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CEMENT vs ADHESIVES – A COMPARISON

TECHNICAL ARTICLE
TB 05
info@rachtr.com

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Cement is a fine, grey **powder that is used as a construction binding material.** When mixed with water, cement reacts chemically and becomes hard and strong. Cement is categorized as either hydraulic or nonhydraulic, depending on how it mixes with water.

Nonhydraulic cement does not harden underwater or in damp conditions. Certain chemicals are added to make hydraulic cement, which sets underwater or in wet conditions.

Cement is made by combining silicon, aluminum, iron, calcium and other chemicals in a controlled mixture. Other materials added to the mixture include chalk, clay, slate and limestone.

When combined, the ingredients form a hard substance that is ground into cement. It is mixed with water to form mortar or mixed with sand, gravel, and water to make concrete.

White Cement, Difference between Grey and White Cement:

White cement is largely used to increase the aesthetic value of a construction. It is a kind of Ordinary Portland Cement inclusive of clinker, fuel oil and iron oxide. The content of iron oxide is maintained below 0.4% to secure whiteness. White Cement and Grey Cement are usually compared on five terms which are as follows:

1. Raw Material: Grey colour of the cement is mainly due to high content of oxides of iron, manganese and chromium which are present in limited amount in white cement.

2. Strength and Setting Time: Its setting behavior and strength development are essentially the same as those expected in grey cement.

3. Fineness: White cement is usually finer than grey cement and thus, gives better finishing.

4. Cost: Due to more complex manufacturing process of white cement, it is expensive than grey cement. In India, white cement is usually costlier than grey cement.

5. Uses: White cement due to its whiteness is mainly used for architectural beauty, interior and exterior decorations, floorings, ornamental concrete products such as idols while grey cement are mostly used for construction purposes.

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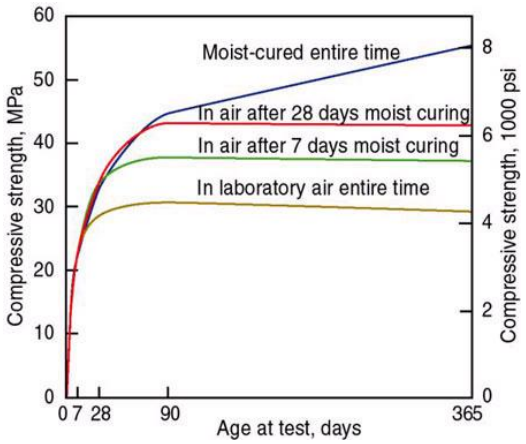
Cement Properties

Curing Time

Curing plays an important role on strength development and durability of concrete and takes place immediately after concrete placing and finishing.

It involves maintenance of desired moisture and temperature conditions, both at depth and near the surface, for extended periods of time. Properly cured concrete has an adequate amount of moisture for continued hydration and development of strength, volume stability, resistance to freezing and thawing, and abrasion and scaling resistance.

Effect of curing duration on compressive strength development is presented in Figure



Compressive strength

Compressive strength test is carried out to ascertain quality of cement when used for important structures. Strength test is not made on plain cement due to excess shrinkage and cracking of plain cement paste and is carried out either on cube or cylinder.

Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, and quality control during production of concrete etc.

Various standard codes recommend concrete cylinder or concrete cube as the standard specimen for the test.

Compressive Strength = P/A
Where,

P=Maximum load applied to the cube. (N)
A=Cross sectional area (Calculated from the mean dimensions) (mm^2)

Tensile strength

Cement is very weak in tensile strength. Its strength is determined directly using the briquettes.

Tensile Strength = P/A
Where,

P=Maximum load applied to the cube. (N)
A=Cross sectional area (Calculated from the mean dimensions) (mm^2)

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Flexural Strength

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending.

It is measured by loading 6 x 6 inch (150 x 150-mm) concrete beams with a span length at least three times the depth.

The flexural strength is expressed as Modulus of Rupture (MR) in psi (MPa) and is determined by standard test methods ASTM C 78 (third-point loading) or ASTM C 293 (center-point loading).

$f_r = bf_c^n$

Where f_c is the compressive strength of the concrete b (varies from 0.33 to 0.94)
n (1/2 or 2/3) are coefficients which depend on factors such as strength levels, aggregate properties and mineralogy, admixtures types, moisture content of specimen, compaction and curing conditions, specimen geometry and confinement, age of concrete, etc.

The value reported for the flexural tensile strength by various investigators and standards in square root form (n = 1/2) ranges from 0.3 to 1.0 $f_c^{0.5}$ MPa

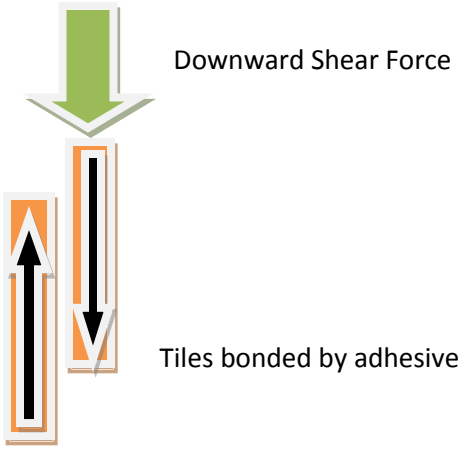
Shear Bond Strength

Shear bond strength of a adhesive is the shear force required to debond a known area of two porcelain tiles and of two wall tiles, respectively, joined at their fair faces with an adhesive.

The pieces used in testing consists of two fragments of tile, measuring about 6,8 x 4,8 cm, stuck together at their fair faces with the adhesive tape, the contact area being about 5,0 x 4,8 cm. The force was applied using a steel wedge with a 1-mm-thick flat edge that rested on one of the tile fragments, as close as possible to the side where the adhesive was applied. The tests were performed in a universal testing machine at a speed of 0, 5 mm/min. Shear bond strength was expressed as follows:

σ= A. Fmax (1)
A= e·b (2)

Where,
F max = Maximum force (N)
A = Contact area (mm^2)
b = Piece width (mm)
e = Height of the fitted fragment (mm)
σ= Shear bond strength (N/mm^2)



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Construction Adhesives

Construction adhesives are used to bond common materials used in the construction, renovation and finishing of homes by replacing traditional adhesives or fixings like cement, wood glues, nails and screws.

They are created by mixing the base material with fillers, pigments, stabilizers, plasticizers and other additives.

Low performance products are based on natural substances like starch protein or synthetic polymers like polyvinyl alcohol, acrylics, etc.

High performance products are based on polymers like epoxy, silicone, etc. and have enhanced properties like bond strength, elongation capacity, durability and environmental resistance.

Types of Adhesives

Along with cement, other adhesives to be considered are:

Unsaturated Polyester resin based Adhesive (UPR)

The polyester resin-based adhesives can be divided into two distinctive groups: saturated thermoplastic and unsaturated thermosetting resins.

Unsaturated polyester based adhesives usually involve the reaction between a dibasic acid or an anhydride and a diol. Without special catalysts, they cure only at elevated temperatures.

They are mainly two-part systems that harden by the addition of a catalyst, usually peroxide such as methyl ethyl ketone peroxide or benzoyl peroxide (BPO).

They are widely used for glass fibre flooring, and automobile body repair. They find many applications in the construction industry as Mastic for Stones.

2. Epoxy Based Resin

Epoxies are one of the most versatile families of structural adhesives. They bond well with many substrates and can be easily modified to achieve a wide range of properties. They provide high shear strength on a wide variety of plastics, metals and glass.

When fully cured, these thermosetting adhesives offer high thermal and chemical resistance, as well as high cohesive strength and minimal shrinkage.

The majority of epoxy adhesives contain diglycidyl ether of bisphenol A (DGEBA) as the main base epoxy resin. Other epoxy resins are also used but to a much lesser extend due to their (much) higher price.

3. Modified Cement based Adhesive

Cement-based, polymer modified adhesives are suitable for fixing a variety of ceramic tiles, mosaics, quarries, natural stone, marble and terrazzo in interior and exterior situations.

Suitable for walls and floors. May also be used for the installation of rigid foam insulating materials, for external walls.

Thin set Mortar adhesives are used for tile & marble flooring. They can be used to install tiles in wet areas or areas subjected to frequent heat.

They have a stronger, more flexible bond and ability to support a lot of weight and hence used for flooring.

They are not come pre-mixed and need to be mixed with water or sometimes an acrylic additive if it's not blended in already. For outdoor and wet mosaics, thin set is recommended instead of adhesives.

Polyurethane based Adhesive (PU)

Polyurethane adhesives are one of the most important types of structural adhesives. Their properties can be tailored over a wide range for a large number of applications. They can be rigid and hard or flexible and soft. They provide extremely strong bonding.

Even before the adhesive dries and seals completely, the initial bond is strong enough that clamps and other types of securing instruments are unnecessary.
This makes manufacturing and construction processes both simpler and cheaper.

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Adhesive Usage Areas

Polyester adhesives bond well to glass, many plastics, and rubbers and to metal and wood. The adhesive bonds are resistant to water, gasoline, weak acids and many solvents. Unsaturated polyester adhesives are widely used for glass fiber laminates, optical products, furniture, concrete flooring and many applications in the construction industry.

PU adhesives bond exceptionally well to wooden substrates and find many uses in the wood industry. They have excellent low temperature properties but do not have high temperature resistance and decompose at much lower temperatures than epoxy adhesives. They do not bond well to metals unless a primer is applied to the substrate prior bonding.

Heavy duty construction adhesive

Heavy duty construction adhesive is ideal for a variety of surfaces, and can be used outside and indoors.

Indoor construction adhesive

For interior projects using foam board, drywall, molding, paneling, plywood, masonry/concrete, corkboard or furring strips use an indoor construction adhesive.

Extreme temperature subfloor & deck adhesive

An extreme temperature subfloor & deck adhesive actually increases the structural integrity of the wall, deck or subfloor, including plywood, OSB, particleboard, lumber and treated lumber.

Solid surface materials adhesive
To bond marble, granite, cultured and engineered stone to wood, drywall, painted surfaces, chipboard and concrete backer board use an adhesive designed specifically for the material.

Tub surround & shower wall adhesives

Use a tub surround & shower wall adhesive to bond plastic, fiberglass and foam back tub and shower surrounds to drywall, cement backer board, ceramic tile, plywood or green board.

Fiberglass reinforced plastic panel adhesives

The best way to adhere fiberglass reinforced plastic (FRP) panels to cured concrete, cement backer board, drywall, wood or green board is with an adhesive specifically designed for the panels.