful fabrics by traditional weaving; laid scrim; multi-axial weaving; three dimensional weaving; knitting; wet and dry laid mat; needling; preforming; etc. A reinforcement fabric can be designed for virtually any application by the suitable selection of fabric forming method, fabric design and materials;
- History in EIFS: fiberglass mesh has been used in cement basecoats for the EIFS industry for decades.

The design of the initial product, now commercially available under the name PermaLath, evolved mostly through empirical testing but guided by dimensions, strengths, etc. of existing plaster base products. Additionally, it was desirable for the product to utilize similar types of fasteners, fastener spacing, trim accessories (corner beads, etc.) and design details typical of stucco that incorporates metal lath.

Some of the properties and characteristics deemed to be more critical to the success of the fabric included thickness, hole or opening size and tensile strength. Since the lath serves as a key or attachment mechanism for the stucco, and must have sufficient bending rigidity or stiffness to support the stucco as the stucco is being applied. The International Code Council has established Acceptance Criteria, referred to as AC 11⁶, for One Coat Stucco systems. Within AC 11 is stipulation that furring crimps must hold the body of the lath at least 3 mm (1/8 inch) from the substrate. As result, this dimension was used as the starting dimension for the thickness and it was found through field trials and subsequent testing to be appropriate for PermaLath when used in One Coat Stucco applications.

Initial prototypes started with an opening size of about 13 mm by 13 mm (1/2 inch by 1/2 inch) however it was found through field trials to be too narrow for efficient passage of the stucco. A

later design with opening dimensions of 13 mm by 19 mm (1/2 inch by 3/4 inch) was shown in field trials to be more workable.

The initial prototype was also secured to the substrate in field trials using fastener types/spacing, etc. typical of metal lath. As a result of the trials, it was determined the lath had less than the desired amount of rigidity or stiffness since the weight of the wet stucco during application resulted in some sagging of the stucco. Although supplemental fasteners improved this condition, later designs used heavier glass yarns spaced wider apart, as well as a different coating system than the initial design. The later design has proven reliable for use in one coat stucco over polymeric type weather resistive barriers (Tyvek, etc.). In the case of asphaltic based weather resistive barriers (building paper), it was found these types of barriers can, in some cases, be subject to swelling of the barrier due to moisture pick up from the environment as well as wet stucco. As a result, in some cases, products which are not overly rigid, such as wires and in this case PermaLath, may have a tendency to follow the contours of the “pillows” formed by the paper which may lead to a surface with less than desired flatness.

Also during the development process, the tensile load and extension characteristics of the PermaLath product were compared to both 17 and 20 gauge wire lath since these were considered to be the weakest of the metal plaster base products used in one coat stucco systems. As seen in Table 1, 2 and 3 below, the following items were noted

- PermaLath has a higher tensile rigidity than either the 17 or 20 gauge wire netting. This is true at all strain levels and regardless of the direction of testing;
- PermaLath has a higher load to failure than either the 17 or 20 gauge wire netting. While this result is interesting, loads high enough to break the meshes are not likely to be encountered in practice.

Note that the load-extension curves were very non-linear. Thus the strength of the fabrics had to be considered at several points along the curves, though the data generated under the initial column are most relevant considering the small load 2 N/cm (22.5 lbf/inch) imposed by the wet stucco.

From a performance standpoint, the ultimate breaking strength of the PermaLath is not a significant factor in the early life of the wall as the lath is many times stronger than required to support the weight of wet stucco. From the installation side, PermaLath was found to be sufficiently stiff and rigid to accept and serve as a key for the wet stucco.

TABLE 1: Tensile Modulus of Elasticity* Comparison

<u>MESH/PRODUCT TYPE</u>	<u>INITIAL</u>		<u>PLATEAU</u>		<u>ULTIMATE</u>	
	<u>MD</u>	<u>CD</u>	<u>MD</u>	<u>CD</u>	<u>MD</u>	<u>CD</u>
PermaLath (N/cm)	8526	346	14192	544	14192	15764
(lb/in)	4872	198	8110	311	8110	9008
20 Gauge (N/cm)	180	96	60	30	1092	404
(lb/in)	103	55	34	17	624	231
17 Gauge (N/cm)	499	138	192	28	2863	1004
(lb/in)	285	79	110	16	1636	574

*Note: tensile modulus is calculated by assuming that the stress on the wire is in units of N/cm (lbs per inch) of width and neglects the thickness of the mesh. Also, the modulus is calculated at all displacements by using the initial 50 mm (2 inch) specimen width and neglecting the loss in width that happens with the metal netting at high elongations.

TABLE 2: Strength Comparison

<u>MESH TYPE</u>	<u>Ultimate Load</u>	<u>Strain to Ultimate Load (%)</u>	<u>Ultimate Load Occurs at Break or Yield Point?</u>
PermaLath MD* (N/cm)	460	3	break
(lb/in)	263		
20 Gauge MD (N/cm)	122	27	break
(lb/in)	70		
17 Gauge MD (N/cm)	350	28	break
(lb/in)	200		
PermaLath CD** (N/cm)	490	8	break
(lb/in)	280		
20 Gauge CD (N/cm)	40	33	yield
(lb/in)	23		
17 Gauge CD (N/cm)	87	42	yield
(lb/in)	50		

* Machine direction

**Cross direction

TABLE 3: Deformation of Various Mesh/Products Due to Weight of Stucco

ΔL **

<u>MESH/PRODUCT TYPE</u>	<u>MD</u>	<u>CD</u>
PermaLath (mm)	0.0086	0.216
(inches)	0.00034	0.0085
20 Gauge (mm)	0.4064	0.762
(inches)	0.016	0.030
17 Gauge (mm)	0.1499	0.533
(inches)	0.0059	0.021

**Note: this is the change in length of a section of mesh that is 15 cm (6 inches long) which is exposed to a load of 0.49 N/cm (0.28 lb/in). The load of 0.49 N/cm (0.28 lb/in) is equivalent to that of a typical One Coat Stucco which is typically applied at approximately 3 g/cm² (6 lbs/square foot).

FIELD TRIALS AND PRODUCT INTRODUCTION

After completion of product development and small scale installations, field trials commenced to validate application of the glass fiber lath as well as determine the impact, if any, on the stucco application under actual field conditions. Several residential as well as commercial projects in New Jersey, Pennsylvania, Rhode Island and New Mexico were selected for initial field trials. Project selection for the field trials was based on a number of factors such as location, project size, complexity, time of year products were to be applied, project availability, etc. Figures 3 and 4 of New Jersey and Rhode Island projects are shown below and are fairly representative of the size/scope of the trials. Installation was completed by plastering contractors using a one coat stucco system and PermaLath Glass Fiber Lath marketed by BASF Wall Systems. Specific feedback gathered as part of the field/application trials included production rates, ease of installation, pros/cons versus metal plaster bases, roll size, flatness, resistance to sag, means of attachment, detailing, effect of weather exposure prior to stucco application, integration with trim accessories, suggested modifications, and impact, if any, of the type of weather barrier as well as the application of the stucco including ability to key and bond to the lath. Final product designs and installation methods were based on input obtained through field/application trials, regulatory requirements, performance testing, etc. Additionally, the trials further confirmed there to be little, if any, difference in detailing, trim attachment, or fastener type/spacing whether the lath is glass fiber or metal.



Figure 3 Providence RI Field Trial



Figure 4 Frenchtown NJ Field Trial

BASF Wall Systems began marketing glass fiber lath in early 2005 and as noted previously offers it for use with one coat stucco under the name PermaLath. Additionally, the authors are also aware of at least one other company that currently markets glass fiber lath products for use in stucco applications. The glass fiber lath products are being used in all types of applications ranging from small residential to large commercial both in the United States as well as other parts of the world. Additionally, interest has been expressed to use the patent pending glass fiber lath technology in other applications such as tile, concrete countertops, as well as other applications which historically have used metal plaster bases. The products continue to gain acceptance in stucco systems mainly as a result of ease of handling, lightweight rolls, labor

savings which has ranged up to 50% on some projects, inherent resistance to corrosion, and ability to handle safely since the product does not contain sharp edges, as is typical of metal products.

PRODUCT DEVELOPMENT....PHASE 2

Following the introduction of PermaLath, there became market interest for a non-metallic plaster base or lath that could be used in traditional Exterior Portland Cement Plaster (Stucco) as well as for masonry stone veneer applications which include products such as Cultured Stone, etc. As a result, product development commenced with the objective to develop a non-metallic plaster base, similar to PermaLath that would be suitable for such applications. The result was development and introduction in of a product referred to as PermaLath 1000. Although PermaLath and PermaLath 1000 are based on the same concepts and are similar in appearance, PermaLath 1000 has a higher tensile strength and higher bending strength or rigidity to suit the demands of applications such as 3/4 inch thick Exterior Portland Cement Plaster and masonry stone veneer. Additionally, the higher rigidity enables it to be used with one coat stucco applications over asphalt water resistive barriers. PermaLath 1000 provides sufficient embedment and keying properties in the thicker base coats to meet the standard furring requirement of 1/4 inch set forth in ASTM C 1063⁹ which is also referenced in the International Building and Residential Codes.

BUILDING CODES AND STANDARDS DEVELOPMENT

Building Codes

The International Code Council Evaluation Services (ICC-ES) is a United States based organization that amongst it services, provides technical evaluations of building products, components, methods, and materials to be able to show code compliance code compliance. Since standards and building codes in the United States were developed around the use of metal plaster bases, ICC-ES was contacted to determine the tests and other criteria needed to enable recognition of glass fiber lath as a code acceptable alternative to metal plaster bases. As a result of various meetings with ICC-ES as well as public hearings to consider proposed criteria/guidelines for this technology, Acceptance Criteria for Glass Fiber Lath used in Cementitious Exterior Wall Coatings or Exterior Cement Plaster (Stucco) was initially issued in December 2004, modified in June 2006 and again in June 2007. This document, which is also referred to by ICC-ES as AC 275⁵, provides the Acceptance Criteria that Glass Fiber Lath products must meet to demonstrate compliance with the International Building as well as Residential Code requirements as an alternative to metal plaster bases used in One Coat Stucco, Exterior Portland Cement Plaster (Three Coat Stucco) as well as Masonry or Precast Stone Veneer products which are governed by ICC ES Acceptance Criteria referred to as AC 51⁷. The Glass Fiber lath acceptance criteria primarily consists of minimum test and performance criteria such as tensile strength, structural loads (transverse and racking), attachment, vertical load, fire, etc. however it also contains requirements such as minimum embedment of the lath which is essentially 3 mm (1/8 inch) for One Coat Stucco Systems and 6 mm (1/4 inch) for Traditional or Three Coat Stucco Systems. Both PermaLath and PermaLath 1000 have been tested per the requirements of AC 275 and are currently recognized in ICC ES Evaluation reports.

Standards Development

ASTM International

This is one of the largest voluntary standards development organizations in the world. Within ASTM are numerous committees, subcommittees and Task Groups that develop standards for a wide range of products. C11 is the committee related to Gypsum and Related Building Materials and Systems while C11.02 is the subcommittee responsible for Specifications and Test Methods for Accessories and Related Products. Within C11.02 is a Task group responsible to develop standards for non-metallic plaster bases which include glass fiber lath products. This Task Group has been working for several years on the development of standard specifications, test methods and installation of non-metallic lath. Several drafts of these documents have been developed with the latest being balloted at the C11.02 subcommittee. Results of the ballots will be reviewed at upcoming ASTM meetings. Upon completion, the standards are expected to provide a means for design professionals to specify the products, serve as an installation guide as well as provide minimum performance criteria

PERFORMANCE

University of Florida Research Program¹⁰

Numerous challenges can be expected when a new technology is introduced as an alternative to long accepted products and practices. Amongst the challenges that might be expected are validations of features/benefits, overcoming perceptions, changing norms, as well as market acceptance of a new, innovative technology. To help overcome possible challenges to Glass Fiber lath technology, a contract was entered into with the University of Florida Building Construction Department in Gainesville, FL to independently research the use and performance of Glass Fiber Lath in Stucco. The program is intended to provide a comparison of various properties of BASF Wall Systems PermaLath and PermaLath 1000 Glass Fiber Lath to typical metal plaster bases used in Stucco. The tests incorporated various sample configurations that differed with respect to Stucco type (One Coat and Traditional), plaster bases (various weights and configurations of metal and two types of Glass Fiber lath) as well as weather resistive barriers (polymeric and traditional building or 'black' paper). Specific objectives of the program included determining if there is quantifiably more/enhanced crack resistance with stucco reinforced with Glass Fiber Lath rather than metal plaster bases, review minimum material properties (tensile strength, etc.) needed for use in Stucco, relative impact testing, as well as review the alkali resistance of Glass Fiber Lath reinforcement in Stucco. Means to accomplish these objectives were as follows:

- Literature review of past and present practices related to the use of glass fiber materials in cementitious materials such as concrete, mortars, etc.;
- Alkali resistance using current industry standard tests as well as newly developed methodology;
- Finite Element Analysis modeling that plots effective stress versus applied pressure;
- Mechanical and environmental testing such as impact strength, flexural bending, tensile strength, and plastic shrinkage, using ASTM Standards and other tests that are either published or have been developed specifically to address Glass Fiber Lath materials.

Below is a summary of key findings as a result of the research:

Impact

Impact is one of several tests used to determine the effect, if any, of different types of plaster bases on mechanical properties of One Coat as well as Traditional, Three Coat Stucco. For the One Coat Stucco samples, plaster bases tested included 17 gauge metal stucco netting, 20 gauge metal stucco netting, 2.5 lb expanded metal lath, PermaLath and PermaLath 1000 Glass Fiber Lath by BASF Wall Systems Inc. For the Three Coat Stucco samples, plaster bases tested included 17 gauge metal stucco netting, 2.5 lb expanded metal lath, 3.4 lb expanded metal lath and PermaLath 1000 Glass Fiber Lath by BASF Wall Systems Inc. None of the samples contained backing or sheathing so as to eliminate possible contribution of the substrate. The laboratory test set up as shown in Figure 5, consisted of securing a stucco sample to a steel channel and subjecting the sample to one drop of a Humboldt 4.5 kg (10 lbs) drop hammer such as described in ASTM D 1557. The impact test loads used were 18 J (160 inch lbs) for the One Coat Stucco and 36 J (320 inch lbs) for the Three Coat Stucco samples. Although other loads could have been chosen, the 18 J (160 inch lbs) was deemed reasonable since it is an impact load imposed on Exterior Insulation and Finish Systems (EIFS) and there are not any standard impact tests for stucco.



Figure 5 Impact test set up

After the each sample was subjected to the impact device, a visual inspection was conducted to determine crack patterns, deformation/indentation, and if broken lath was evident. Photographic results of the tests are shown for the One Coat Stucco in Figure 6 and 7 for the Three Coat Stucco sample. For the One Coat Stucco samples, the specimen with PermaLath, which is a lighter and thinner Glass Fiber Lath than PermaLath 1000, visually appeared to have the least amount of cracking and indentation of all the samples. The authors attribute the results to the design of the lath including the choice of glass fiber lath which is more flexible and ductile than metal plaster bases and tends not to take a permanent set. For the Three Coat Stucco, the samples appeared pretty much the same visually which is attributed to the thickness of the stucco which, in and of itself, is able to withstand much of the impact load.

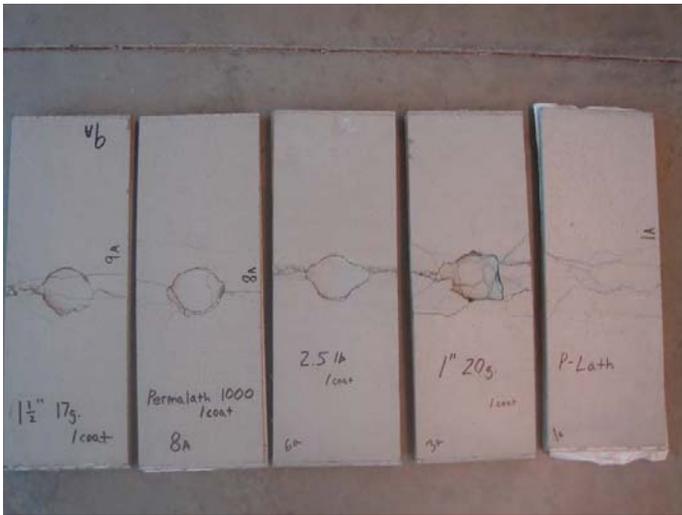


Figure 6 One Coat Stucco - post impact testing
 Plaster bases (left to right): 17 ga metal wire, PermaLath 1000, 2.5 lb expanded metal lath, 20 gauge metal wire, and PermaLath

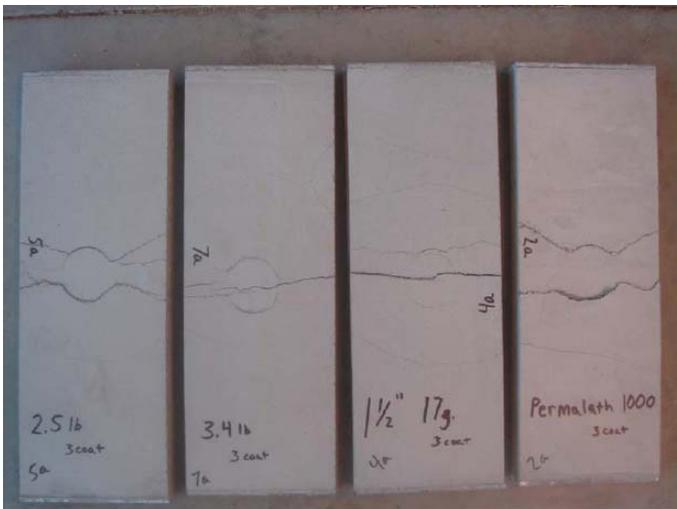


Figure 7 Three Coat Stucco - post impact testing
 Plaster bases (left to right): 2.5 lb expanded metal lath, 3.4 lb expanded metal lath, 17 ga metal wire, and PermaLath 1000

Plastic Shrinkage

The objective was to compare the crack propensity, based on visual observations, of One Coat Stucco when used with various plaster bases including 17 gauge wire, 20 gauge wire, 2.5 lb metal lath, PermaLath and PermaLath 1000. All samples were fabricated at the same time under ambient conditions using the same stucco mix. The completed wet stucco samples were placed in a hot box with 120 degree F /65% relative humidity (see Figure 8) and subjected to fans blowing hot air across the samples for a 24 hour period. The conditioning was intended to represent conditions that stucco might be subjected too immediately post application. After the conditioning period, plastic shrinkage cracks in the stucco were observed only in the samples

using 17 and 20 gauge wire which, in the authors' opinion, can be attributed to one or more conditions such as adhesion of the stucco to the plaster base, geometry of the plaster base and or size of the plaster base openings.



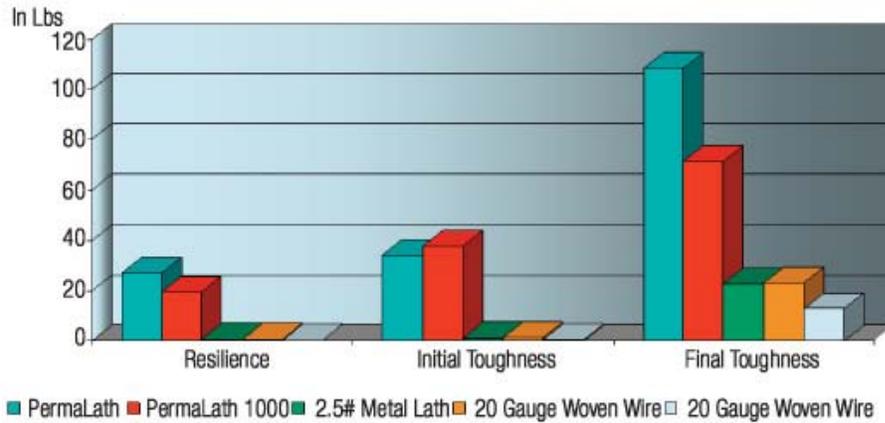
Figure 8 Hot box setup

Flexural

The objective of flexural testing was to compare the resilience, initial toughness and final toughness of One Coat Stucco when used with various plaster bases including 17 gauge wire, 20 gauge wire, 2.5 lb metal lath, PermaLath and PermaLath 1000 and Three Coat Stucco when used with 17 gauge wire, 2.5 lb metal lath, 3.4 lb metal lath, and PermaLath 1000. All samples were fabricated at the same time under ambient conditions using the same stucco mixes.

An Instron testing machine was used to test the samples in three-point (flexural) loading according to American Association of State Highway and Transportation Officials (AASHTO) test method T97-03. The graphs below reflect measured area under the load vs. deflection curves. The higher values exhibited by the PermaLath and PermaLath 1000 samples represent the best performance in terms of resiliency the property of a material that enables it to return to its original shape - and toughness is the property which involves determining a material's ductility and strength.

One Coat Stucco



Three Coat Stucco

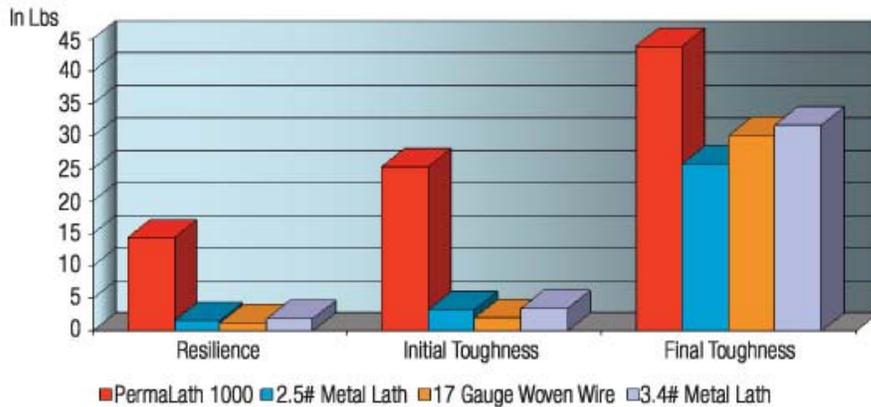


Figure 9:

Resilience: start of the test to the elastic limit (peak load at first crack).

Initial Toughness: elastic limit to the lower yield point.

Final Toughness: elastic limit to the breaking point at which the sample fails.

Finite Element

A Finite Element Analysis model was created using the ADINA* software program to determine effective stresses based on an applied load to the one-coat stucco with plaster bases that included PermaLath, PermaLath 1000, 2.5 lb metal lath and 20 gauge wire as well as three coat stucco that included PermaLath 1000, 3.4 lb lath, 2.5 lb lath as well as 17 gauge wire. (*Adina R & D, Inc., 71 Elton Road, Watertown, MA; www.adina.com). All samples used the same mix types were fabricated and cured under the same ambient conditions.

The finite element model applied various pressures across the top middle surface of the simply supported samples. Figure 9 provide the effective stress (sum of all principal stresses in x, y, and z directions) in One Coat Stucco Systems. As shown in the figures, One Coat Stucco specimens with PermaLath and PermaLath 1000 handle more applied pressure with lower effective stress prior to reaching the stucco specimen tensile strength capacity than those with 2.5 lb lath or 20

gauge wire. For three Coat Stucco, specimens with PermaLath 1000 handle more applied pressure with lower effective stress prior to reaching the stucco specimen tensile strength capacity than those with 2.5 lb lath, 3.4 lb lath or 20 gauge wire.

CONCLUSIONS

Although metal has been the most commonly used material to produce plaster bases or lath for many years, recent technology has resulted in the development and introduction of non-metallic lath fabricated from glass fibers. Glass Fiber Lath, as it's commonly known, has been shown through tests, applications and research to be viable alternative to traditional metal plaster bases. Additionally, since the material is non-metallic, it provides added benefits such as no possibility of corrosion as well as ease and relative safety during handling as well as installation.

REFERENCES

1. Portland Cement Plaster/Stucco Manual (Fifth Edition)
John M. Melander, James A. Farney, Albert W. Isberner, Jr.
Portland Cement Association
5420 Old Orchard Road
Skokie, IL 60077
 2. The Metal Lath Handbook (First Edition)
Gary J Maylon
Metal Lath Consulting Co., LLC
P.O. Box 285
Trussville, AL 35173
 3. International Building Code (IBC)
 4. International Residential Code (IRC)
- ICC Evaluation Service Inc.:
5. Acceptance Criteria for Glass Fiber lath used in Cementitious Exterior Wall Coatings or Exterior Cement Plaster (Stucco) AC 275 approved June 2007
 6. Acceptance Criteria for Cementitious Exterior Wall Coatings AC 11 approved June 2007
 7. Acceptance Criteria for Precast Stone Veneer AC 51 approved February 2008
- ASTM International:
8. C 926-06 Standard Specification for Application of Portland Cement-Based Plaster
 9. C 1063-08 Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster

10. Comparison of PermaLath Reinforcement to Metallic Lath Reinforcement in Stucco Cladding Systems

A Thesis presented to the Graduate School of the University of Florida in Partial Fulfillment of the requirements for the degree of Master of Science in Building Construction, 2006

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