NEW TILE INSTALLATION TECHNOLOGY TRANSITION IN MATERIALS AND METHODS

by Joe Tarver

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Joe A. Tarver, has served as Executive Director of the National Tile Contractors Association since 1972. He has been closely associated with the tile industry in the United States for the past thirty six years, and was instrumental in the development of an internationally recognized workshop program for tile contractors.

On behalf of NTCA, he worked diligently with representatives from ASCER, Assopiastrelle, Ceramic Tile Distributors Association (CTDA), and Tile Council of America (TCA) to unite the five organizations in the formation of the International Tile & Stone Exposition. Now preparing for its 5th annual show, ITSE is the largest industry exposition in North America. Mr. Tarver is currently the Secretariat of the ITSE Board of Governors; he served as its 1991 Vice Chairman, and was the Board's Chairman in 1992.

A frequently sought out speaker for industry and allied programs, Mr. Tarver is also the author of numerous tile oriented articles in national trade publications. Under his guidance, the NTCA has grown from a small regional contractors' association into a national entity with world wide ties.

Slide 1

New Tile Installation Technology A Transition In Materials And Methods.

To fully understand the contents of my presentation, we must recognize that the conventional mortar bed is still the predominant method of tile installation in Europe. In the United States, many many different methods of installation and installation products are used. As a matter of fact, over 95% of the tile installed in the United States today is in «thin bed».

Slide 2

Therefore, it is necessary today that we discuss mud set, thinset and everything in between.

Slide 3

Since mud set is the first part of the evolutionary process taking place in our industry we will discuss it first.

Slide 4

What exactly is mud set (mud bed, thick bed)¨?

Slide 5

Mud set is the original method used to install ceramic tile. This method dates back centuries in Europe and the United States, however, as I mentioned before, it is used only for about 5% of the tile installations in the United States today.

Slide 6

This method involves floating a bed of portland cement mud to a thickness of 1 1/4" to 2" for floors and 3/8" to 3/4" for walls.

What does this portland cement mud consist of?

Slide 7

The cement mud mixture for floors consists of five parts sand (ASTM C 144) and one part cement (ASTM C 150). Mix with water to a consistency like wet sand. The mixture requires only enough water to stay together when squeezed by hand. To make this mudmixture much stronger, mix with a latex liquid instead of water.The SBR (Styrene Butadiene Rubber) type works well for this mixture. We will discuss other types of latex later.

Slide 8

The cement mud mixture for walls consists of seven parts sand (ASTM C 144), one part cement (ASTM C 150) and one part lime (ASTM C 206). Water or latex can be used for mixing. A mineral called pearlite is sometimes used to provide a lighter mixture which is easier to float, however, the addition of pearlite substantially reduces the compressive strength of the mortar bed. Cement must have water to properly hydrate (cure), but too much water is cement's greatest enemy. The hydration process is dependent on evaporation. The wetter the mixture, the more water that must eventually evaporate. When the water leaves, what takes its place? Air, and there is no strength in air.

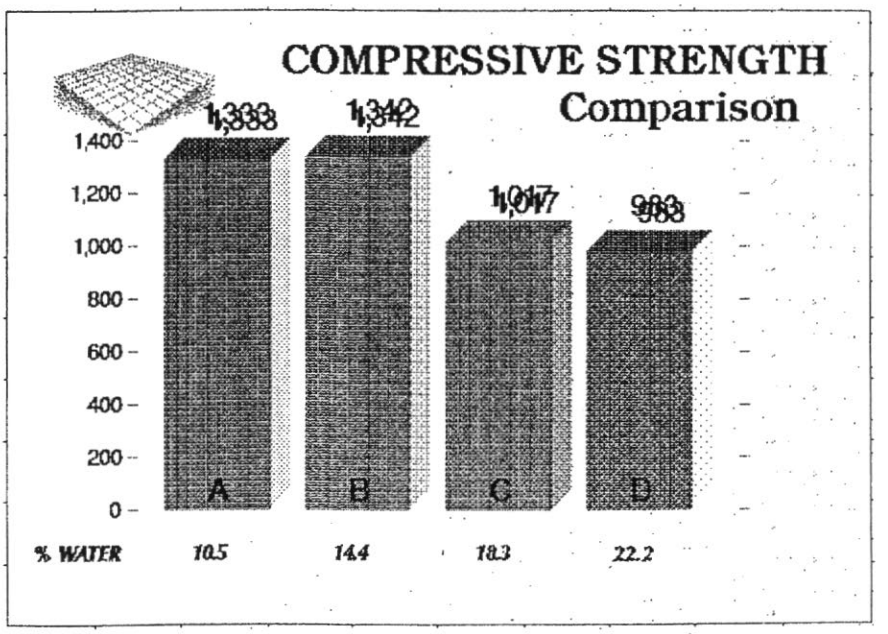
Slide 9

Comparisons of floor mud mixed with different amounts of water were done to show the decrease in compressive strength as the amount of water is increased. One mixture was extremely dry almost to the point that it was not workable one was mixed very wet and two were mixed with percentages of water in between.

10.5% or 1.3 gallons to 100 1bs. of mortar mix.
14.4% or 1.7 gallons to 100 1bs. of mortar mix.
18.3% or 2.2 gallons to 100 1bs. of mortar mix.
22.2% or 2.7 gallons to 100 1bs. of mortar mix.

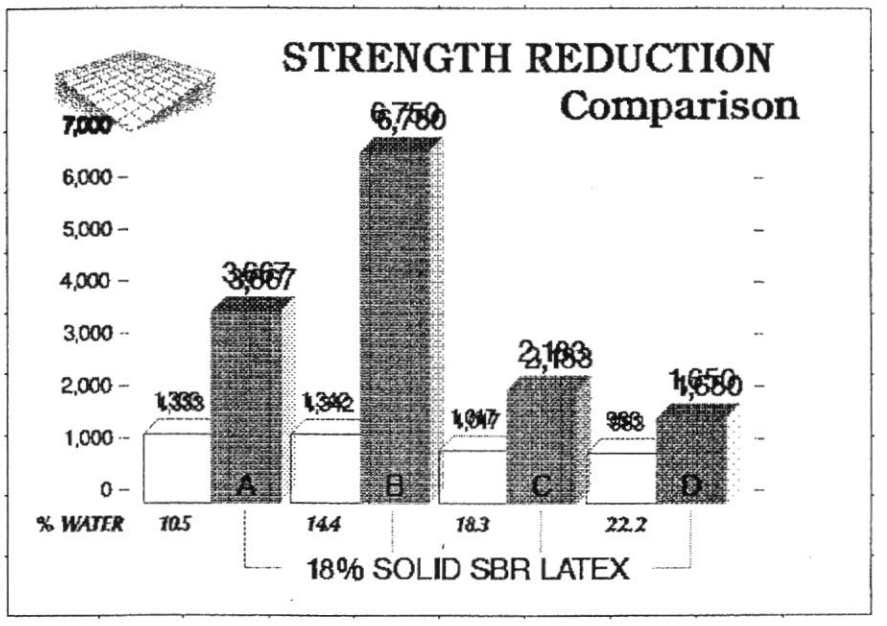
The strength reduction is rather dramatic.

The same procedure was used substituting an 18% solids SBR latex.



Slide 10

The reduction in strength shows a similar trend, however, the latex modified mix is much much stronger. In fact, the latex modified mud is 20% stronger than the strongest mud mixed with water. The optimum amount of liquid, be it water or latex, appears to be 14.4% or approximately 1.7 gallons of liquid per 100 1bs. of powder.



Slide 11

The Tile Council of America Handbook illustrates certain methods for tile installation which require reinforcement for mud beds.

Slide 12

When is reinforcing necessary?

Slide 13

1. Reinforcing is necessary when a mud bed is installed over any kind of membrane. This can be a waterproofing membrane if needed, or simply a cleavage membrane to isolate the tile installation from substrate movement, cracking, bending or deflecting.

Slide 14

2. Reinforcing is necessary on walls where you have wood or metal studs.

TYPES OF REINFORCING

Slide 15

The reinforcing used on floors is no larger than 2" x 2" and no smaller than 16 gauge wire mesh.

Slide 16

And for walls is an expanded metal lath. The lath should be galvanized and electrically welded to avoid rust.Now that the bed(s) are in place, you are ready to install tile.

Slide 17

The installation can be accomplished in two ways.

Slide 18

1. Wet Set Method Install the tile with neat cement neat meaning dry cement not mixed with anything. This method requires the tile to be soaked for 24 hours. Sprinkle the mud bed with the cement (white cement is better so you can see where you have sprinkled it on a gray mud bed). Set the wet tile and beat in. This can only be done while the mortar bed is still plastic (workable).

Slide 19

2. Thin Set Method
Set the tile with a dry set or thin set mortar. The U.S. ANSI requirements state: «...20 hours of cure of the mud is adequate but 10 days is desirable before applying the dry set mortar.

Slide 20

ADVANTAGES OF USING A MUD SET TYPE INSTALLATION:

Slide 21

1. Leveling the floor to proper or required tolerances and to slope the floor if a drain is required.

Slide 22

2. With a cleavage membrane underneath, this system will provide stress crack protection.

Slide 23

3. Good method to install small mosaic tile on the floor. When using the wet set method, you can level the tile and get evenly spaced grout joints with just enough mortar between the joints to provide a mechanical key.

Slide 24

4. For slab below grade, a waterproof membrane under a mud bed will tend to eliminate hydrostatic pressure problems.

Slide 25

5. It is not so much an advantage as it is a necessity, since it is the only approved method to install ceramic tile on a structural floor which is subject to bending and deflecting and particularly over prestressed or postformed concrete slabs.

Slide 26

Prestressed or postformed concrete slabs are designed and engineered with a built in convexity,

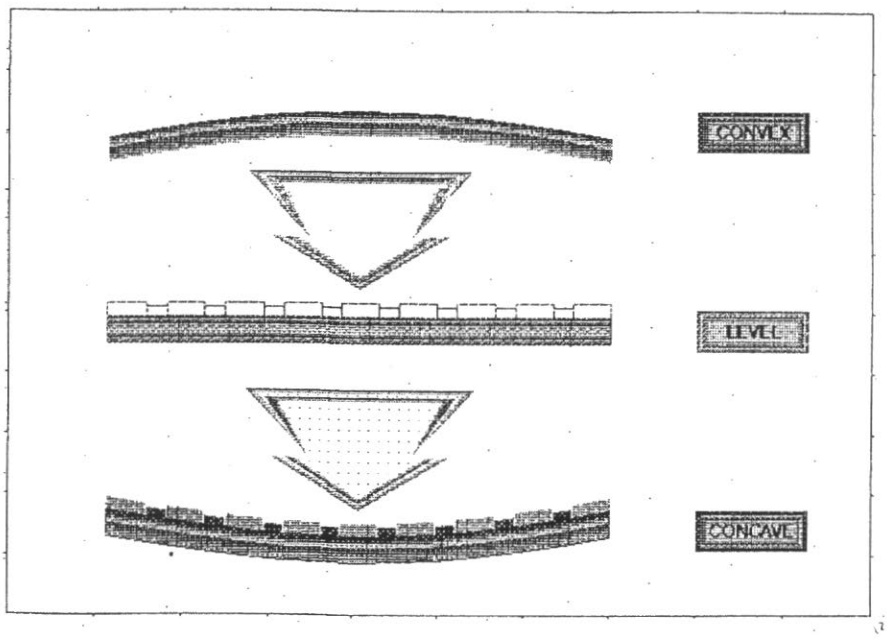
Slide 27

supposedly to allow the slab to return to level under the live and dead loads (people and furnishings).

Slide 28

Most often they pass level and become concave. None of the thin™ set methods available today can withstand that kind of movement.

This is a major problem for the U.S. tile industry and the Tile Council of America is completing a study to find thin set products and methods which will work under these conditions. This effort was funded by interested parties, including Assopiastrelle and ASCER.



Slide 29

DISADVANTAGES OF THE MUD SET METHOD:

Slide 30

1. The 1 1/4" to 2" that is needed to build up for the mud bed.

Many of the prestressed and postformed slabs are not much thicker than that.

Slide 31

2. Heavy a one inch thick mortar bed weighs 12 1bs. per square foot. (Example:A 10'x 10'room with 1 1/4" 1500 1bs.)

Slide 32

3. Labor Intensive It costs much more to screed a mortar bed than to spread a thin set bonding material and immediately set tile.

Slide 33

4. Time Required Soaking the tile for 24 hours or allowing 20 hours for the mud bed to set before using a dry set mortar requires a two day minimum.The disadvantages of the conventional mortar bed, plus the loss of experienced craftsmen, rising costs of tile, installation materials and labor are some of the things that provided the incentive to develop and improve thin bed methods.

Slide 34

Or Thin Set.

Slide 35

What exactly is thin set?

Slide 36

The term «thin set» is used to describe the method of installing tile with a bonding material which will provide a final thickness between the tile and substrate of 1/32" to 3/32" after proper twist, beat in or vibration of the tile. The thin set method of tile installation emerged during the early 1950's. Its success was due in part to the diligent efforts of the Tile Council of America. Their search for innovative new bonding and grouting materials to simplify tile setting practices without compromising the performance and dependability of the installation led to an era of chemical dependency. Chemicals such as methocel, a water retention agent, were introduced into the mortars and grouts to retain the water necessary for the hydration of the cement when setting unsoaked tiles. These new products were referred to as dry set mortars and dry set grouts, simply because the tiles did not have to be soaked and the mortar bed or substrate did not have to be wet for them to perform. The terms dry set and thin set are used interchangeably. It is well to remember, however, that thin set is a method and dryset is a product. Once the thin set method was proven successful, a steady stream of new thin set bonding and grouting materials began to emerge.

Slide 37

Some of those products are:

Dry set mortars (thin set mortars)

Latex portland cement mortars

Organic adhesives

Epoxies

Furans and Furnans

All of these products evolved as a result of new technologies developed within the chemical industry. There is currently a strong emphasis to continue developing new and better things to benefit the tile industry.

Slide 38

Dry set mortars are designed to bond tile to a clean concrete slab. For good adhesion to take place the slab must be fully cured and have a fine broom finish. Suitable for slab on grade only, the slab must be clean and not contaminated with sealers or curing compounds. A quick test to determine if a slab has been treated is to drop water in several areas. If the water soaks in immediately, it is more than likely untreated. If the water puddles, further preparation such as sand blasting, shot blasting, or some other method of scarifying will be necessary before tile is installed. Even though dry set mortars were formulated for use over cementitious substrates, they are widely used over drywall and wood.

APPLICATION:

Mix the dry set mortar with water and allow it to slake (sit) for five to ten minutes, then remix. Slaking is important since it allows the chemicals in the mortar to wet out (dissolve) and become active. You do not get the full benefit of these chemicals if you mix and use immediately. Select the proper notched trowel and key the mortar into the substrate with its flat side; then comb with the notched side. Our industry is the only construction industry to use notched trowels for the specific purpose of applying a predetermined gauged amount of bonding material to our substrates. For example: it is natural human tendency to hold a trowel at a 45 degree angle. If you are using a 1/4" x 1/4 x 1/4" at a 45 degree angle, you are applying 1/8" of material to the substrate. After proper twist, beat in or vibration of the tile, you should have 1/16" of bonding material between the tile and substrate. This is slightly less than our ANSI specifications call for, however, it is sufficient to provide a serviceable application. The same 1/4" trowel should be used to install 1/4" thick ceramic mosaics. This will allow some mortar to squeeze into the joints providing a mechanical key. Mosaics are impervious and very difficult to bond.

Slide 39

LATEX PORTLAND CEMENT MORTAR (ANSI A118.4)

This nothing more than a dryset mortar with the addition of a liquid or dry latex.

Slide 40

Addition of latex provides:

Added strength

Added flexibility

Better adhesion (suitable now for applications other than concrete and drywall substrates)

Added freeze thaw properties

Many areas of the U.S.have severe freeze thaw cycles; which means the products are contracting when cold and expanding when hot. This continuous cycle is less likely to break down a latex modified product than one without latex.

Slide 41

Some of the common latex products that are used in our industry to modify a dry set mortar are:

LIQUID (latex)

Acrylics

SBR (Styrene Butadiene Rubber)

PVA (Polyvinyl Acetate)

Slide 42

DRY POWDERS (polymers)

(Latex is defined as «a milky liquid» consequently powders are now commonly referred to as polymers.)

EVA (Ethylene Vinyl Acetate)

Acrylic

The evolution of latex products has been almost as drastic as the move from thick bed to thin bed installations.

Slide 43

Let's take a look at the evolution and progression of these almost miracle products.

Slide 44

PVA They have good adhesion and flexibility but poor water resistance.

Slide 45

SBR They have good adhesion, flexibility and water resistance, but poor color retention.

Slide 46

ACRYLICS They have better adhesion, strength and color retention, but less flexibility.

Slide 47

EVA Virtually the same properties as acrylics except in powder form. The powdered polymers are added to the mortar at the factory, reducing the probability of improper mixing in the field. This gives us our best opportunity for the finished product to meet all industry specifications.

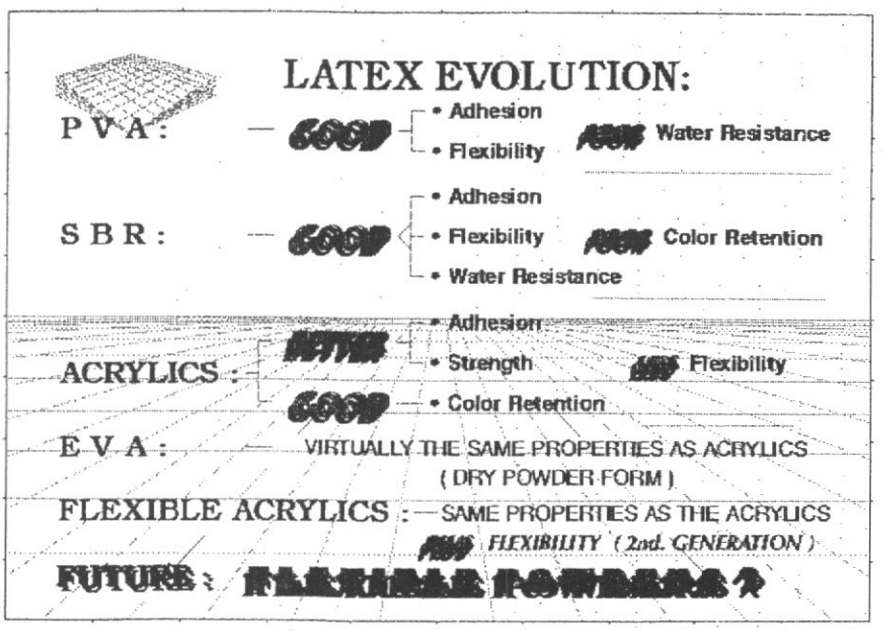
Slide 48

FLEXIBLE ACRYLICS - Same properties as the acrylics, plus flexibility

Slide 49

FOR THE FUTURE Continued quest for flexible dry powders.

The quality of the latex modified mortar is dependent on how much latex actually gets into the mortar. As we have seen, specific types of latex have advantages and/or disadvantages. Liquid latex is a polymer mixed with water. The higher the percentage of polymer or percent of solids, the higher the quality of the mix. The higher quantity of dry polymer in the mortar dictates the quality of the final product. The jury is still out on which of the two is better (the liquid latex or the dry polymer). The technology of the powders has evolved to the point that when used properly, they should be equal to the quality of the liquids.

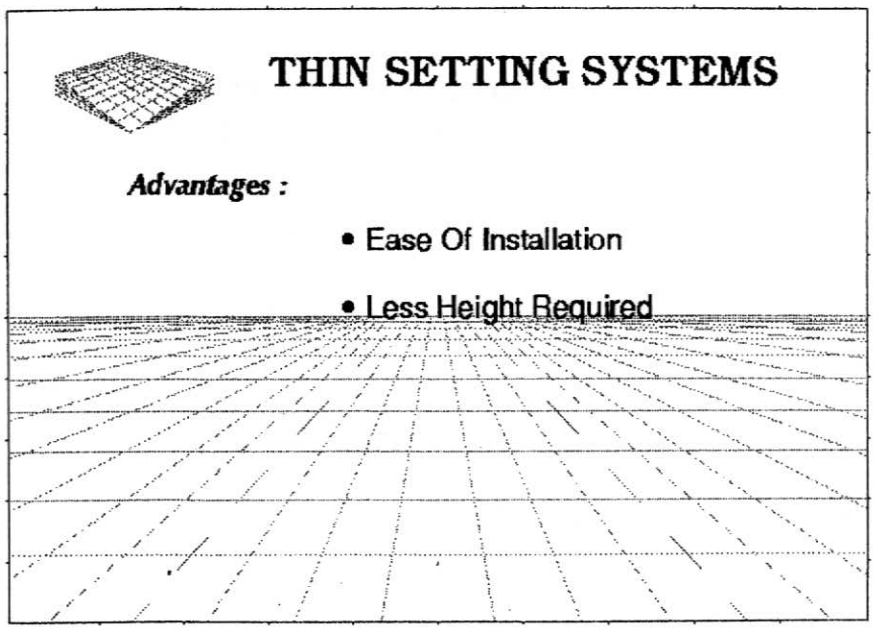


Slide 50

Three types of latex portland cement mortar were used to achieve the comparative shear bond strengths to mosaics and quarry tile. 1. Contains 5% solids of dry polymer 2. Contains 8% solids of acrylic latex 3. Contains 6% solids of SBR polymerA 28 day shear bond strength test was conducted with some surprising results. The powdered polymer, with a lower percentage of solids, had a higher adhesion to mosaic tile (the most difficult to bond) than the liquid with a higher percentage of solids, did to the quarry tile.

Slide 51

Compressive strength comparisons were also done and the liquids performed a little better than the powders, especially the SBR.



Slide 52

Organic adhesives are another thin setting material (ANSI A.136.1). These products are ready to use directly out of the bucket and offer convenience in application. They require no mixing and provide good trowelability and flexibility.

The cost of organic adhesives is about double that of latex portland cement, however, time and labor savings offset most of that difference.

Since they don't hold up well when continuously exposed to moisture and are not recommended in areas where the temperature exceeds 140 degrees, they are limited to interior use only. They have a tendency to oxidize and become brittle over a long period of time and temperature accelerates this oxidation process.

Specifications require that organic adhesives have at least 1/32" of material between the tile and substrate after proper twist, vibration or beat in. They are not designed to nor should they be applied thicker than the 1/32". Thicker applications will not dry properly and their flexibility allows sufficient movement to crack grout and/or tiles.

ANSI standards require a 24 hour waiting period or manufacturer's recommendations, before grouting tile set with organic adhesives. Rarely does that happen. The tile is grouted too quickly, the adhesive does not cure properly, causing a number of problems from tile movement to discoloration. Manufacturers are formulating new products to combat these problems.

Slide 53

EPOXIES (100% solids) (ANSI A118.3)

Slide 54

There are two essential parts to 100% solids epoxies an epoxy resin and an epoxy hardener. When mixed together, they react chemically to produce a plastic type material. They cure chemically and the 100% solids simply means that they do not contain any water or solvents. There is nothing to evaporate, consequently, there is no shrinkage. There is no cement in epoxies, since there is no water that cement requires for hydration. Epoxies are highly acid resistant since acids do not normally affect plastic.

100% solids epoxies work well on nonabsorptive surfaces such as plastic laminates, vinyl floors and tile over tile. Water based bonding materials, when used over nonabsorptive substrates dry much slower since the water must evaporate through the grout joints. The chemical curing of epoxies is not affected by nonporous products nor substrates.

The coverage is the same as latex portland cement, or 3/32" between tile and substrate after proper twist, vibration or beat in.

They produce extremely high bond strength, compressive strength and impact resistance. Since the epoxy is almost always stronger than the tile, shear strengths cannot be run.

Slide 55

What are the advantages of thin setting systems?

Slide 56

1. Ease of installation. Simply trowel on the material and se the tile.

Slide 57

2. Less height or depth of setting bed required. This reduces the potential 2" mortar bed to 3/32" of thin set material.

Slide 58

3. Convenience no lathing, scratching or screed strips.

Slide 59

4. Less total weight of the installation. Remember that a 1" mortar bed weighs 13 1bs. per square foot.

Slide 60

NOW LET US LOOK AT EVERYTHING BETWEEN MUD AND THIN SET.

1. Cementitious backer units.
2. Medium bed mortars.
3. Crack isolation systems.
4. Sound reduction systems.

Slide 61

CEMENTITIOUS BACKER UNITS (ANSI A118.9)

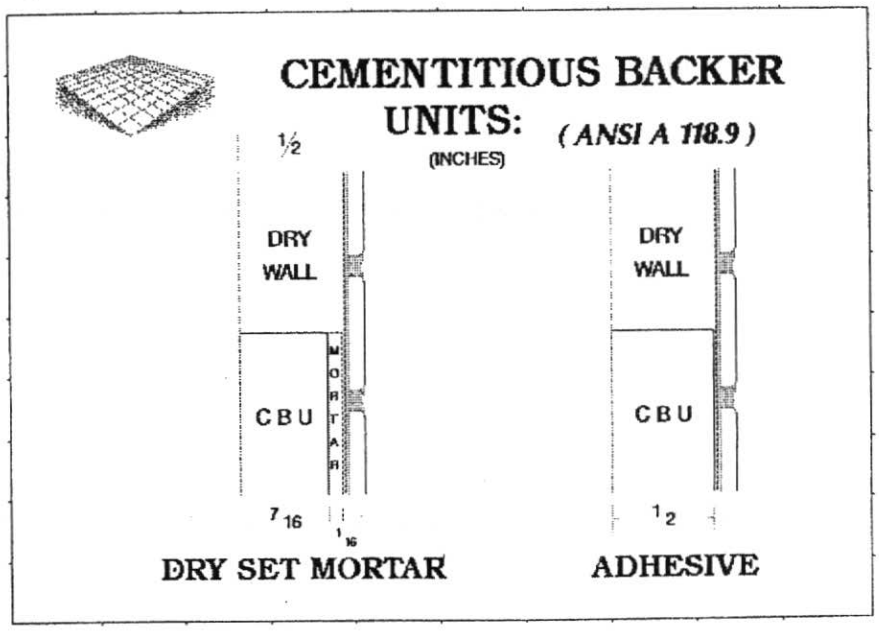
Cementitious backer units (CBU's) were invented and developed to provide a substrate which will not deteriorate in wet areas, without the labor intensive conventional mortar bed method. The first CBU was a concrete core prestressed by two opposing sheets of fiberglass mesh on either side of the board. Many types have since come into the marketplace and they have a wide variety of uses.

Slide 62

Originally, the CBU's were manufactured in two thicknesses (7/16" and 1/2") to accommodate mortar and adhesive installations. The combined thicknesses of the mortar and/or adhesive and the CBU's matches drywall that is normally above or adjacent to the tile installation.

For example: 7/16" board and 3/32" mortar = 1/2" drywall
1/2" board and 1/32" adhesive = 1/2" drywall

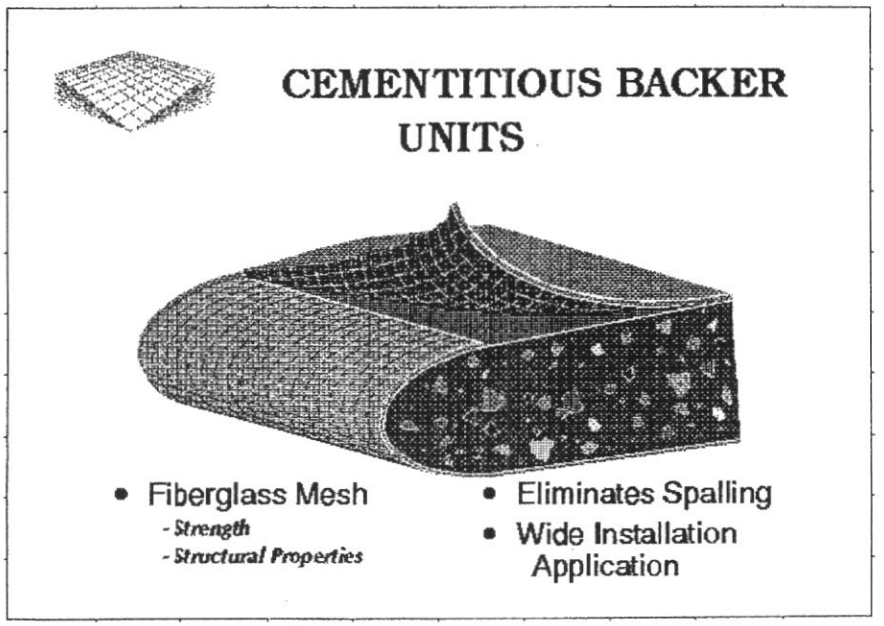
CBU's have reduced the thickness of cement substrate from 1 1/4" to 1/2". Virtually every board manufacturer is producing 1/4" board today for vertical and horizontal applications.



Slide 63

Cementitious backer units are comprised of a cement core with opposing sheets of fiberglass mesh on either side. The glass mesh provides the strength for the board except for compressive strength. Wrapped edges allow nailing or screwing close to the edge without spalling.

Cementitious backer units can be used in applications where conventional mortar beds are used with the exception of areas that must be leveled or sloped. For example a shower floor that must have a slope to drain.



Slide 64

CEMENTITIOUS BACKER UNITS VS. MUD SET

Are there advantages? YES

Slide 65

1. Less labor and time to install. Using the proper fasteners you simply nail or screw the board like drywall or plywood.

Slide 66

2. Nothing to mix.

Slide 67

3. Smooth surface to receive ceramic tile.

Slide 68

4. Provides a thinner substrate.

Slide 69

5. Less weight per square foot.

Mortar 6 lbs. per square foot at 1/2" thickness

Board 3 lbs. per square foot

Slide 70

Are there any disadvantages? YES

Slide 71

1. The price of material is higher, however, the labor cost should offset most of the difference.

Slide 72

2. You cannot level with cementitious backer units.

Slide 73

MEDIUM BED MORTARS

This product was developed for a thicker application of mortar to allow some adjustment and to limit, if not eliminate, backbuttering of large tiles.

Why are medium bed mortars needed?

Slide 74

The trend toward larger and thinner tiles, most of which are vitreous or impervious. Tiles that do not absorb are much more difficult to bond and the larger the tile the more difficult it is to «bed» it in a thin set application without voids in the mortar. When these voids appear between the mortar and the tile, particularly near the corners and edges, the tiles are more susceptible to cracking and breaking from nonsupport.

Slide 75

Formulation of these products allows a heavier application, with a 19/32" half moon trowel. Here you see a 19/32" half moon and a conventional 14" square notched trowel. Proper twist, vibration or beat in using the medium bed mortar and the larger trowel will provide your best opportunity to get near 100% mortar coverage. Manufacturers specify the thickness obtainable with their medium bed mortars between the tile and substrate, however, it must meet the minimum specifications of 3/32".

Slide 76

PICTORIAL DEMONSTRATION OF MEDIUM BED MORTAR:

after mixing water or latex and allowing to slake

Slide 77

The mortar is keyed into the substrate with the flat side of the trowel.

Slide 78

Then mortar is combed with the 19/32" trowel.

Slide 79

Set the tile with a twisting and/or sliding motion or use some type of vibrator. Placing and beating in the tile is not an effective way to eliminate voids and give 100% coverage.

Slide 80

Beating in at this point will assure level installation with a minimum of lippage.

Slide 81

This illustrates the desired 100% coverage.

Slide 82

The same procedures were followed except a 1/4" notched trowel was used. This slide illustrates the results.

Slide 83

A comparison coverage obtained with the 1/4" trowel will not meet minimum U.S.ANSI specifications.

Slide 84

Advantages of Medium Bed Mortar

Slide 85

1. Possibility of achieving 100% coverage under large tiles without backbuttering - labor savings.

Slide 86

2. Makes it possible to overcome some irregularities in substrate and/or thickness of tile.

Slide 87

NOW LET'S TAKE A LOOK AT CRACK ISOLATION SYSTEMS:

These types of products separate and protect the tile from cracks in the substrate. With the thinset method and the quality of concrete substrates, they are becoming more and more popular and necessary for a professional installation.

Slide 88

If a good system is used and installed properly, crack isolation systems can prevent cracks from telegraphing through the tile. This is a relatively new field of products and several association in the U.S. are working to complete a specification for these products concerning how large a crack can be bridged, how soft or flexible the membrane can be, and what tests will be required to make sure these systems work.

Slide 89

Some of the products used for crack isolation are:

. Urethane

. Chlorinated Polyethylene Sheets

. Cork

. Polyvinyl Chloride Sheets

. Elastomeric Mortars

These systems are not designed for use over expansion or control joints.

Slide 90

Crack isolation systems are designed for lateral movement only.

Slide 91

Definitely not for vertical movement.

Slide 92

Some Advantages of Crack Isolation Systems:

Slide 93

1. They protect, if not eliminate, cracked tile when the concrete slab settles and cracks.

Slide 94

2. They can also serve as a waterproofing membrane.

Slide 95

3. They offer the possibility of repairing old cracked tile installations without replacing the entire floor. Cracked tile can be removed, the substrate crack treated with an isolation membrane and new tile installed. This type installation should be done with strict adherence to manufacturer's recommendations.

Slide 96

4. Offers some potential at some point in the future to eliminate control joints or expansion joints in certain installations.

Slide 97

SOUND REDUCTION SYSTEMS:

A very high percentage of commercial construction in the United States is high rise or multilevel. Sound control above the ground level is becoming a major consideration and at some point in time, will be mandated by upgraded building codes. This will involve new construction and renovation of apartments, condos, multifamily housing units and hotels.The systems are basically designed to reduce noise transmission from one level to the lower level.

Slide 98

The typical building code requirements that have been established for sound reduction to date are:

Slide 99

1. STC of 50 is a minimum requirement

STC = Sound Transmission Class or how much noise is created in a space by people and devices such as radios, televisions and appliances.

The STC rating measures how much noise is stopped within a given space. The higher the rating the quieter it is between spaces.

Slide 100

2. Another typical building code requirement is IIC of 50 minimum.

IIC = Impact Insulation Class or, for example, tapping noises.

IIC is also a rating of how much noise is stopped.IIC types of noises are more common and more annoying with hard surface flooring.

Slide 101

Some typical sound reduction systems:

. Cork

. Fiberglass matting

. Low density mortar beds

. Elastomeric mortars

. Sound rated wall and floor methods are detailed in Tile Council of America Handbook

Slide 102

Our greatest asset is Common Sense. A common sense approach to our industry problems, all over the world, will provide professionally installed and aesthetically pleasing tile installations for the consumer.

It is my fondest hope that in the very near future we can celebrate the «quality» of ceramic tile installations. If we can do that the quantity will naturally follow.