Review the Study Guide in preparation for the written test

INTERNATIONAL CFI CERTIFIED FLOORCOVERING INSTALLERS ™

CERAMIC INSTALLATION TRAINING

Presented by the CFI Team of Trainers

and

Sponsored by Flooring Manufacturers

Disclaimer: The International Certified Flooring Installers Association® assumes no liability for the application of the principles or techniques contained in this manual. The information in its entirety was prepared for professionals in the industry to use as guidelines when addressing installation and difficulties that arise concerning the installation of ceramic tile. **The primary source of direction is the individual product manufacturers who reserve the right to provide specific installation instructions, which are to be strictly adhered to by installation professionals.**

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SECTION 1 – TOOLS OF THE TRADE and PROPER USE

In a skilled trade, proper equipment and tools make the difference between the results being acceptable or not acceptable. Owning the right tools and using them correctly makes the job easier, requires less installation time and make the results more predictable. A tile installer's toolbox should include:

LAYOUT TOOLS

- Chalk line – 100 ft
- Measuring tapes – 25-ft and 50-ft
- Carpenter's square – 24" x 16" – one of the most important tools
- Small combination square with an adjustable blade that is usually 1" x 12"
- Levels – 24" and 48"
- One-Man Water level – 3/8" hose with clear ends or self-leveling lasers
- Straightedge – 6ft.
- Sliding 'T-Bevel'
- Various sponges
- Wedges – spacers
- Calculator
- Story pole
- Trammel points

SETTING TOOLS

- Notched trowels – V and Square
- Flat trowel
- Margin trowels – several sizes for mixing bonding mortar and grout. Square nose removes mortar/grout from pail
- Pointing trowels – used in every phase of the work, especially straightening tiles
- Wood float – for smoothing small irregularities left on the mortar bed, working the surface of the mortar
- Hawk (11" square preferred)
- Rubber floats – for grouting
- Beating block – 4" x 14" of hardwood to beat in the tiles for flushness
- Power hand drill
- Mixing paddle for power drill to mix bonding mortar and grout
- Grout scrubbing pads – non-scratch nylon pad with abrasive for cleaning grout

CUTTING TOOLS

- Tile nippers – 8" for inside curves and 10" for straight cuts that cannot be made with the tile cutter
- Tile cutter / score and snap
- Hand-held power grinder / cutter
- Chisels – small
- Chipping hammer – lightweight hammer
- Grout saw
- Carbide drill bits
- Rubbing stone
- Rod saw and blades – used to cut circles or irregular curves in tile
- Wet saw
- Blades: Wet diamond blades - Dry diamond blades - Carborundum blades - Rod saw blades

SECTION 2 - CFI RESIDENTIAL CERAMIC-I STUDY GUIDE

The CFI TILE Study Guide for Installation Knowledge

The CFI Team shares the proven methods of tile installation that work for thousands of installers worldwide. We also invite you to share with us methods that work for you. Techniques that are demonstrated have been proven to provide the customer with the highest degree of customer satisfaction. The CFI Study Guide is widely used throughout the industry as a "tool" for understanding the requirements of a successful tile installation. Manufacturers and the Tile Council of America offer written guidelines. The Ceramic Tile Education Foundation provides extensive training to increase your knowledge and skills. By acquainting yourself with the CFI Study Guide and Terms, the written test that is administered at the close of the event is not difficult. The Study Guide provides the answers to the test.

OSHA and EPA Information

1. **OSHA** - Occupational Safety Health Administration
2. **OSHA** - Office of the Federal Government
3. **OSHA #3165** "Employee's Right to Know" - Employees must be trained to install ALL products handled.
4. **HAZCOM** -Hazardous Communications Plan
   (a) Keep Safety the #1 Priority
   (b) Plan lists training procedures for company employees
   (c) State's location of MSDS Sheets
   (d) Identifies all products company uses and chemical inventory
5. **FINES**
   (a) Maximum first time fine is $7,000.00
   (b) Maximum-next offense is $70,000.00
6. **FINES** issued for items such as:
   (a) No HazCom Plan (e) Defective tools
   (b) No Kneepads (f) Improperly labeled or unmarked containers
   (c) No First-Aid Kit (g) Ground wire removed from electrical cords
   (d) No Ventilation (h) No MSDS sheets (Material Safety Data Sheets)
   Power tools are to be grounded with a ground-fault circuit interrupter
7. **MSDS-MATERIAL SAFETY DATA SHEET lists:** (Request MSDS at time of purchase)
   (a) Manufacturer and product
   (b) Physical data (volatile, boiling point, etc.)
   (c) Fire and explosion hazard data -how to extinguish fire, etc.
   (d) Hazardous Ingredients
8. **CHEMICALS** can only be transferred by ONE person to another properly labeled container.
9. **HEALTH HAZARD DATA listed on MSDS** (exposure limits, first aid) includes the following.
   (a) Reactive data (stability - what not to mix with product)
   (b) Special handling precautions (d) Spill and leak procedures
   (c) Special protective equipment and procedures - gloves/ventilation
10. **ASBESTOS** should always be covered or encapsulated -Testing is only way to properly identify
11. **FIRST AID KIT**- Contents of kit must be undisturbed with a letter signed by a physician
12. Always be aware of the location of the **First-Aid Kit and the MSDS Sheets.**
13. To avoid tripping, hoses and power cords should be placed **along walls and away from traffic.**
14. **Be aware of silica dust and prevent airborne particles** by wetting the surface and removing with a Hepa vacuum.
15. **Silica** is found in lead-based paints and in tile, masonry materials and mortars.
16. The **disposal of wastewater** is always done according to local regulations.
17. **EPA –** Environmental Protection Agency of the federal government

CFI

1. CFI is the industry organization that **represents the professional flooring installers** and promotes them to the industry and consumers.
2. CFI installers are expected to perform successful installations **EVERY time.**
3. CFI Ceramic Installers are **required to pass oral, written and hands-on tests.**
4. CFI promotes **pride and professionalism.**
5. CFI has trained over **40,000 installers nationwide**.
6. CFI logo – **PRIDE** – Professionalism, Responsibility, Integrity, Dependability and Education.
7. CFI "**People Skills**" are described as professional ability to satisfy the customer and to communicate in an intelligent and informative manner.
8. The ultimate goal of the CFI installers is **CUSTOMER SATISFACTION!**

RULES

1. **ASTM:** American Standard Testing and Materials (Standard)
2. **ANSI:** American National Standards Institute (Standard)
3. **CTEF:** Ceramic Tile Education Foundation
4. **TCNA:** Tile Council of North America
5. **EPA:** Environmental Protection Agency
6. **OSHA:** Occupational Safety Health Administration

TOOLS and SUPPLIES

1. **Tile nippers** are used for inside curves and straight cuts.
2. The tool used to drill holes through masonry or concrete is called a **carbide drill bit.**
3. **Cement backer board** is used to cover wood subfloors and eliminates the wire mesh and mortar coat. It is a rigid sheet, usually 3 feet x 5 feet and ¼-inch or ½-inch thick.
4. The **mixing paddle** for a power drill is used to mix bonding mortar and grout.
5. Wet diamond, dry diamond, carborundum, and rod saw are all **types of blades.**
6. The tool used to locate straight lines is called **chalk or dry line.**
7. The tool used to cut circles or irregular curves in tile is called a **rod saw.**

MEASURING AND ESTIMATING

1. The best installation starts at the **time of the sale**. Installers are to receive a detailed diagram.
2. Tile is sold by the **full box.**
3. Length times the width **equals the square footage** of the area.
4. The type of tile, subfloor type, movement areas, door and appliance clearance and areas to cover are included in the **detailed diagram.**
5. Installation problems are definitely minimized when the installer receives a **detailed diagram.**
6. The door is expected to clear **two tiles.**
7. In a larger room, the installation begins by **snapping a chalk line in the center of the area in both directions.**
8. All floor layouts must incorporate **movement joints.**
9. The **3-4-5 rule** is used to check if the lines are square.

SAFETY

1. The form that lists items such as physical data, fire explosion hazard data and hazardous ingredients is called the Material Safety Data Sheet – **MSDS.**
2. If the installers are not qualified to address an **asbestos** situation, they should cover or encapsulate the surface.
3. **OSHA** is the Occupational Safety and Health Administration.
4. Installers should always be aware of the location of the **first-aid kit.**
5. **Power equipment** should only be operated by people authorized to use the machines.
6. **To avoid tripping**, hoses and power cords should be placed along walls and away from traffic.
7. It is recommended that tile setters **wear gloves.**
8. Tools and extension cords are to be **grounded** by 3-prong plugs.

9. When working with wet saws, it is recommended that installers should keep **their hands safe and wear eye protection.**
10. The **disposal of wastewater** is always done by according to local regulations.
11. Be aware of **silica dust and prevent airborne particles** by wetting and removing with a HEPA vacuum.
12. **Silica** is found in tile, masonry materials and mortars and in lead-based paints.
13. Power tools are to be **grounded** with a ground fault circuit interrupter.
14. When lifting heavy objects, it is important to follow **safe lifting procedures.**

TILE SPECIFICS

1. The wear surface of the tile is called **glaze.**
2. Glazed tile is composed of two parts, called the **bisque and the glaze.**
3. **Marble, granite and slate** are taken from the earth, can be natural and mined from the earth.
4. Marble, granite and slate are taken from the earth and can be **inconsistent in appearance.**
5. The strength and wear resistance of the glaze is determined by its **hardness.**
6. Difference between **glazed and unglazed tiles** is that unglazed tiles are generally thicker and denser, superior strength for commercial use.
7. **Non-vitreous tiles** are suited for indoor use only because they absorb their weight in water by 7% or more.
8. Ceramic tile is known as **glazed and unglazed.**
9. The **strongest tiles** are known as impervious and absorb between 0 and 0.5% of their weight in water
10. **P. E. I** (Porcelain Enamel Institute) is the wear rating of the tile.
11. **Quarry tiles** are generally slip resistant and denser than other tiles.
12. **Mosaic tiles** are small and usually less than 9 square inches.
13. **Impervious tile** has water absorption of 0.5% or less.

INSTALLATION FACTS TO KNOW

1. **ALWAYS follow the manufacturer's installation instructions.**
2. **Wood expands and contracts** when its moisture content changes
3. **Backer boards** replace the mortar beds and separate the tile from much of the structure's movement to protect the installation.
4. **Backer board installations** will usually fail as the result of an insufficient amount of mortar underneath.
5. **Lippage** is the height difference between tiles that are adjacent to each other.
6. Deflection means to **bend, flex or bow.**
7. Most installations limit joist spacing to **16-inches on center.**
8. In place of latex or acrylic caulks, use a **flexible sealant**, such as 100% silicone or urethane.

THE SUBSTRATE - SUBFLOOR

1. The **substrate** is known as the surface over which tile is installed.
2. Poured in place concrete is known as a **substrate.**
3. The performance of a properly installed thin-set tile installation is dependent upon the durability and **dimensional stability of the substrate**.
4. A **cold or construction joint** is when concrete is poured at different times and sections are joined together
5. **CBU** is the abbreviation for Cement Backer Units.
6. New, poured concrete can be tiled over according to industry recommendations in **28 days.**
7. **Wood products are dimensionally unstable** because wood possesses tremendous **movement** characteristics
8. Wood based panels such as particle board, composition (veneer) panels, non-veneer panels (CDX, OSB, etc.), lauan and softwood plywood are **NOT recommended as backing materials** for direct bonding of tile.
9. **1/8-inch spacing** is required at all end and edge joints of plywood subflooring for expansion, according to the APA Engineered Wood Association

10. **Stress cracks** continue to open and close with seasonal changes
11. Non-asbestos cushioned or perimeter installed **sheet vinyl goods should be removed.**
12. Unsuitable substrates should be **covered or replaced**.
13. The amount of **deflection** in the floor is to be minimized to prevent failures where bending occurs
14. A measure of acidity or alkalinity is **pH.**
15. A **pH under 9** is usually recommended for tile and grout to minimize efflorescence.
16. A **calcium chloride test** measures the vapor emission rate **from** a concrete slab over a 24-hour period, but it takes 60-72-hours to conduct. The emission rate is generally **3-pounds per 1,000 square feet in 24-hours.**
17. The **In-Situ test** measures the relative humidity of the slab to assess the moisture contained **in** the concrete that can potentially be emitted at the surface.
18. All methods require the subfloor to be at least **19/32" or 5/8" thick.**
19. If the substrate is porous, **damp mopping** will increase the bond strength of the cement mortar to the substrate, as long as the substrate remains damp when the mortar is troweled.
20. In a concrete floor, **expansion joints** continue to open and close with seasonal changes.
21. Leave a minimum**1/8-inch** accommodation movement around all perimeter abutments and horizontal to vertical abutments.
22. Structural wood panels with edges that interlock with other panels are known as **tongue and groove** and should have 1/8-inch expansion built into the system.

MORTAR and ADHESIVE

1. Today, most tile installations are done by using **thin-bed methods.**
2. **Thin-bed installation** is so common that newer buildings no longer accommodate the thickness of a mortar-bed installation.
3. Reduced mortar performance and open time are the result of **mixing too little or too much.**
4. One of the most common causes of tile failures is the **lack of mortar coverage.**
5. Joist spacing, tile size and type, underlayment type and subfloor thickness all **affect tile performance.**
6. Dry-set mortar is suitable for use over a variety of surfaces and can be used in one layer as thin as **3/32-inch,** which is the **MINIMUM** allowed.
7. Latex-portland cement mortar compared to dry set cement is **more flexible.**
8. If chemical resistance, high-bond strength and high-impact resistance are required, use an **epoxy mortar.**
9. Remove **mortar** from joint area before grouting, leaving **2/3's of the depth** of the tile available for grouting.
10. **Back buttering** is the term used for applying adhesive to the back of tiles that have large lugs or grooves.
11. **Organic adhesive shrinks** as it dries more than mortar and because of drying issues, can only be used on tiles that are no larger than 6x6 inches for floors and 12x12 inches for walls.
12. Latex additive mixed with dry set mortar instead of water and used when tiling over a non-porous subfloor is called a **bond coat strengthener.**
13. When latex additive is mixed with dry set mortar instead of water, the mortar is **stronger.**
14. **Dry-set Portland-based cement mortar -** standard term for cement-based mortar that does not contain polymers or latex.

MEMBRANES

1. An **uncoupling membrane** is a plastic sheet which is bonded to the substrate to accommodate movement.
2. A plastic membrane that provides air space between the tile and substrate to allow movement between the two is called the **uncoupling membrane.**
3. **Uncoupling membranes** are plastic sheet goods that are sold in a roll or as individual sheets and used throughout the entire installation.
4. A **crack isolation membrane** is a thin, flexible material adhered to concrete substrates and poured underlayment's to prevent cracks in the substrate from telegraphing through the tile.

5. A thin, flexible liquid material, applied to a substrate to minimize moisture/fracturing damage to the tile and grout and applied with a trowel, roller or sprayer is known as a **waterproofing or anti-fracture membrane.**
6. Typically, when covering a single crack in a concrete substrate, the width of the installed crack isolation membrane should be at least three times the width of the tile to be installed over the crack.

GROUT

1. A **bad grout** can ruin a perfect installation.
2. When **mixing thin set and grout**, it is important to follow the recommended mixing speed and slake time.
3. When mixing grout, use **lower** speeds. Mixing too fast or too long produces weaker grout if the air is trapped.
4. Minimizing the amount of water used will make the **grout stronger.**
5. When grouting, use the **recommended joint sizes** stated by the manufacturer.
6. After the **thin-set has cured**, the tile is ready to grout.
7. **Portland cement** is the base for most grouts.
8. **Epoxy grouts** provide high-bond strength and impact resistance.
9. **Epoxy grout is used** where chemical resistance is of high importance and provides a high-bond strength and impact resistance also.
10. If the grout becomes too stiff, remix it by hand, but **do not add liquid.**
11. Do not pack the grout into the **movement joints.**
12. Grout must be **firm in the joints** before beginning to rough wash.
13. Fill visible movement joints with a compressible material, but do not use **grout.**
14. Before the **final wash**, allow the grout film to dry to a haze.
15. **Restrict the traffic** in freshly grouted areas for 24-hours and no heavy traffic for 72 hours.

BONDING

1. To ensure proper mortar coverage of the tile and setting material check by **lifting a tile and inspecting it.**
2. If tile is bonded directly to concrete over a crack without a crack isolation membrane, **it will most likely crack.**
3. Tile installation may fail because the **incorrect bonding material** was used and/or by improper coverage of the correct bonding material.
4. If the mortar sets up too quickly, the bond strength will be **much weaker.**

VOCABULARY

Acclimate: become conditioned to the surrounding environment. Dried plywood and OSB absorb moisture as they acclimate to the environment.
Acid: pH lower than 7
ANSI Standards: American National Standards Institute – describe till installation requirements and product performance requirements
Asbestos: fibrous material that can be harmful when airborne (in older vinyl tiles and adhesives)
ASTM: American Society for Testing and Materials
Back butter: Spreading a bond coat to the back of tile to improve coverage and transfer
Backer board: Rigid, sheet product, such as 3 feet x 5 feet and ¼-inch or ½-inch thick
Balanced cuts: refers to a mirror image from front to back and side to side in a patterned installation
Beating block: wooden block used to imbed tiles – method is called beating in
Bed: to provide support for
Bisque: clay that has been fired
Bond-breaker tape: thin strip of material installed in a shallow movement joint that sealants will not bond to
Bond coat: Material that attaches the tile to the substrate
Bond-coat strengthener: latex additive mixed with mortar instead of water, used when tiling over a non-porous subfloor
Breaking strength: amount of force required to break a tile
Bullnose: a trim tile with a convex radius on one side

Calcium chloride test: Measures the vapor emission rate. Recommended at a rate of 3lbs per 1,000 square feet in 24-hours. High vapor emission rate can create an alkaline situation which can break down some membranes and adhesives. A pH of up to, but not exceeding 9 is the highest number acceptable.
Caulk: to fill a joint with a flexible sealant or compressible filler
CBU: a type of cement backer board
Cement board: Type of backerboard, also called CBU.
Cement grout: cementitious mixture of Portland cement, sand or other ingredients and water to produce a water resistant, material used to fill the joints between the tiles.
Ceramic Adhesive: Usually referred to as mastic is for bonding tile to a surface
Ceramic tile: ceramic surfacing unit, glazed or unglazed; does not include tiles made of natural stone
Change in-plane: a section where two planes intersect, such as in a corner
Clean wash: the final washing process after grouting; the finish wash
Co-efficient of friction (COF): numeric indicator of how slip-resistant a tile is in wet or dry conditions
Cold joint: the intersection between the end of one concrete pour and the beginning of a new pour
Compressible filler: flexible sealant
Compressive strength: ability to resist being crushed by weight
Control joint: a saw-cut joint in concrete to control cracking in the concrete
Crack isolation membrane: thin and flexible material adhered to concrete substrates and poured underlayment's to prevent substrate cracks from telegraphing through to the tile.
Crazing: cracking which occurs in fired, glazed or other critical tensile stresses
CTEF: Ceramic Tile Education Foundation
CTI: Ceramic Tile Institute
Damp cure: create humid condition for fresh grout by misting and covering it
Deflection: variation in the position or shape of a structure due to effects of loads or volume change; to bend, flex or bow
Direct-bond method: installation method where the tile is applied to an existing surface
Directional troweling comb all notches of a bonding material in the same direction to form parallel, uniform ridges of mortar.
Dry cut (scraper or grind): Removal or scarification of materials without using water
Dry-set mortar: cement-based setting material for thin-bed installations
Dusting: application of dry Portland cement to a wet floor or deck mortar surface
Efflorescence: residue deposited on surface of a material (usually the grout joints) by the crystallization of soluble salts
EGP mortar: cement-based mortar designed to bond to wood. ANSI A118.11
Embed: to set inside of, encapsulate or enclose
Embossed: decoration on the wear surface
Epoxy grout: two-part adhesive system using epoxy resin and epoxy hardener used to fill grout joints
Epoxy mortar: often contains silica filler formulated for industrial and commercial installations where chemical resistance is of importance.
Epoxy resin: an epoxy composition used as a chemical resistant setting adhesive or resistant grout
Expansion joint: joint through the tile, mortar and reinforcing wire down to the substrate
Feather-in: create a more gradual transition by forming a slope
Final wash: clean wash
Firing: ceramic manufacturing step of using a kiln or furnace to develop desired properties through heat
Flatness: amount of surface variation from being straight across
Flexible sealant: material such as 100% silicone or urethane installed in movement joints in place of grout
Float strip: strip of wood about ¼" thick and 1 ¼" wide used as a guide to align mortar surfaces
Floating: method of using a straightedge to align mortar with float strips or screeds.
Foam backer rod: synthetic "rope" to which sealants do not bond
Freeze thaw stability: ability of tile to withstand freezing and thawing without cracking (32-degrees F)
Glaze: a coating applied to ceramic products, but it is not a ceramic coating
Grade: a predetermined degree of slope that a finished floor should have
Grout: material used to fill the spaces between the tiles
GFCI: ground fault circuit interrupter – stops an electric current when it detects a surge or short in the current

Grout joint: space between the tiles
Hard screed: a mortar screed that has become firm
HEPA: High Efficiency Particulate Air, type of vacuum attachment used to trap dust
Impervious tile: has water absorption of 0.5% or less
In-plane: on or within the same level, such as a flat floor
In-Situ Test: Measures the relative humidity of the slab to assess the moisture contained **in** the concrete that can potentially be emitted at the surface.
Irritant: material that causing itching or other discomfort until it is removed
Joist: structural unit of a wood floor system to which the subfloor panels are fastened that measure from the center of one joist to the center of the next adjacent joist.
Key-in: force mortar contact by firmly flat troweling
L-Strip: metal strip shaped like the letter "L," used as the termination of a tile installation, particularly if the tile is higher than the adjacent floor to protect the edge of the tile
Latex Portland cement grout: combines Portland cement grout with a special latex additive to make a less rigid, less permeable grout than regular Portland cement grout
Layout lines: lines chalked in a substrate to guide setting tile accurately
Lippage: condition exists where the edge of one tile is higher than the edge of the adjacent tile
Litmus test: determines the acidity (pH) of a liquid, such as a cleaner or a solid, such as grout or concrete
Load: weight that a floor or floor system must support
Mastic: tile adhesive made from organic substances used in thin-bed tile installation
Membrane: flexible sheet used for multiple purposes including tile underlayment, waterproofing and crack isolation.
Mexican Paver Tile: used mainly on floors, the handmade tiles vary in color, texture and appearance. A terracotta-like tile coated with various types of sealers to provide a wearing surface.
MIA: Marble Institute of America
Modified mortar: Latex/polymer modified portland cement mortar
Mortar bed: Layer of mortar on which tile is set. The final coat of mortar on a wall, floor or ceiling is called a mortar bed.
Mosaic tile: Formed by either dust-pressed or plastic method, usually with a facial area of less than 6 square inches. Made of porcelain or natural clay composition, in plain or with an abrasive mixture throughout.
Movement joint: space left open or filled with a compressible material to allow movement to occur in the floor without affecting the surrounding materials
Mud: a slang term for thick-bed mortar
Neat Cement: Portland cement mixed with water to a desired creamy consistency.
Non-vitreous tile: has water absorption of more than 7% to 20%
NTCA: National Tile Contractors Association
NTMA: National Terrazzo and Mosaic Association
Off-set: staggered
Open time: period of time during which the bond coat retains its ability to adhere to the tile and bond the tile to the substrate
Organic adhesive: prepared organic material, ready to use with no further addition of liquid or powder, which cures or sets by evaporation.
OSB: Oriented Strand Board, wood panel made of rectangular wood strands or chips that are pressed and bonded together and arranged in cross-oriented layers.
Paper and wire: tar paper and wire mesh or metal lath used as backing for tile installation
pH: measure of acidity or alkalinity – having a pH of about 7
Plastic mat test: method of determining if a concrete substrate is releasing moisture vapor
Plumb: perpendicular to a true level
Polymer: plastic
Porosity: amount of empty space within a material – amount of water that a material can absorb
Pourable underlayment: tile substrate that is mixed and poured in place
PSI: pounds per square inch
Quarry tile: unglazed tile that is usually six inches or more in surface area and ½" to ¾" thick.
Reducer: trim unit used to shorten the radius of a bullnose or a cove to another radius or to a square

Re-emulsify: soften, break down or dissolve
Relative humidity probe: gauge placed beneath surface of concrete to detect the amount of moisture within concrete
Rodding: method of using a straightedge to align mortar with the float strips or screeds. This technique also is called floating, dragging or pulling.
Rough-wash: the first washing process when grouting
Roughing-in: act of preparing a surface by applying tar paper and metal lath (or wire mesh); sometimes called wiring.
Saltillo tile: Adobe-type tile made of clay and other natural raw materials, molded and allowed to dry – not a fired clay product.
Sand- Portland cement grout: on-the-job mixture of Portland cement, fine graded sand, lime and water.
Sanded grout: grout used in joints that re 1/8-inch to about ½-inch
Screed or screed strip: strips of wood, metal, mortar or other material used as guides on which a straightedge is worked to obtain a true mortar surface.
Sealant: an elastomeric material used to fill and seal expansion and control joints to prevent the passage of moisture and allows horizontal and lateral movement at the joints.
Setting bed: layer of mortar on which the tile is set.
Silica: found in many construction materials such as concrete, masonry and tile, and lead-based paints.
Silicone grout: engineered elastomeric grout system for interior use
Slake: brief time allowed for mixtures of mortar, Thinset mortar or grout to stand after the ingredients are thoroughly combined and before the final mixing occurs. Slaking allows the mixture to mix to penetrate lumps in the dry components, making it easier to complete the mixing procedure.
Slot cut: describes tile that is cut to fit around pipes or switch boxes, usually in shape of an "H" or the letter "L."
Slump: to sag
Soft joint: space between two hard materials, such as between two rows of tile that is filled with a compressible material to allow movement
Spacers: cross, tee-shaped and y-shaped used in installation to separate tile installed on floors.
Split "L" cut: an improper "L" cut made by splitting a tile instead of cutting it
Straight joint: style of installation which features all joints in alignment.
Straightedge: straight piece of wood or metal used to rod mortar and to align tile
Striking joints: process of removing excess grout from the joints by wiping them with a sponge or cloth or by scraping them with a curved instrument
Stoned: use of a carborundum stone to smooth rough edges caused by cutting
Studs: vertical framing members that support the walls
Subfloor: an unfinished floor (plywood or boards) laid over joists on which an underlayment or substrate is installed
Substrate: underlayment for ceramic tile
TCNA: Tile Council of North America
Tent: to buckle or form a tent shape
Thermal expansion: the condition when tile size increases because its temperature increases
Thick-bed mortar: thick layer of mortar (more than ½-inch) used for leveling
Thin-bed method: tile installation with thin-bed bonding materials and without using a mortar bed
Thin-set mortar: cement-based bonding materials applied approximately 1/8-inch thick for thin-bed tile installation
3-4-5 Triangle: triangle with sides in proportion of 3-4-5 producing one 90-degree corner. Plotting a 3-4-5 triangle is a method to establish a pair of square reference lines on a large surface to determine if the installation site is square and to create a grid of layout lines for tile setting.
Tie wire: 8-gauge galvanized wire used for a variety of purposes in construction work
Tile: a ceramic surfacing unit made from clay or a mixture of clay and other ceramic materials.
Tile nipper: special pliers to nibble away little bites of ceramic tile to create small, irregular or curved cuts.
Tooling: forming grout joints by rubbing by using a sponge or other material
Tongue and groove (T&G) exterior glue plywood: a structural wood water-resistant panel that has edges that interlock with other panels
Tongue and groove (T&G): edge on a wood panel, such as plywood, which allows panels to interlock

Uncoupling membrane: Plastic sheet membrane thicker than a flat membrane used to limit the transfer of stresses from substrate to tile and to limit the transfer of stresses; installed over a wood floor for tile installation.
Unglazed tile: hard, dense tile of uniform composition throughout, deriving color and texture from the materials of which the body is made
Unsanded grout: Grout that is used for joints 1/8-inch and smaller
Urethane membrane: crack isolation and waterproofing membrane formed by the application of a rubber-like material that dries in place
Vapor-retardant membrane: – asphalt-saturated paper-like material or plastic behind backer board on walls to prevent moisture from migrating into the wall cavity
Vertical broken joint: ceramic tile installation featuring each vertical row offset one half its length
Vitreous tile: has water absorption of more than 0.5%, but not more than 3%
Waterproofing membrane: covering applied to a substrate before tiling to protect the substrate and framing from damage by water; applied below mortar beds or directly beneath the thin-set tiles.
Wedging: amount the tile is out of square; deviation of corners from being exactly 90-degree angles
Wet areas: tile surfaces that are soaked, saturated or subjected to moisture or liquids
Wet-cut (wet-grind): Use of water when cutting or grinding for the purpose of minimizing dust

INFORMATION CONCERNING EXPANSION JOINTS *by Dave Gobis, Former Technical Director of CTEF*
Know the joint types: expansion, isolation, control and construction

1. **Use recommended guidelines - TILE COUNCIL OF NORTH AMERICA HANDBOOK FOR CERAMIC TILE INSTALLATION** specifies a particular method and is the accepted industry standard for tile installation. The manufacturers of the products and supplies provide instructions that are pertinent to each company. They are to be followed!
2. **Numerous ceramic tile failures are created by movement**. All tile moves; even the strongest steel or concrete must be addressed as to movement.
3. **Tile expands when exposed to sunlight**. Even the very dense porcelain tile expands approximately .0000004 inches per degree Fahrenheit. Example: Covering 40 linear feet exposed to a change in surface temperature of 50 degrees could possibly expand between 1/16" and 3/32". The coverage and type of thin-set makes a big difference whether the tile stays in place.
4. **AT THE TIME OF THE SALE**, the need for movement joints in tile installation must be addressed. This is of much greater importance than the grout color.
5. Tile will expand and contract due to **temperature variations.**
6. **Concrete shrinks!** Control joints are placed primarily for concrete shrinkage during the initial curing process. If there are no control joints in the slab, the cracking occurs at random locations over a period of time.
7. **Doorways**: Install a movement joint just to be safe.
8. **Moisture is a force on tile**. Once moisture expands; it does not contract. The growth rate is very slow and very minimal. If this happens, it is usually due to defective workmanship; use of the wrong thin-set or insufficient full curing moisture exposure or no expansion (movement) joints. Failures due to moisture usually take years to occur unless there is a very high rate of water exposure.
9. Other good reasons for expansion joints include the fact that **wood moves**. All wood supported floor systems display deflection in some amount. If there is a beam down the center of an area this is a pivot point from which the floor will deform on either side. Place a soft joint or movement profile over the area to allow movement without creating stress on the tile floor.
10. **Movement/expansion joints must be at all control joints**. It is possible that tile may **crack or debond** if it is installed without the proper movement accommodation joints. Using a membrane does not eliminate the need for expansion joints.

SECTION 3 – MEASURING – ESTIMATING – A SUCCESSFUL BID

A. PREPARATION

Preparation makes the difference! This includes all parties. The importance of the detailed drawing contributes to the overall success of the installation. The diagram "paints a picture" of what is expected to happen. Every time a job is PROPERLY planned, it is finished to everyone's expectations. It is not guesswork! "If it doesn't start right, it absolutely will NOT finish right!" Proper planning pays big dividends!

THE "IF'S" THAT SATISFY CUSTOMERS…

- IF the flooring and installation are sold correctly,
- IF the customer has been properly prepared,
- IF the estimator has "painted the true picture" for the installation,
- IF the installer follows the detailed diagram,

ANOTHER HAPPY CUSTOMER WILL RETURN TO PURCHASE FLOORING AGAIN!

B. COMMUNICATION WITH THE CUSTOMER – If it doesn't start right, it will NOT finish right!

Knowing what the customer expects from their flooring investment helps the installers to provide better service. Associates who develop a real partnership with installation professionals find they encounter fewer problems during and after the installation. Installation problems are minimized depending on the accuracy of the measurements and the care with which the details are recorded for the installer.

Consider the numerous details in figuring a tile installation that must be properly planned and coordinated. A drawing is required in order to determine for the floor area:

1. Each area of installation
2. Type of tile
3. Amount of tile
4. Edge treatments
5. Floor preparation
6. Required trim pieces
7. Various accessories
8. Door and appliance clearance
9. Subfloor type
10. Appliances and furniture to more
11. Stairs
12. Movement areas
13. Pattern layout - diagonal
14. Utility turnoffs - responsibility
15. Customer requests

Generally, for new construction, the installer receives architectural drawings with space names or number and a finished schedule of styles, patterns, colors and installation methods. Existing structures require new measurements and drawings. The estimator should use ¼-inch scaled graph paper and steel tape measure.

C. CALCULATE THE AMOUNT OF TILE

- Square off the area
- **Tile is sold by the FULL carton**
- To calculate the number of cartons
    - Divide the net square footage plus the waste factor by the square feet in a carton of tile and round off to the next full carton
    - To determine the number of square feet to purchase, multiply the total number of cartons by the square feet in one carton

D. THE ESTIMATING FORMULA

1. SQUARE FOOTAGE FORMULATIONS

a. Length times width = square footage of area
b. Add 10% or 13% for waste
c. Net square footage divided by the square feet in carton = full and partial number of cartons
d. Round off to the next full carton = exact full cartons
e. Full cartons times square feet per box = total square feet

EXAMPLE:

Facts: Area is 20 feet long and 15 feet wide
Tile is packed 16.1 square feet to one carton

Answer:

a. 20 feet times 15 feet = 300 square feet of area
b. 300 square feet times 1.10 = 330 square feet
c. 330 divided by 16.1 square feet = 20.49 cartons
d. Rounded off = 21 cartons
e. 21 cartons times 16.1 square feet = 338.1 total square feet

E. CUT-TILE BASE FORMULATION

Length of wall divided by 2 = number of square (30 L/F = 15 S/F)

NOTE: This formulation is never exact because you are working with different size tiles, but it is easy and avoids potential problems

F. TRIM (Bullnose) FORMULATION

1. Linear feet of area times 12 = linear inches
2. Linear inches divided by the length of bullnose = number of pieces

EXAMPLE:

Facts: Area receiving bull nose is 10 feet in length
This particular bull nose is 6-inches long

Answer
a. 10 feet times 12 inches = 120 inches
b. 120 inches divided by 6 = 20 pieces

G. VINYL CAP FORMULATION

Linear feet divided by 6 feet = number of pieces - Vinyl cap is available in 6-foot lengths

H. MARBLE THRESHOLD FORMULATION

Measure linear feet of doorway - Use the next larger size and cut it to fit

I. MEASURING FOR DOOR CLEARANCE FORMULATION

Door should clear height of two tiles. Lay one tile on top of another. Always verify before cutting.

J. STEPS and RISER (Combined) FORMULATION

Width of steps times the number of steps = linear feet

K. CEMENT BACKBOARD FORMULATION

Area square foot divided by square foot of board = number of sheets

L. DIAGRAM MUST SHOW THE MOVEMENT AREAS

M. BALANCING A TILE INSTALLATION

There is more to consider than a square room. Considerations include entrances, doorways, adjoining rooms, fireplaces, built-ins

N. DIAGRAM MUST SHOW PATTERNS and DIFFERENT SIZES of TILE

SECTION 4 – Moisture – Alkalinity – Porosity - Humidity

It is not the responsibility of the installer to conduct moisture testing, but it is the installer's responsibility to make certain that the moisture tests were conducted and the results are documented for future reference. ***(Industry White Paper ----www.CFlinstallers.org)***

WHITE PAPER on Moisture Emission Testing *www.wfca.org* Position statement on moisture emission testing and accompanying document, "Moisture Emission Testing – Responsibility and Qualifications for Testing" adopted by the World Floor Covering Association (WFCA) Board of Directors to begin the process of soliciting industry-wide support for the measure. The focus of the position statement is that concrete moisture vapor testing needs to be performed by qualified independent agencies, and not by floor covering personnel. This recommendation, if adopted, will require that architects move such testing away from Division 9 of Construction Specifications and place it with other construction-related test requirements. Building industry practice historically has been that floor-covering installers, dealers and contractors have been held accountable for testing of moisture emissions in concrete and the satisfactory installation of floor covering on this material. Horror stories abound about floor covering professionals being held liable for non-performance, often in extenuating circumstances beyond their control. Compounding complexity of the situation are technological advancements in concrete formulations, as well as new, "fast track" construction techniques. It was in this environment that the Ad Hoc Task Force of interested professionals was brought together by WFCA to attempt to rectify what has proven to be a serious problem. That led to the development of the "Position Statement on Moisture Emission Testing" that was finalized in 2001. Document is available online at ***www.WFCA.org*** and at ***www.CFlinstallers.org.***

MOISTURE – ALKALINITY – POROSITY - HUMIDITY

1. It is not the responsibility of the installer to conduct moisture testing, but it is the installer's responsibility to make certain that the moisture tests were conducted and the results are documented for future reference.
2. **Calcium Chloride testing** ASTM 1869
3. **In-situ rH probe testing** ASTM 2170
4. **MAT TEST** is a qualitative test that ONLY checks for moisture using a plastic or rubber mat left in place for 48-hours.
    a. Test for moisture by trapping it under a plastic or rubber mat.
    b. Clean the floor where the mat is to be placed, DO NOT wet mop the floor; this will create moisture.
    c. Place the mat on the floor and tape it on all sides with duct tape, sealing all edges.
    d. Leave the mat in place for **48-hours** and then remove. Performing the test in less time, allows for the margin of error to increase.
    e. Look for droplets of moisture and changes in the appearance of the floor when the mat is removed.
    f. Consider: Is the surface drying (whitening)? Is the duct tape stuck to the floor? If the duct tape is loose or will hardly stick to the floor, this may be an indication of a moisture condition.
5. **Efflorescence** – residue deposited on the surface of a material by the crystallization of soluble salts.

Understanding "pH"
For many years, the Industry has looked upon moisture as being the primary contributor to flooring failures. As the Industry has become more knowledgeable with information gathered from some specialists in the field, it has been discovered that the pH level of a concrete substrate has a significant bearing on the success or failure of applied floor coverings, such as ceramic tile, carpet, VCT, hardwood, etc.

1. A measure of acidity or alkalinity is **pH.** A **pH under 9** is usually recommended. **pH of concrete neutral is 7. Strong salt (alkali) is represented by a 14 reading.**
2. A **calcium chloride test** measures the vapor emission rate which is generally 3-pounds per 1,000 square feet in 24-hours.
    a. **pH tests determine the strength of salts**, known as a base or the strength of acids in a substance, whether in a liquid or solid state.
    b. **An aqueous solution,** which is pure water (distilled) is applied to the substrate and tested by the use of litmus paper or electronic meters. Test results will determine the value of acid or alkali (salts) present in concrete.
    c. **Alkali** migrates to the surface through the capillaries in the concrete. Water in vapor form is the transport. Alkali can be present in the ground or in the aggregate mix.
    d. **The pH scale is logarithmic**; the intervals are exponential and thus, represent far greater differences in concentration than the values themselves seem to indicate – each interval is 10 times itself starting from 7. The pH measures hydrogen-ion concentration of solution.
    e. **pH tests are conducted** at the same time on floors free of sealers and contaminants. 3 tests are taken for the first 1000 square feet and one additional test for every 1000 feet thereafter.

TESTING the pH of CONCRETE
- The pH scale is from **0-14**
- **7** is neutral
- **1** is a strong acid
- **14** is a strong salt (alkali) or base

THREE TYPES OF TESTS
1. PH paper – Litmus
2. Liquid Indicators
    a. Phenolphthalein liquid - turns red with higher pH or pink with lower pH
    b. Rainbow indicator - reacts to the different values of pH
    c. pH pencil - reacts to different values of pH
3. Electronic Surface Probes - Digital displays

PROCEDURES TO CONDUCT a pH TEST
1. Test is to be conducted at the same time as the moisture test
2. Floor must be free of any sealers or contaminants
3. Take three tests for first 1000 square feet
4. Take one additional test for every 1000 square feet
5. Use distilled water for litmus paper
6. Use a buffered solution for electronic test
7. Phenolphthalein or liquid solutions – pour directly onto slab – can be toxic
8. pH turns red with phenolphthalein
9. pH turns different shades with rainbow Indicator

MOISTURE TESTS

pH TEST

- **PAPER STRIPS**: Place a few drops, one inch in diameter, of distilled water on the area to be tested. Wait 60 seconds, place a strip of pH paper on the wet area and remove immediately, after which time the color of the paper is compared to the chart that came with the paper. Record the findings.

- **pH METER:** Either mist or place a few drops of distilled water on the area to be tested. The less water, the more accurate the testing. Hold the testing end of the meter against the dampened area until the meter stabilizes. Read the meter and record the findings. Before testing another area, clean the end of the probe with a clean towel.

POROSITY

1. The **more porous the slab**, the more vapor migration occurs
2. The more porous the slab, the **less open-time** for adhesive. Webster's Dictionary explains porosity as "possessing or full of pores – permeable to liquids" **Porosity has a direct affect on adhesives.** When conducting pH testing, one can determine the porosity of a slab by watching the water that was applied for the pH:

    - If the water absorbs quickly – the slab is porous
    - If the water does not absorb – slab has a low porosity
    - The more porous the slab, the less open time for adhesive-moisture
    - Moisture from the adhesive will absorb into the slab
    - The lower the porosity, the longer the open-time is for adhesives
    - Moisture needs to evaporate from adhesive, rather than being absorbed into concrete
    - Water cement ratios and on-site finishing methods are two key factors determining the amount of porosity a concrete slab displays.

DEW POINT (condensation)

Dew Point is another factor that comes into play with all the other concerns regarding moisture, pH and concrete science. Dew Point is the temperature at which condensation forms.

HUMIDITY

- **Humidity** is the amount of water vapor in the air and can be described in different ways.
- **Relative humidity** is the term used most often in weather information for the public.
- **Relative humidity** is the amount of water vapor in the air compared with the amount of vapor needed to make the air saturated at the air's current temperature or more simply; the amount of moisture in the air in percentage.

PATCHING COMPOUNDS

1. **GYSUM BASED:** White in color – lower psi rating – susceptible to mold and mildew. Expands during dry out and expands with moisture after it is cured.
2. **PORTLAND BASED or CEMENTITIOUS:** Usually gray in color – higher psi rating – will not promote mold and mildew may shrink during dry out period - may need to apply a second coat
3. **SELF-LEVELING COMPOUNDS:** Used for irregular substrates

SEALER – PENETRANTS

1. Liquid sealers / penetrants are top coatings for a concrete slab and reduce the amount of vapor emissions by filling in the capillaries – usually silicate-based.
2. NOT all sealers are ready for floor coverings within 24-72 hours
3. Sealers address moisture, but not all are resistant to pH and can react with certain adhesives, causing a failure.

REMOVAL of EXISTING FLOORING

Proper precaution and OSHA procedures must be taken if there is an existing floor covering that may contain ASBESTOS. If in doubt, assume that flooring contains asbestos until properly tested.

For existing and remodel projects, removal must be addressed at the time of the sale! This is critical to the success of the installation!

A salesperson who is knowledgeable can direct the end user in the right direction and offer the proper corrective procedures, resulting in a successful sale AND installation.

Asbestos removal systems should be used by abatement companies. The majority of installation firms are not experienced or qualified concerning the chemicals necessary for removal or the proper techniques and disposal methods. CFI suggests that a recognized abatement firm be contacted.

SECTION 5 – Grade Levels

It is very important to be aware of the grade level so the correct flooring will be used.

IMPORTANT: <u>ALWAYS</u> follow manufacturer guidelines! NOTE: If there is more than 3" of soil against any wall, the entire level is considered to be **BELOW grade.**

SUBFLOOR GRADE LEVELS

Ground should be sloped away from the house (3" in 10') for proper drainage

- **ABOVE GRADE**
- **ON GRADE**
- **BELOW GRADE**

GRADE LEVEL

1. If there is more than 3" of soil against any wall, the entire level is considered to be **BELOW grade.**
2. Ground should be sloped away from the house (3" in 10') for proper drainage
3. Three grade levels are recognized as above-grade, on-grade and below grade.
4. Prior to installing flooring, concrete slabs must cure for a minimum of 90-120 days unless the manufacturer states otherwise.
5. Before beginning moisture testing, slab should be cured a minimum of 30 days (check with manufacturer)
6. Tolerance should be flat to within 1/4" in 10-feet 1/16" in 1-foot.
7. Slabs on, above, below grade, and lightweight concrete should have a vapor retarder installed.

Onsite Conditions

1. Building should be closed in and outside doors and windows must be in place.
2. In warm months the building must be well ventilated.
3. Basements must be dry and well-ventilated.
4. Crawl space must be dry and must be a minimum of 18” from ground to underside of joists with perimeter venting.

SECTION 6 – SUBFLOOR TYPES

A. SUBLFOOR TYPES - IMPORTANT INFORMATION

According to the IRC (International Residential Code) and the IBC (International Building Codes), the general contractor must **provide a suitable subfloor** for the tile installer. (TCNA Handbook)
The installation of direct bonding of tile to a wood board subfloor, plywood, OSB and particleboard is considered by the ceramic tile industry as a high-risk-of-failure installation.

1. SUBFLOOR GUIDELINES - CONCRETE

a. Concrete slabs shall be cured for a MINIMUM of 28 days before ceramic tile can be installed. **ALWAYS** KNOW the manufacturer’s requirements.
b. Subfloor must be flat, dry, sound, clean and free of abrupt highs and lows.
c. Tolerance should be flat to within 1/4" in 10-feet, 1/16” in 1-foot
d. High spots should be ground down with grinder with dust containment system.
e. Low spots must be filled in with a proper leveling compound.

RULE OF THUMB:

- Draw a nail across the top. If it leaves an indentation, it is probably lightweight concrete
- Slabs on, above, below grade, and lightweight concrete should have a vapor retarder installed.

2. PLYWOOD SUBFLOOR SPECIFICS

a. The problem with bonding tile to wood products is NOT in bonding to the wood, because the bond is achieved, but the tremendous movement characteristics of wood itself as dimensionally unstable.
b. The wood products expand and contract creating problems.
c. Moisture, type of wood, relative humidity, installation on interior or exterior and how well the wood is nailed or adhered affect the amount of movement.
d. Tile is brittle and requires a dimensionally stable surface upon which to be bonded.
e. This problem can be corrected by applying a mortar bed or cement backer board. Each of these provides a dimensionally stable substrate and is more serviceable and compatible for ceramic tile.

3. GYPSUM BOARD (DRY WALL)

a. Typically installed on walls and tiling over it in a dry area is acceptable.
b. Use a dry set mortar or an organic adhesive (mastic) to bond the tile to the surface
c. Not suitable for a wet area, such as a tub or shower. Water will deteriorate the gypsum and result in a failure
d. Use water-resistant gypsum board in wet areas. However for a longer, lasting installation, a mortar bed or cement backer board can be applied over the gypsum in these areas. Consult the TCNA Handbook for the best method of application

4. **CEMENT BACKER UNIT (CBU)**
    a. Generally consists of portland cement, aggregate and fiberglass mesh exterior available in various sizes
    b. May be applied over wood studs on walls, over plywood subfloor, over counter tops, over gypsum wall board or almost anywhere that a mortar bed can be used.
    c. Cement backer board is the next alternative to use when the wire reinforced mortar bed behind ceramic tile is not possible or time constraints will not allow.
    d. ***Always*** follow the manufacturer's specifications for installation.
    e. The preferred method of attaching the panels is with manufacturer-recommended screws or galvanized nails with a minimum penetration of ¾-inch into the substrate.
    f. Cover the joints of the board with "alkali-resistant" fiberglass mesh tape and a coat of bonding material applied over and under the tape.
    g. **CONCERN:** The CBU will mirror whatever surface placed over it. It is critical to inspect the substrate and check for irregularities such as high spots, depressions and other imperfections that may create a potential problem. These must be removed or filled to achieve a flat installation.
    h. It is also critical that the joints be taped and coated with mortar per the manufacturer's instructions. If not done, cracking may develop along the joints of the board resulting in repair work and an unhappy customer.

B. Treatments and corrective procedures

The special treatments or corrective procedures should not be confusing. They are easily understood:

- Cover or replace unsuitable substrates
- When installing over substrates that tend to move slightly, use an elastic mortar (latex or acrylic) that bends rather than breaks
- Roughen up hard-to-bond surfaces
- Cover cracks with a membrane

SECTION 7 – Basic Overview of Ceramic Tile prepared by Dave Gobis, Industry Consultant

Poorly prepared substrates and the use of improper setting materials are the cause of many major installation failures. Not all latex and acrylic additives are designed to do the same job. For example, some are not recommended over plywood.

Thousands of tiles are made worldwide. The sale of tile products has escalated during the past ten years and is expected to continue. Ceramic tile has many advantages. It is available in a multitude of colors, shapes, sizes, textures, glosses, and features. This variety lends itself to an unlimited spectrum of design possibilities. Many tiles are available in "modular sizes" with grout joints that line up with various sized tiles. Tile lasts for a long time.

Tile can be installed floors, walls, countertops, ceilings, pools, tubs, showers, outside walls, even moving surfaces as found in motor homes and boats can be tiled. But the tile must be properly selected and properly installed. Substrate selection and preparation are of vital importance.

A complete lesson on tile is not possible in this article but there are a few basics. One concern is to use proper wear ratings for areas exposed to traffic. A simple chart inserted here can be used as a guide for consumer selection. This chart refers to glazed tile products only; don't oversell the product especially in the case of porcelain. Glazed porcelain is glazed porcelain; you walk on the glaze, not the body.

There are six ratings that outline the recommended use that can be achieved by the glazed tile wear test (0 to V).

O. Decorative only with no use on floors
I. Light foot traffic without scratching dirt and direct outside access, such as residential bath
II. Residential areas without exposure to abnormal footwear or outside access
III. Normal residential areas and normal footwear and traffic
IV. Commercial foot traffic such as entrances, kitchens, offices and sales rooms
V. Areas subjected to severe pedestrian traffic such as airports, shopping centers, hotel foyers, public walkways, and industrial applications.

The adhesives and grouts must be properly selected for the type of tile, surface to receive the installation, and expected use. Above all, don't oversell the product or installation system. The industry standards are published and available from the Tile Council of America at *www.tileusa.com* or by calling (864) 646.8453. These guide you toward proper recommendations. Certain construction techniques and building materials are either not compatible with ceramic tile or require additional attention to detail.

Deflection of the substrate (the surface to which the tile is bonded) must be less than L/360. This simple statement means that any span or section of span must not deflect with the expected static and dynamic loads more then the length of the span (L) divided by 360. Static loads are furniture, cabinets, appliances and other normally not moving objects while dynamic loads include people, dogs, moving objects, etc.

There are three main categories of tile work failures. *The first* is the deflection mentioned above and this is rectified by adding strength to the system such as a second sheet of plywood. *Second*, is the lack of coverage of the setting material. The standards require at least 80% of the tile in dry areas, on an average to be covered by adhesive and bonded with no voids (air trapped beneath the tile). In wet areas such as showers and tubs, the requirement is for 95% coverage. This is harder to do with larger tiles and has become a greater problem recently. Tiles greater than 8" x 8" need to have the trapped air released from underneath.

Third, there must be an allowance for movement. This is done by using soft joints (caulk) instead of hard grout in the required places. These places include intersecting planes (walls and floors for example), between dissimilar materials (fiberglass, metal, wood floors, etc.), and in large areas of tile (this varies with the potential changes in the ambient temperature). Put, buildings move and materials expand and contract with temperature, moisture, wind load, and other factors and allowances must be made for this movement.

The Tile Council of America has been publishing the *Handbook for Ceramic Tile Installation* for 41 years. This industry consensus publication shows the tried and true details for tile installation. It does not cover every situation and is not a DIY instruction book. However, by following the methods, the possibility of failures is reduced. This does not mean that other methods will fail, but the person doing things their own way by designing their own system is taking a big chance. The TCA also publishes the American National Standards Institute (ANSI) standards for ceramic tile and for the installation of tile. These are critical documents to obtain, read and use. Many architects rely on these standards for their specifications. As always, local practices and building codes prevail over these standards.

CERAMIC TILE CHARACTERISTICS

GLAZED CERAMIC TILE

These tiles are made up of two parts – the body, which is called the **BISQUE**, and the surface, which is called the **GLAZE**. The ingredients are all natural materials mined from the earth. The main ingredient is clay. Types of materials vary from company to company, but include such elements as quartz, kaolin, fritz, dolomite, cobalt selenium and talc. The manufacturing of single-fired glaze tile can be broken down into five parts: mixing, molding, glazing, firing and completion.

All the raw materials that are used to manufacturer ceramics come from the earth, including the color of the glaze. While man has been successful in finding ways to improve most products by substituting natural materials with synthetics, they have not been able to improve on the quality of raw materials found in ceramics, which have remained unchanged for thousands of years.

IMPORTANT: In order to use the proper thin-set materials, the installer must possess the knowledge of the different types and installation requirements of each type of tile.

TWO BASIC GROUPS

Glazed tiles These are made the same as unglazed tiles except that a glass wear layer, called a glaze is fused to its surface by means of tremendous heat.

Unglazed tiles True inlaid; simply baked pieces of clay where colors run throughout the body of the tile.

FEATURES

A. GLAZED TILES

1. Most glazed tiles are NOT suited for heavy commercial installations. They are generally suited for light residential to medium commercial use. There are exceptions. Technology for glazes has improved dramatically. New glazes are hard and durable enough for heavy use.

2. ADVANTAGES of GLAZED TILES

The glaze offers the manufacturers the ability to produce an unlimited array of beautiful colors and designs.
The non-porous glaze creates a smooth surface that is practically stain proof.

3. FACTS ABOUT THE GLAZE

The glaze is a liquid glass that has been sprayed or poured onto the surface of the tile. It is then fused and hardened by strong heat. The colors of glaze are made from a mixture of minerals such as gold, silver, zinc, copper, mercury, cobalt and others.

4. HARDNESS

The strength and wear resistance of the tile is determined by its hardness.

- Temperature – the higher the kiln (oven) temperature, the harder the glaze.
- Color – Dark color glazes, such as blacks and blues are usually softer than light colored ones.
- Gloss levels – shiny glazes are usually softer than mat or satin finished glazes.

B. UNGLAZED TILES

1. DESCRIPTION

Superior strength for heavy commercial use as well as residential; the rugged surface texture and mat finish of the unglazed tile give them good “slip resistant” qualities for use in wet areas.

These tiles are the workhorse of the industry. They are generally thicker and denser than glazed tiles. They include such products as quarry tiles and porcelains.

The tough inlaid qualities of most unglazed tiles make them ideally suited for, but not limited to, extra heavy commercial installations. Many customers appreciate the natural qualities and beauty of unglazed tiles for residential use.

The color in the tiles is generally limited to the natural colors of clay….ranging from light sand to a red brick tone, with exceptions. Manufacturers achieve a wide range of beautiful colors by mixing color pigments in with the clay.

2. ADVANTAGES

Superior strength for heavy commercial use as well as residential; the rugged surface texture and the mat finish give them good "slip resistant" qualities for wet areas.

3. FACTS ABOUT CLAY

The clay body, also called the **BISQUE**, is made up of various types of clay and other minerals. Combined, these raw materials give the BISQUE its strength and stability, which is also determined by its density. The strongest BISQUES are for heavy commercial installations have the smallest and fewest number of air pockets.

4. TILE DENSITY

The density of the clay also determines if the tile is suitable for outdoor use. Tiles that are too porous, absorbing more than 3% moisture will freeze and crack if installed outdoors in cold climates. The density of the tile is measured by the amount of water it absorbs. The labels state where the tile may be used and if it is frost resistant.

a. **NON-VITREOUS TILES** – absorb 7% or more of their weight in water – for indoor use only
b. **SEMI-VITREOUS TILES** – absorb 3-7% water – suited for indoor use only.
c. **VITREOUS TILES** – absorb 0.5% - 3% water – suited for interior and exterior use (frost resistant).
d. **IMPERVIOUS TILES** are the strongest. They absorb between 0 – 0.5% of their weight in water.

5. WEAR RATING SYSTEM – P.E.I.

The Porcelain Enamel Institutes (P.E.I) rating has nothing to do with the price, only the durability. Some of the most expensive and luxurious tiles rate only I or II. The ratings go from Group I to Group IV+, with the IV+ Group being the most durable.

C. DESCRIPTION of POPULAR UNGLAZED TILES

1. **QUARRY TILE** – Unglazed tiles made from clay and shale; colors limited to earth tones, but manufacturers add pigments to the clay to offer a wider color variety. Thick and dense; a popular choice for both heavy commercial and residential use. Surface is generally slip resistant.

2. **PORCELAIN TILES** – Made of special clays and minerals similar to those found in China (fine dishes). Available in a wide range of colors; highly stain resistant and strong. Finish is plain, rough or polished. Ideal choice for heavy commercial and residential use.

3. **TERRA-COTTA TILES** – Tiles are handmade or machine-made pavers. The machine-made tiles are much denser and can usually be installed outside as they are frost resistant. The most popular handmade tile is from Mexico (Saltillo) and are crudely made, vary in size, shade and texture, are very porous and must be sealed and waxed to prevent staining and wear.

4. **MOSAIC TILES** – Small tiles, less than 9 square inches in size, mounted on perforated sheets for easy installation. Usually, very dense, tough and highly stain resistant. Ideal for shower because the size allows flexibility to conform to the floor as it slopes to the drain. Toughness and stain resistance make them ideal for counter tops. Most are unglazed, but can be produced with a glaze.

D. DESCRIPTIONS of ADDITIONAL TILE

1. **MARBLE**
   Marble is made from nature; it is not a man-made substrate and can be inconsistent. More veining can mean a stone may be more brittle and susceptible to breakage or fill removal, even after installation. Marbles have voids and faults filled with cement and epoxy prior to shipping the finished product.

   More technically, marble is a limestone that has crystallized due to a geological metamorphism over a very long period of time, ranging from 7 to 120 million years. The Marble Institute of America assigns group classifications for soundness and working qualities. "D" marble are generally more decorative and more expensive than "A" marble.

   Group A – Sound marbles with uniform, favorable working qualities and suitable for heavy traffic.

   Group B – Similar in character to "A" marble, but working characteristics are somewhat less favorable, occasional natural faults; suitable for most normal traffic – light commercial; residential.

   Group C – Somewhat less favorable working qualities; geological flaws, voids, veins and lines of separation; suitable for walls and very light traffic areas.

2. **TERRAZZO** – Primarily a concrete composition with marble chips mixed in. Composed of 70% - 95% marble, it was very popular in the 1930's – 1950's. It can be polished as all stones.

3. **AGGLOMERATE MARBLE** – This material is sometimes call modern day terrazzo and is composed of 90-05% marble. The marble chips are bound with resin; may have a granite-like appearance. This material tends to be soft; but reacts with normal maintenance and restoration procedures.

4. **TRAVERTINE** – Ivory to golden brown colored limestone formed over 600,000 years by precipitation in hot, mineral springs. It comes from the ground, relatively "hot" compared to marble, but hardens with age and exposure. It has a sponge-like texture with up to ½" holes and is much softer than marble.

5. **LIMESTONE** – A sedimentary rock; relatively soft, weathers well. Has a tight-grained appearance and usually is seen in a honed (unpolished) state. Tends to be much more porous and needs special attention. Most limestone can be polished, but the polish is generally not durable.

6. **GRANITE** – Derived from an Italian word; "granito," meaning grained. It is very hard, crystalline, igneous or metamorphic rock primarily composed of feldspar, quartz and less amounts of dark minerals. Mineral grains are visible and are a distinct characteristic of granite. Granite can be 10 times harder than marble and is considerable less porous than most marbles; more resistant to wear and damage. The surface is difficult to restore.

7. **ONYX**– An agate-like stone formed by precipitation in cold mineral springs. It is often translucent with a layered appearance. It is not used extensively and caution is to be used when working with Onyx.

8. **SLATE** – A stone that does not take polish. A fine-grained metamorphic rock derived from clays and more often, shales. It has a cleavage that permits it to be readily split into thin, smooth sheets. Most popular colors are green and black, but new shades are imported.

SECTION 8 – MATERIALS and USES

A. MATERIALS AND USES to be noted on the diagram (if applicable)

1. **Cement backer board -** Used to cover wood subfloors, wood steps and risers and all wet areas; eliminates the need for wire mesh and mortar coat.

2. **Cut-tile base -** Trim piece cut from the floor tile and used around the perimeter of the walls in place of bull nose.

3. **Marble thresholds -** A reducer used at doorways; most commonly in bathrooms

4. **Vinyl cap -** Trim piece that is used to cover the unglazed edge of a tile. Ideal for the top edge of a cut-tile base. It can also be used to make the transition between the ceramic and vinyl or wood.

5. **Bond coat strengthener -** Latex additive mixed with the mortar in place of water. It must be used when tiling over a non-porous subfloor.

6. **Grout protectant -** Latex additive mixed in the grout in place of water. It adds resistance to staining and should be used when working with light colored grouts.

B. MATERIALS FOR SETTING CERAMIC TILE (Installation Procedures in Section 14)

The most widely-used materials for setting ceramic tile each possess qualities for installation under certain specifications. The **CONVENTIONAL PORTLAND CEMENT MORTAR** application, including the one-coat method is the only recognized thick-bed application. The other types are thin-bed methods.

1. TYPES

A. PORTLAND-CEMENT MORTAR
Mixture of Portland cement and sand, roughly in proportions of 1:5 for floors

1. Suitable for most surfaces
   A. Mortar bed of up to 2-inches in thickness
      1. Two methods:
         a. Set tile on a mortar bed that is still workable
         b. Set tile on a mortar bed with dry-set or latex/polymer modified Portland-cement mortar

Dry-set mortars and latex-portland cement mortars can be used in place of a neat cement (portland-cement mixed with water to a desired consistency) as a 1/16" thick bond coat to bond ceramic tile to a Portland cement mortar bed that is workable. This is also used on a cured Portland cement mortar bed (minimum 3/32" thickness after tile is embedded). Absorptive ceramic tile must be soaked before setting on a mortar bed that is still workable when using a neat Portland cement bond coat. A minimum of 20 hours cure at 70 degrees is adequate, but longer mortar bed cures of up to 10 days are preferred.

B. DRY-SET MORTAR

Mixture of portland cement with sand and additives imparting water retentively, which is used as a bond coat for setting tile.

a. Suitable for use over a variety of surfaces
b. Used in one layer as thin as 3/32”
c. Excellent water and impact resistance
d. Water-cleanable, non-flammable
e. Good for exterior work
f. Does not require soaking of tile

C. LATEX/POLYMER MODIFIED PORTLAND CEMENT MORTAR

Mixture of portland cement, sand and special latex/polymer additive used as a bond coat for setting tile.

a. Uses are similar to dry-set mortar
b. Less rigid than portland cement mortar
c. If used in an area that may not dry out (pools, showers), it is recommended that the completed installation be allowed to dry out thoroughly BEFORE exposure to water (14 to over 60 days depending on climate, exterior, interior, etc.)

D. EGP (EXTERIOR GLUE PLYWOOD) LATEX PORTLAND CEMENT MORTAR

Modified portland cement dry-set mortar to which a polymer is incorporated in latex form to bond ceramic tile to exterior glue plywood in interior dry or limited water exposure areas only.

E. EPOXY MORTAR

Mortar system designed for chemical resistance employing epoxy resin and epoxy hardener portions.

a. Suitable for use where chemical resistance of floors, high-bond strength and high-impact resistance are important considerations.
b. High temperature resistant formulas are also available.
c. Acceptable subfloors, when properly prepared include:
    - Concrete
    - Wood and plywood
    - Steel plate
    - Ceramic tile
d. Application is made in one thin layer
e. Pot life, adhesion, water-cleanability before cure and chemical resistance vary with manufacturer.
f. Epoxy grout is also available.

F. MODIFIED EPOXY EMULSION MORTARS

Mortar system employed emulsified epoxy resins and hardeners with portland cement and silica sand.

a. Formulated for thin-set installations of ceramic tile on floors and walls, interior and exterior
b. Features include high-bond strength, ease of application, little or no shrinkage and economical
    epoxy application
c. NOT designed for chemical resistance
d. Recommended for residential floors, over substrates such as glass mesh mortar units and concrete
e. 100% coverage is required where firm support under the tiles is mandatory
f. Some manufacturers recommend this as a bond coat or setting material and also for grouting.

G. FURAN RESIN MORTAR

Mortar system designed for chemical resistance consisting of furan resin and furan hardener portions.

a. Suitable for use where chemical resistance is an important consideration
b. Acceptable sub-floors when properly prepared include concrete, wood and plywood, steel plate and ceramic tile
c. Furan grouts are also available

2. ADHESIVES

A. EPOXY ADHESIVE

1. Epoxy adhesives are used in place of thin-set mortar materials, but the installation methods are the same.
2. Adhesive system employing epoxy resin and epoxy hardener portions.
3. Epoxies are usually a two-part system that is to be mixed prior to use. Each has its own use.
4. Formulated for thin-setting of tile on floors, walls and counters.
5. Designed primarily for high bond strength and ease of application, not for optimum chemical resistance, but tends to be better than that of organic adhesives
6. Spot-bonding epoxy is a multi-component high-strength epoxy adhesive designed for spot bonding

B. ORGANIC ADHESIVES

1. Interior use only; ready to use with no further addition of liquid or powder, which cures or sets by evaporation
2. Suitable for tile installation on floors, walls and counters where surfaces are properly prepared.
3. Suitable prepared backings for DRY areas include gypsum board, gypsum plaster, portland-cement mortar, formed concrete and masonry.
4. Suitable prepared backings for WET areas include portland-cement mortar, formed concrete, masonry.
5. Adherence to ANSI A136.1 is a minimum criterion for selecting an organic adhesive.
6. Organic adhesives are not recommended in areas exposed to temperatures exceeding 140F.

CONCERNS with organic adhesives

a. Shrinks as it dries, much more than mortar
b. Has low compressive strength compared to mortar
c. Stays moist and fresh inside a bucket and in conditions similar to the inside of a bucket and can lead to bond failures
d. Because of the issues with drying, they can only be used on tiles no larger than 6x6 inches for floors
e. Not suitable for swimming pools or exteriors
f. Supply some flexibility to the tile facing
g. Bond strength varies greatly among numerous brands available
h. Solvents in some adhesives are irritating to some persons and some are flammable

3. ADHESIVE APPLICATION

- Adhesives are applied in one thin layer with a trowel
- Use the flat edge for continuous coverage
- Use the notched edge for uniform thickness
- If leveling or truing is required, an underlayment is used

4. THIN-SET BED METHOD

Description

Thin-set or thin-bed method is the installation of tile with thin-bed bonding materials without using a mortar bed.

a. The majority of today's tile installations are set by using a thin-bed method.
b. Thin-bed installation is so common that many buildings are no longer designed to accommodate the thickness of a mortar-bed installation.
c. The thin-bed method direct-bond to the concrete floor uses for the first layer, dry-set or latex-portland cement mortar bond coat with the ceramic tile as the final layer.
d. If the floor is made of wood, the direct-bond method is not used.
e. Wood based panels, such as particle board, composition (veneer) panels, non-veneer panels such as CDX, OSB, etc, lauan and softwood plywood are not recommended as backing materials for direct bonding of ceramic tile.
f. Wood-based panels such as particle board, composition (veneer) panels, non-veneer panels (CDX, OSB, etc.), lauan and softwood plywood are NOT recommended as backing materials for direct bonding of ceramic tiles.
g. Each thin-set product is specific to meet the special needs of a particular installation.
h. Thin-sets are not designed to create a mortar bed in an undulating substrate.
i. Thin-set does not bond to the polymer accent pieces because of a non-porous surface.

5. BACKER BOARDS – UNCOUPLING SYSTEMS

SPECIFICS

- Thickness of backer board is ¼" for floors and ½" for walls are generally used.
- Thin-set is required under the backer boards for support

Suitable backer boards and wood underlayments:

A. CEMENTITIOUS BACKER UNITS (CBU)

1. Backing and underlayment designed for floors, walls, ceiling in wet or dry areas
2. Bond ceramic tile to it with dry-set, latex/polymer modified portland cement mortar or epoxy using the manufacturer's recommendations

B. COATED GLASS MAT WATER-RESISTANT GYPSUM BACKER BOARD

1. Designed for use on floors, walls, and ceilings in wet or dry areas
2. Applied directly to wood subfloors
3. Bond ceramic tile with dry-set, latex/polymer modified portland cement mortar, organic adhesive or epoxy
4. No vapor retarder used behind the panels on the walls

C. FIBER-CEMENT UNDERLAYMENT

1. Dispersed fiber-reinforced cement backer and underlayment
2. Designed for use on floors, walls, ceilings in wet or dry areas
3. Board is applied directly to wood or metal wall studs or wood subfloors
4. Bond to it with latex/polymer modified portland cement mortar, organic adhesive or epoxy

D. FIBER-REINFORCED WATER-RESISTANT GYPSUM BACKER BOARD - UNDERLAYMENT

1. Designed for use on floors, walls, ceilings in wet or dry areas
2. Board is applied directly to wood or metal wall studs or over wood subfloors
3. Bond to it with latex/polymer modified portland cement mortar, organic adhesive or epoxy
4. No vapor retarder used behind the panels on the walls

E. CEMENTITIOUS COATED FOAM BOARDS

1. Waterproof backer board constructed from extruded polystyrene and coated with a cementitious coating
2. Designed for substrate and use in wet and dry areas
3. Applied directly to wood or metal wall studs or over wood subfloors
4. Bond to it with dry-set latex, latex/polymer modified portland cement mortar or epoxy.

6. MEMBRANES

Description: A membrane is a flexible sheet used for multiple purposes including tile underlayment, waterproofing and crack isolation. A flat membrane is relatively thin and two-dimensional.

A. Waterproof Membranes

1. For use with both vertical and horizontal thin-bed and thick-bed tile installations. Types:
   a. Single or multi-component membranes applied in liquid/paste form which cure into continuous membranes
   b. Membranes applied in flexible sheet form
   c. Some have reinforcing fabrics for tensile strength and minor crack-bridge properties
   d. Others are a combination waterproofing and setting material for tile

B. Crack-isolation Membranes

1. Act to insulate the tile or stone from minor inplane substrate cracking
2. Membranes are bonded to a variety of manufacturer approved substrates
3. May be sensitive to naturally occurring moisture and alkalinity if used over cement and gypsum based substrate

C. Uncoupling Membranes

1. Plastic membrane system configured to provide air space between the tile and substrate
2. Allows independent movement between the two and limits the transfer of stresses

7. GROUT (Grout Installation Procedures in Section 15)

"A bad grout can ruin a perfect installation."

The quality of the grout affects the longevity and the maintenance requirements of the tiled area.

1. Use the recommended joint sizes stated by the manufacturer.
2. A common mistake is installing grout in joints that are too large, which causes problems.
3. Grout shrinkage produces unsightly results, particularly if unsanded grout is used in joint that are too large.
4. The grout's compressive strength may be too low when used it joints that are too wide.

SECTION 11 – RADIANT-HEATED FLOOR SYSTEMS

Description: Radiant-heating systems involve supplying heat directly to the floor or to panels in the wall or ceiling

- Systems depend largely on radiant heat transfer: the delivery of heat directly from the hot surface to the people and objects in the room via the radiation of heat, which is also called infrared radiation.
- Radiant heating is the effect you feel when you can feel the warmth of a hot stovetop element from across the room.
- When radiant heating is located in the floor, it is often called radiant floor heating or simply floor heating.

INSTALLATION of TILE OVER RADIANT SYSTEMS

- The substrate cannot exceed 85 degrees before, during or after installation.
- Check with the manufacturer of tile and thin-set for installation recommendations before installation.
- The system must be operational a minimum of 2 weeks prior to the tile installation.
- Special attention is to be addressed concerning radiant systems as many manufacturers of tile and thin-sets do not recommend direct-bonding to radiant substrate.

Types of Radiant Floor Heat

A. ELECTRIC RADIANT FLOORS

1. Electric radiant floors typically consist of electric cables built into the floor.
2. Systems that feature mats of electrically conductive plastic are also available, and are mounted onto the subfloor below a floor covering such as tile.
3. Because of the relatively high cost of electricity, electric radiant floors are usually only cost-effective if they include a significant thermal mass, such as a thick concrete floor, and your electric utility company offers time-of-use rates.
4. Time-of-use rates allow you to "charge" the concrete floor with heat during off-peak hours (approximately 9pm to 6am)
5. If the floor's thermal mass is large enough, the heat stored in it will keep the house comfortable for eight to ten hours, without any further electrical input (particularly when daytime temperatures are significantly warmer than nighttime temperatures).
6. Electric radiant floors may also make sense for additions onto homes for which it would be impractical to extend the heating system into the addition.

B. HYDRONIC RADIANT FLOORS

1. Hydronic (liquid) systems are the most popular and cost-effective radiant heating systems for heating-dominated climates.
2. Hydronic radiant floor systems pump heated water from a boiler through tubing laid in a pattern under floor
3. In some systems, the temperature in each room is controlled by regulating the flow of hot water through each tubing loop.
4. This is done by a system of zoning valves or pumps and thermostats.
5. The cost of installing a hydronic radiant floor varies by location and also depends on the size of the home, the type of installation, the floor covering, remoteness of the site, and the cost of labor.

C. The R-VALUE

1. The R-value indicates insulation’s resistance to heat flow.
2. The higher the R-value; the greater the insulating effectiveness.
3. It depends on the type of insulation and includes its material, thickness, and density.

4. When calculating the R-value of a multilayered installation, add the R-values of the individual layers.
5. Installing more insulation in the home increases the R-value and the resistance to heat flow.
6. Effectiveness of the insulation's resistance to heat flow depends on how and where the insulation is installed.
7. For example, insulation that is compressed will not provide its full rated R-value.
8. The overall R-value of a wall or ceiling will be somewhat different from the R-value of the insulation itself because some heat flows around the insulation through the studs and joists.
9. It is important to properly install the insulation to achieve the maximum R-value.
10. The amount of insulation or R-value needed depends on the climate, type of heating and cooling system, and the section of the house to be insulated.

SECTION 10 – DEFLECTION – JOIST SPACING

A. DEFLECTION

Description: Deflection is to bend, flex or bow. Wood expands and contracts when the moisture content changes. Wood substrates deflect under loads more than concrete substrates.

1. A substrate must be rigid enough that the floor will not deflect for ceramic tile installations.
2. The amount of deflection in a floor must be minimized to prevent failures where the most bending occurs. This is between the floor joists and over the joists.
3. Too much deflection causes cracked and powdered-out grout joints followed by the appearance of unsightly tiles.
4. If the subfloor is made of wood panels fastened to joists, the greatest amount of subfloor deflection occurs in the subfloor panels at the midpoint between joists under concentrated loads.
5. Too much deflection at this point causes cracked and powdered grout joints, followed by cracked and debonded tiles over time.

B. JOIST SPACING

1. Most installation methods limit joist spacing to 16” on center.
2. All methods require the subfloor to be at least 19/32” thick, or 5/8”.
3. Others require a thickness of ¾-inch.
4. A spacing of 1/8-inch is recommended at all end and edge joints on all sides to provide room for the wood to expand. If ignored, this can cause tiles above butted panels to crack or debond (loosen).

SECTION 11 – TILE INSTALLATION PROCEDURES

A. TILE-SETTING PROCEDURES

1. Inspect areas to set tile
2. Address potential concerns
3. Prepare the area to receive the mortar bed, CBU, etc.
4. Lay out the area and establish gridlines
5. Install tile using appropriate adhesive
6. Check that the proper bond is achieved
7. Clean surface and grout joints of excess adhesive
8. Grout area
9. Clean thoroughly

B. ITEMS THAT AFFECT THE FLOOR INSTALLATION PERFORMANCE

1. Joist spacing
2. Subfloor thickness
3. Underlayment type
4. Underlayment thickness
5. Bonding material type
6. Grout type
7. Tile size
8. Tile type

C OPTIONS FOR THE INSTALLATION OF TILE

1. Ceramic tile set with dry-set portland cement mortar on a cured mortar bed
2. Ceramic tile set on a plastic (wet) mortar bed
3. Tile set with dry-set portland cement mortar or latex portland cement mortar on prepared concrete, masonry, glass mesh mortar units or other cementitious underlayment and backing units certified by the manufacturer as suitable for the intended use
4. Tile set with organic adhesives or epoxies adhesive on smooth, sound interior surfaces
5. Tile set with modified epoxy emulsion mortar
6. Tile set and grouted with water cleanable, chemical resistant tile setting epoxy mortar

D. TYPES of INSTALLATION

1. THIN-SET / THIN-BED METHOD

a. Thin-bed installation is so common that many buildings are no longer designed to accommodate the thickness of a mortar-bed installation.
b. The thin-bed method direct-bond to the concrete floor uses for the first layer, dry-set or latex-portland cement mortar bond coat with the ceramic tile as the final layer.
c. If the floor is made of wood, the direct-bond method is not used. Wood based panels, such as particle board, composition (veneer) panels, non-veneer panels such as CDX, OSB, etc, lauan and softwood plywood are NOT recommended as backing materials for direct bonding of ceramic tile.

2. THE MORTAR BED

To install tile using the wire reinforced mortar bed method, follow these steps:

a. Inspect the area to receive tile
b. If it is a floor, the wood subfloor must be properly fastened with the nail pattern 8-inches in field and perimeter.
c. Staple a layer of 15-pound roofing felt to the wood subfloor
d. Reinforce the wire, either a 2.5 gauge expanded metal lathe or 2” x 2” welded wire mesh and lay it over the felt, but not attached to the subfloor. It is supported so when the mortar is installed, the wire will be in the center of the mortar.

e. Establish the screed line by placing float sticks in a row of mortar and leveling it so the floor is either flat or sloping toward a drain.
f. Place the cement mortar and tap into place. Using a straightedge, rod off any excess mortar
g. After the mortar has reached its initial set, rub the surface with a wood or resin float to remove any high spots.
h. Fill the low spots from rodding it with the straightedge. This also tightens up the mortar to provide a solid surface to set tile.

After the mortar bed has cured

i. Determine the starting point for the layout. Layout the gridlines
j. Mix the thin-set mortar according to the manufacturer's specifications
k. Begin spreading the thin-set on the mortar bed using the flat side of the notched trowel to achieve an even coat of material
l. Use the notched side of the trowel to comb the material to achieve a consistent thickness of material
m. Place the tile into the thin-set, using a twisting motion to achieve full contact with the tile
n. Straighten the tiles using a straightedge or spacers to keep the tile square and straight to the grid lines
o. Clean off any excess thin-set from between the tiles and from the surface of the tiles.

3. PLASTIC (WET) MORTAR BED

This method requires more skill on the part of the installer. The steps are the same with the exception:

a. The mortar bed is not cured first
b. The tile is set into the wet mortar using a bond coat of portland cement applied to the mortar
c. Press the tile into the mortar
d. All other steps remain the same

4. DRY-SET PORTLAND CEMENT MORTAR

This method is used for setting tile over prepared concrete, masonry, glass mesh mortar units or cement backer units or other cementitious underlayments.

Preparation for the Dry-Set Portland Cement Mortar

a. Inspect these surfaces to make sure they are clean, dry and free or any sealers
b. If installing tile directly over concrete, find your layout and draw grid lines
c. If installing over cement mortar units and you are installing the cement mortar units, install them first.
d. Fasten the backer board according to the manufacturer's installation instructions.
e. Draw the starting lines and grid lines after determining the cuts at the perimeter are at ½ tile or greater
f. Mix the thin-set according to the instructions.
g. Key in an even coat of thin-set with the flat side of the trowel
h. Comb with the notched side of the trowel to achieve an even consistency
i. Place the tile into the thin-set with a back and forth motion to securely bond the tile
j. Wipe off any excess material from the grout joints and the surface of the tile
k. Straighten the tiles with a straightedge or with spacers to the grid lines.

E. CHECKING FOR PROPER BOND

It is important to check the proper bond. This is done by:

1. Periodically lifting a tile after setting it into the adhesive.
2. Inspect the back of the tile for complete coverage with setting material
3. If it is not completely covered, apply more adhesive or back butter the tiles
4. Check that the correct notch trowel is used
5. Dry areas require 80% coverage on the back of tile.

6. Wet areas require 95% coverage on the back of tile.
7. A minimum of 3/32" to 1/8" thin-set is required under the tile after setting.

F. BACK BUTTERING

This is done when the back of the tile has large lugs or grooves.

1. Apply adhesive directly to the tile with a margin trowel
2. Cover the entire surface to achieve the proper bond

After the thin-set has cured

1. The tile is ready to grout
2. Using masking tape, cover any adjacent material before grouting
3. Mix the grout to manufacturer specifications.
4. Use a rubber grout float to move the grout in a direction diagonal to the grout joints
5. Hold the grout float at a 45-degree angle to the tile
6. After forcing grout into the joints, float at a 90-degree angle to the tile
7. Pull across the tile in a diagonal direction to remove excess grout from the surface of the tile
8. Use a damp sponge to wipe the tile diagonally in one direction once with each side of the sponge
9. After the grout has set up, a film is visible on the surface. Remove with cheesecloth, using a polishing action.
10. Remove the masking tape from adjacent areas to complete the installation.

SECTION 14 – GROUTING THE TILE

A. MIXING: Proper mixing is extremely important!

1. Follow the manufacturer's recommendations for the amount of liquid to use.
2. Water should be clean and cool.
3. Before mixing the powder with water or a polymer additive, dry-blend the bag of powder for a consistent blend of all components.
4. Create a stiff working consistency that must be scooped out of the bucket with a trowel or a float.
5. Follow the recommended mixing speed and time. Usually, lower speeds are specified because mixing too fast or too long produces weaker grout if air is trapped.

PROBLEMS OCCUR when the grout is mixed with too much liquid or when liquid is added to the grout during the grouting process to keep the material workable.

B. SPREADING THE GROUT

1. Shading variations occur when the grout joints vary in width or depth.
2. Remove all mortar before grouting.
3. Wipe the surface with a damp sponge immediately before grouting using very little water.
4. Firmly pack grout into clean joints. Good compaction produces dense grout that is stronger and more stain-resistant.
5. DO NOT pack grout into movement joints.
6. Remove as much excess grout as possible to minimize the amount of water that is necessary for washing and tooling the joints later.
7. If the grout becomes too stiff, remix it by hand, but DO NOT add water.

C. ROUGH WASHING

1. Grout must be firm in joints before beginning to rough wash.
2. Press on the grout; if ready the surface will be dry enough not to dent. Usually, it becomes a lighter color.
3. It can take between 5 and 45-minutes before grout is ready to wash

4. Factors that impact this
    a. High temperatures and low humidity cause faster drying
    b. porous tiles absorb moisture and cause faster drying
    c. smaller grout joint dry faster
    d. Stiffer, drier grout dries faster
5. Wash the tiles with a minimum amount of water and tool the joints and wring the sponge out thoroughly
6. Minimizing water will:
    a. Make the grout stronger, denser and more stain and abuse resistant
    b. Grout remains firmer during the washing process to avoid low grout joints
    c. Grout color is more consistent
    d. Installation is completed sooner if the grout stays fairly dry during the process
7. Sculpt joints into crisp, uniform, smooth grout lines
8. Leaving the joints too high results in an unsightly appearance, but do not wash too low.

D. FINAL WASH

1. Allow the grout film to dry to a haze.
2. Use firm, steady pressure to wipe off the haze with a thoroughly wrong out sponge rinsed with clean water
3. Make only one pass with each side of the sponge before rinsing it clean
4. Continually wring and wash out the sponge
5. Stay on the job until the final wash water has dried and there is no longer a visible film on the surface of the tile.
6. Once the grout has hardened somewhat, cut the grout off in a clean line if it has entered a movement joint that will be visible in the finished installation.

E. CURING and PROTECTION

1. Restrict traffic in freshly grouted areas – **NO** heavy traffic for at least 24 - 72 hours.
2. Avoid water exposure and freezing temperatures.
3. Allow extended cure times when temperatures are below 60-degrees and/or relative humidity is above 70%.
4. “Cover curing” or “damp curing” cementitious grout produces stronger grout and darker shading.
5. To damp cure new grout, mist the completed installation with cool, clean water.
6. Cover with protective paper that is free of dyes.
7. Grout improvements make damp curing virtually unnecessary, but this procedure enhances performance.

F. CAULKING

1. Fill visible movement joints with a compressible material, not grout.
2. A “flexible sealant,” such as 100% silicone or urethane, is to be used in place of latex or acrylic caulks.
3. Caulks are worn down by exposure to chemicals, cleaners, moisture, traffic, temperature changes, sunlight and movement.
4. Flexible sealants must bond to the edges of tile, but not the substrate.
5. For joints that **do extend** below tile, such as a saw-cut control joint in concrete, insert a foam backer rod into the joint before filling it with sealant.
6. Install bond breaker tape in joints that **do not extend** below the tile before filling with sealant.
7. With tape and a bond breaker in place, fill the joint if the edges are clean and dry.
8. In a few minutes, remove excess sealant and form the joint with a forming tool.
9. After forming the joint, quickly remove the tape and touch-up any imperfections before the sealer has set.
10. Protect the sealant from traffic for at least 24-hours.
11. In place of filling the joints with sealant, pre-made movement joints in the form of strips are installed during the tile installation.
12. Apply mortar under and over these prefabricated strips or the tiles may crack.

Refer to the manufacturer guidelines for complete installation instructions