A Study on Compatibility of Concrete Repair Materials

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Abstract

Nowadays rehabilitation of concrete structures are common challenges in all countries, the most appropriate strategy to protect the rehabilitate these concrete structures to provide some forms of protective coatings and layers. Compatibility of repair materials is important criteria (Dimensional compatibility & Chemical compatibility) before choosing a repair material, the repair material should be compatible with existing concrete substrate. It is widespread acceptance that the compatible repair material will withstand the adverse environmental condition over a design period. Good bond strength between overlay and substrate is a key factor in the performance of concrete repair materials. The main aim of good repair material is very low permeability, excellent mechanical properties, self consolidating in nature, rapid strength gain, minimal creep and shrinkage characteristics. It is important that bond offers adequate strength to withstand the stresses due to mechanical loading, Thermal effects, while also maintaining an extended durable performance. This review paper can provide many useful information on compatibility of repair material, bond strength and bond characterization and various techniques used by different authors.

Keywords: Concrete, Repair Materials, Cement, Thermal Effects

1. Introduction

Recently civil engineers are facing a common issue in the concrete industry is the increasing the need for the rehabilitation of many concrete structures (Bridges, Malls, Marine structures and many pavements etc) these are constructed in the middle of the last century. Most of the efforts of the engineers were addressed to design new infrastructures. The latter shows an important environmental concern is the researchers are able to design a successful repairs, the material and cost saving can represent a great achievement for the sustainability of the developing concrete industry.

Concrete repair mainly includes removing unsound concrete and replacing it with proper repair material or overlay material. The most important requirement for any kind of repair system is to have a excellent bond between the existing concrete substrate and overlay throughout the entire service life. It is also essential that the bond offers enough strength to resist the stresses due to mechanical loading and thermal effects, while also maintaining as extended service life performance.

A good repair material should improve the function and performance of the concrete structure like bridge, pavement or building. The poor repair material fails soon and deteriorates the adjoining sound concrete material in a short period of time, selection of appropriate repair material depends on the concrete properties and behavior of particular composite section under expected service exposure condition (Vaysburd.et. al -2000).

2.Review of Literature:

2.1 Compatibility of Repair Material

D.R.Morgan et.al states that compatibility means a popular word in the repair industry it indicates the durability of repairs in general and adequate load carrying capacity in the structural repairs. Compatibility is a balance of physical, chemical and electrochemical properties and dimensions between a repair material and the existing concrete substrate that certain thing the repair can withstand all the stresses induced by the volume change, chemical and electrochemical effects without distress.

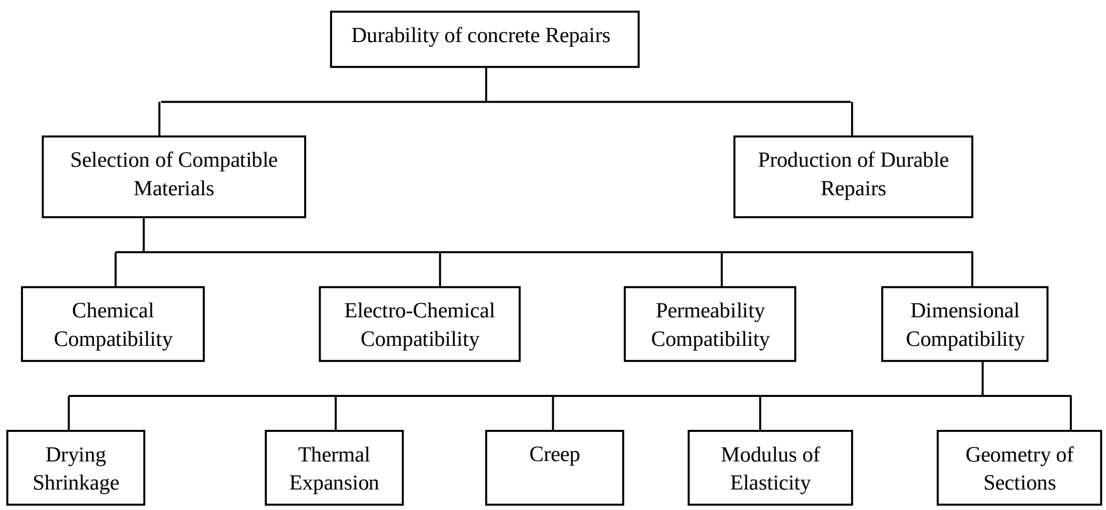

Figure: 1 Factors affecting durability of Concrete Repairs.[2]

2.2 Dimensional Compatibility

The Dimensional compatibility of cement based repair materials deals with the four main types of deformation.

- Shrinkage.
- Creep.
- Strains due to Temperature.
- Elastic deformation.

The safety and durability of repaired structures cannot be realized without a comprehensive knowledge of the materials fundamental properties that determine its deformational characteristics.

2.3 Shrinkage

Shrinkage is the time-dependent decrease in material volume due to temperature and moisture changes, which are caused by external environmental conditions or due to internal reactions.

M.H.Decter et al studied that the fact in the failure of concrete repair material is more likely to occur due to incompatibility between the repair concrete or high shrinkage levels. Either of these factors can lead to cracking and debonding. Excessive shrinkage of a repair mortar also leads to failure. This problem is being increasingly acknowledged worldwide. The formulated single component polymer modified mortar is used. It is based on the technology utilized in original High Build polymer Modified (HBPM) mortar formulation. The drying shrinkage of the mortars HBPM 25 and HBPM 40 in relation to the specification. They achieved very low shrinkage and the results given below.

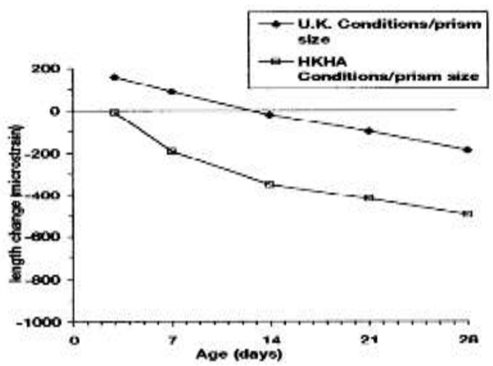

Figure: 2 Drying shrinkage of HBPM 40 under Hong Kong and UK conditions (3)

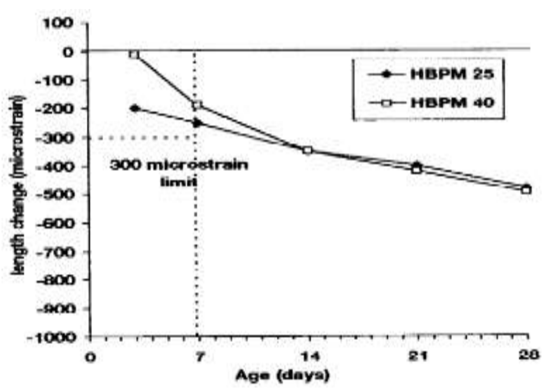

Figure: 3 Drying shrinkage of HBPM 40 and HBPM 25 under Hong Kong conditions (3)

P.S.Mangat et al(1995) based on their experimental investigation to determine typical properties of three commercially available generic repair materials, which are significance to the concrete substrate structural behavior of repaired concrete members. He studied the shrinkage properties of the repair materials, the shrinkage of the specially formulated repair mortars especially those modified with a polymer admixture is very sensitive to relative humidity of exposure compared to normal concrete.

The 90-days results for shrinkage (under different conditions) and swelling deformation are listed in Table-1, the larger magnitude of shrinkage and swelling strains of the repair materials (especially Material - C) relative to plain concrete is clearly evident.

Table 1 Shrinkage & swelling deformation strains @ 90 days (Microstrains) (4)

Repair material	Shrinkage (at 20^{o}C and relative humidity of)			Swelling (at 20^{o}C & 100% RH)
	55%	45%	30%	
A	814	891	931	197
B	918	1033	1098	128
C	962	1230	1474	254
Concrete	450	559	702	87

N.K.Emberson et al (1990) carried out an investigation in the properties of repair system. He studied the Long-term shrinkage using unrestrained prism of mortar (160x40x40) mm to measure the shrinkage from an age of 24-hours to 90 days later it was extended to 16 months in which the temperature was varied from 12^{o}C to 22^{o}C and the relative humidity from 55% to 95%. The author used 9 type of repair material namely A to I. The resin mortars A, B & C has small relatively stable value of shrinkage beyond an age of 1 month and the shrinkage is modified D, H & I is lesser than that of sand cement mortar, Material G (-1140με at 16 months), but similar to that of the vinyl acetate modified system (Material-E) in all cases shrinkage strain increases with time presumably due to continued drying. After undergoing an initial expansion of +1020με at 1 month, the magnesium phosphate system (Material -F) started to shrink with time , again probably due to continued shrinkage figure-3 shows the long term shrinkage.

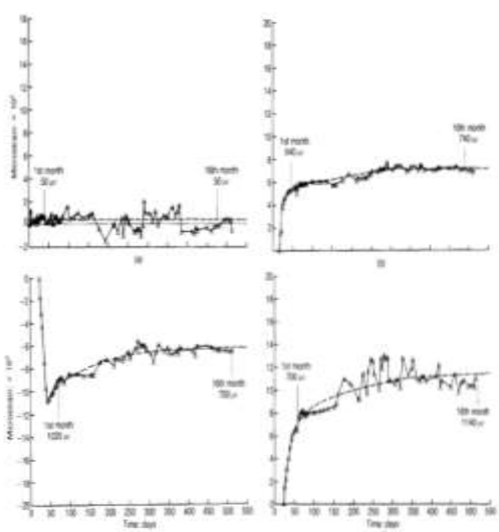

Fig-4.Long term shrinkage:free linear shrinkage **test** results from age of 24hours -1.5years on prism 40 x 40 x 160mm
of materials (a) **A ;** (h) **D;(C)** Fond **(d) G –(5)**

Table -2 General requirements of patch repair materials for structural compatibility-(5)

Property	**Relationship of repair mortar (R) to concrete substrate (C)**
Strength in Compression, Tension and flexure	R≥ C
Modulus in Compression, Tension and Flexure	R ≈C
Poisson’s ratio	Dependent on modulus and type of repair
Coefficient of Thermal expansion	R≈C
Adhesion in Tension and Shear	R ≥ C
Curing and Long term Shrinkage	R ≤ C
Strain capacity	R ≥ C
Creep	Dependent on whether creep causes desirable or undesirable effects
Fatigue performance	R ≥ C

Daniel Cusson et al (1996) made a overview of material and structural characteristics to achieve a lasting repair it is essential that the properties of the repair material and the substrate be properly matched. This alone helps to ensure that the repair material can withstand the stresses resulting from the volume changes and load, for a specified environment over a designated period of time. Most of the shrinkage occurs when the cement paste dries out after setting and hardening. In resin based materials shrinkage is a result of cooling following the exothermic reaction(R<C).

When shrinkage is restrained permanent tensile stresses develop in the repair material and may cause tensile cracking in the material itself, or delamination at the interface of the repair material and the substrate.

P.H.Emmons et al (1996) studied the concept and the factors to be considered in the repairing concrete structure. According to the proposed mode Figure-4 a step by step design of durable concrete repair includes the consideration of compatibility properties. Dimensional compatibility is the phenomenon of the volume changes and the major problem of concrete repairs. Volume changes must be controlled in concrete repairs to prevent or minimize cracks. When material undergoing volume changes is restrained, tensile strains are induced which, if greater than the tensile strain capacity of the system, will leads cracks. If appropriate measures are to be taken to control volume change and resulting induced cracking in concrete repairs, the tensile strain capacity of the proposed system must be known. Unfortunately, cement based materials are not volumetrically stable have a relatively high modulus of elasticity, are brittle materials and the susceptible to cracking.

The author would like to express their conviction of a future for concrete repair material in protective repair application where low drying shrinkage, low modulus of elasticity, and high creep are of value, a deformable material is needed for protective types of repair.

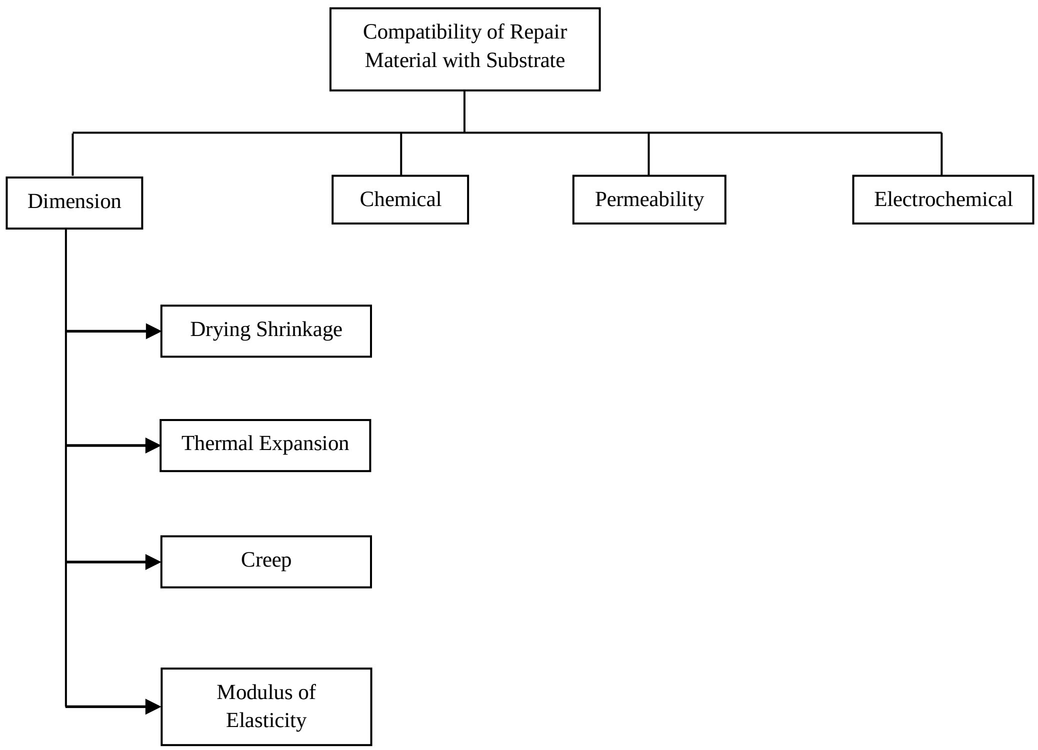

Figure : 4 Factors affecting Dimensional Compatibility. (7)

2.4 Creep

The deformation of a material in response to load is known as rheological behavior (Phileo-1956).

P.S.Mangat and M.K.Limbachiya – (1995) were carried out the compressive creep test on the prism specimens of size 100x100x500 mm, they cured the specimen in water at 20^{o}C for 28 days prior to loading. The authors conducted the test on two prism specimens were loaded together in a standard creep rig, as per the recommendation for standard creep test (Illston.J.M). Each creep rig is comprised with steel end platens supported by nuts on four 36 mm diameter tie rods of high yield steel, this load is maintained at a constant level by regular loading and tightening of the nuts against the end platens. During sustained loading the temperature and relative humidity was maintained as 20oC and 55%. The initial strain on loading and subsequent increase of strain was monitored across a 200mm gauge length, across two opposite faces of each prism, Inorder to calculate the net creep strain was measured on separate specimen and deducted from the total

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strain measured on the specimen in the creep rigs as per the author conclusion (Material –A) has less creep deformation than other two material the creep values are given in the table-3 below.

Table -2 Creep Strain at 90- days and instantaneous elastic strain on loading (Microstrain) (4)

Repair Material	30% Stress/Strength		45% Stress/Strength	
	Creep strain	Inst. Elastic strain	Creep strain	Inst. Elastic strain
A	1217	4888	2078	704
B	1212	342	2161	749
C	1871	553	2552	893
Concrete	1446	454	2148	866

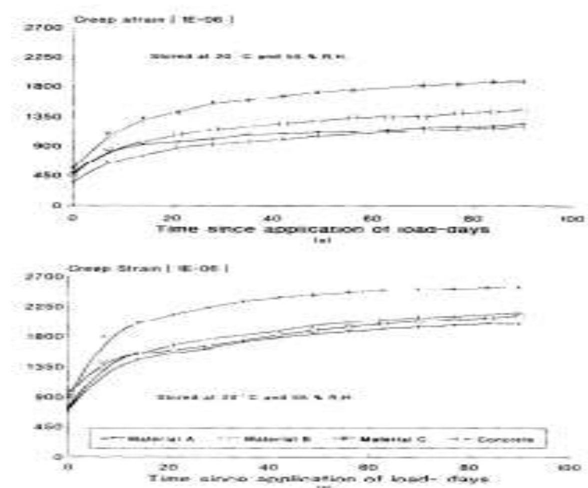


Figure -5 Compression creep at (a) 30% and (b) 45% Stress/Strength ratio.(4)

N.K.Emberson and G.C.Mays-(1990) has conducted the Long-term creep in compression test on hardened mortar samples using a hydraulic compression creep rig capable of testing two 160mm long prismatic specimens. The gas/oil accumulator in the hydraulic system serves to maintain constant pressure applied to the flat jack and hence the specimen for the duration of the test. The load applied to the specimen is 200N/s by the needle valve in the hydraulic upstream of the flat jack. The test was conducted as per recommendations of BS 6319: part 11:1989. From the test results the authors concluded that creep is the dominant characteristics for the most of the material (A, B, C, E, H & I) for the SBR modified mortar (Material-D) and the sand-cement mortar (Material-G) creep value are approximately zero. After an age 0f 30 days, shrinkage strain dominate for material F and its creep is zero.

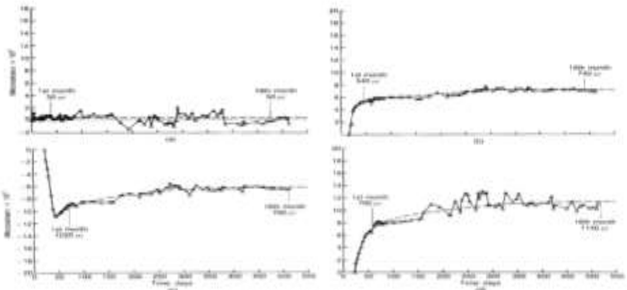


Figure: 6. Long term shrinkage: ,free linear shrinkage test results from age of 24 hours to 1.5 years on prism 40 x 40 x 160mm of materials (a) A ; (h) D;(C) F and (d) G. (5)

Cusson.D and Mailvaganam N.P- (1996) in his studies creep is the continuous deformation of a member subjected to sustained load. It can be result reduced load bearing effectiveness in the repair material and also result in load transfer from the repair material to the concrete substrate, or to a non-structural element. In the case of structural repair loaded in compression, the repair material must posses very low creep potential (Fig-7), as per the author the creep co-efficient should be (R<C or R>C).

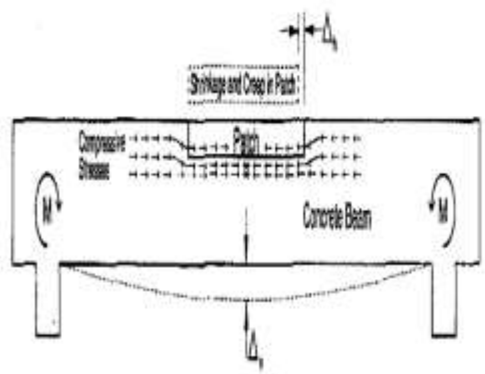


Figure-7 Typical structural repairs. (6)

2.5 Thermal Co-Efficient

Materials typically expand when heated and contract when cooled. These temperature changes caused by external environmental effects or internal cement hydration.

N.K.Emberson and G.C.Mays-(1990) conducted the test using a 25mm square by 530mm mortar sample, housed with an environmental test chamber. The chamber was sited within a universal testing machine. Metal prism of 30mm diameter and 50mm long was set on the machine base and protruded through an orifice in the chamber floor. On this was placed the mortar sample, on which in turn was placed a second metal prism which protruded through a similar orifice in the chamber ceiling. An linear variable displacement transformer (LVDT) located between the upper solid steel prism and the machine cross- head was used to monitor changes in the length of sample figure -8 shows the experimental set of co-efficient of thermal expansion. The chamber was capable of maintaining the sample at temperatures ranges from -

60±0.25°C. The sample normally took 3-4 hour to attain a uniform temperature as monitored by the thermocouples attached. The co-efficient of thermal expansion was determined for each mortar sample at 20K intervals from -60 to 60°C. As per the authors conclusion resinous material have significantly higher co-efficient of thermal expansion than cementitious repair material. Due to post curing effects some material shows a change in the co-efficient of thermal expansion at ambient temperature. In excess of that little effects on the thermal co-efficient of cementitious system. A mismatch in co-efficient between repair and substrate can theoretically result in the development of compressive or tensile stresses in the repair, which in latter case may generate adhesion failures.

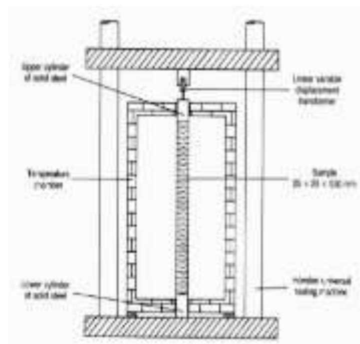


Figure -8 Test arrangement for co-efficient of thermal expansion.(6)

Cusson.D and Mailvaganam .N.P - (1996) the reviewed that (R=C), the co-efficient of thermal expansion is a measure of the change of length in a material when it is subjected to a change in temperature. When two materials of different co-efficient of thermal expansion joined together and subjected to significant temperature changes, stresses are generated in the composite material. These stresses may cause failure at the interface or in the lower strength material, this is a particular evident in meet processing plants where floors are coated with epoxy topping steam cleaning of floors the topping (which has a higher thermal expansion co-efficient) to shear off at the interface .Unless the temperature change is expected to be very small, the repair material should posses a thermal expansion co-efficient similar to that of substrate concrete.

John kosendar and Noel P.Mailvaganam - (2005) studied the co-efficient of thermal expansion, when making large or thick patches or when placing an overlay, it is important to closely match the co-efficient of thermal expansion of the repair material with concrete being repaired. This is best exemplified in the failure of repaired cold room floors, deterioted cold floors are often repaired with epoxy topping, the thermal co-efficient of which are five times that of concrete substrate.

2.6 Modulus of Elasticity

P.S.Mangat and M.K.Limbachiya –(1995) Conducted test on 100x100x500 mm prism specimen of each mix were tested to determine the Static Modulus of Elasticity at the age of 28 days. Specimens are cured in water tank at 20°C. Strain reading is taken at regular load increments on opposite longitudinal faces of the prism. They used demec extensometer of gauge length 200mm for this test. The young's Modulus of Elasticity of prism specimen was determined in accordance with BS:1881:part-121 1983(5). Table -3 shows the Elastic Modulus test results at the age of 28 days.

Table -3 strength and Elastic Modulus at 28 days age.(4)

Repair Material	Elastic Modulus (KN/mm^2)
A	32
B	19.1
C	18.3
Concrete	20

Cusson.D and Mailvaganam.N.P (1996) as per their conclusion (R=C). The Elastic modulus is a measure of rigidity, low modulus material deform more than those of high modulus under a given load. When the external load is applied parallel to the bond line materials with different elastic moduli will transfer stresses from the low modulus material to the high modulus material leading to stress concentration and failure of the high modulus material.

When external load is applied perpendicular to the bond line; the difference is stiffness between both material is less problematic if the external load is compressive however if the perpendicularly applied external load is tensile mismatching elastic moduli is likely to cause failure figure-9 show the conditions. The same criteria was also discussed (10)

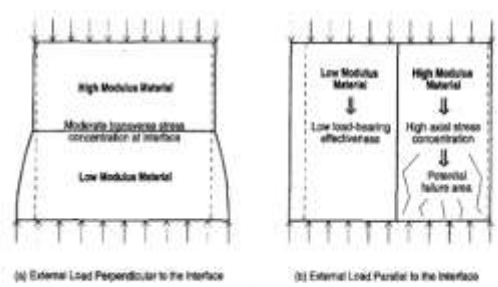


Figure-9 Effects of mismatching elastic moduli.(6)

D.R.Plum-(1990) discussed the behavior of epoxy resins and acrylic/SBR modifiers in repair materials. Elastic modulus of each material was experimentally tested with BS 6319: part-6 and the results for various materials were tabulated below table-4.

Table-4 Test results of Elastic Modulus.(10)

Material	Elastic Modulus (KN/mm^2)
E1	12.2
E2	11.1
E3	4.3

E4	12.4
E5	16.6
E6	6.6

2.7 Co-Efficient of permeability

P.S.Mangat and M.K.Limbachiya-(1995) studied the effects of the water permeability for the cylindrical specimens (100mm diameter and 200mm high) the specimens were cured for 28 days and the cylinders were segmented into three slices. A circular disc of diameter 100mm and thickness 40±1 mm was obtained from the middle portion of a cylinder to provide as test specimens. A liquid permeameter apparatus was used to determine the co-efficient of permeability of water through the disc specimen which was held in a hydro static cell. The co-efficient of permeability was calculated based on Darcy’s law using the formula given below. And the results were tabulated below. The presence of polymer repair material reduced the water permeability than the cementitious material.

$K_{LD}=Qx/Ah$

Table -5 Water permeability Results.(4)

Material	Specimens	Permeability co-efficient
A	1	$2.33x10^{-13}$
	2	$0.92x10^{-13}$
	3	$3.81x10^{-13}$
	4	$3.04x10^{-13}$
B	1	$5.39x10^{-11}$
	2	$5.74x10^{-11}$
	3	$5.74x10^{-11}$
C	1	$1.43x10^{-13}$
	2	$0.84x10^{-13}$
	3	$1.73x10^{-13}$
CONCRETE	1	$5.23x10^{-13}$
	2	$5.05x10^{-13}$
	3	$17.5x10^{-13}$
	4	$15.4x10^{-13}$

Prof.J.G.Cabrera and AS Al-Hasan-(1997) studied the durability of repair material they conducted the studies on permeability (water)and oxygen permeability, corrosion of reinforcement can be avoided by excluding oxygen and moisture from the steel. Concrete is a permeable and a porous material, the rate at which liquid and gases can move in the concrete is determined by its diffusion and permeability. These properties affects the way in which concrete resist external attack for this reason a repair material should have very low permeability.

2.8 Oxygen Permeability

The gas permeability with gas flowing under a pressure head is thought likely to be more sensitive to the presence of large diameter pores which are considered to be largely responsible for poor durability of concrete. As per the author the repair material should satisfy the structural requirement like strength and modulus of elasticity but the most important is permeability and porosity.

T.Parhizkar et al-(2006) conducted experiment on the repair materials in aggressive environment, they studied the permeability characteristics of the repair material which is the most important durability parameters of concrete and they suggested that the silica fume and polymer modified concrete material has very low permeability (43% reduction as compared to the control mix at the age of 90 days). The results are tabulated below.

Table -6 Water permeability results for repair concrete mixes. (13)

Mix	Water Penetration Depth in (mm)	
	28-Days	90- Days
OPC	2.7	3.5
S F	1.5	2.2
PMC	1.9	2

2.9 Bond Strength

Hani Alanazi et al (2016) studied the effects of bond strength of Geopolymer and conventional cement mortar interfaces. He analyzed degradation of cement mortar under various acid medium conditions on the bond strength of geopolymer with conventional cement mortar and compared Metakaolin Geopolymer with other pavement repair material. The author conducted Splitting test, Slant shear test for repair material used for his work.

2.10 Split Tensile Test

The Split tensile test was performed in a cylindrical composite material shown in figure 10 below, the test was conducted as per the (ASTM C 496/C496M-11). The specimens were cured at room temperature for 28 days and then soaked in 0.5M Hcl for different durations. Based on the reference Table: 7 the bond strength quality was established. The bond strength between geopolymer and cement mortar substrate without soaking in acid is Excellent. The rest of the specimens soaked in acid for 24 Hours and 3 days shows fair bond. The results of splitting test are given in Table: 8. Also the failure mode pattern of split test are shown in figure 11.

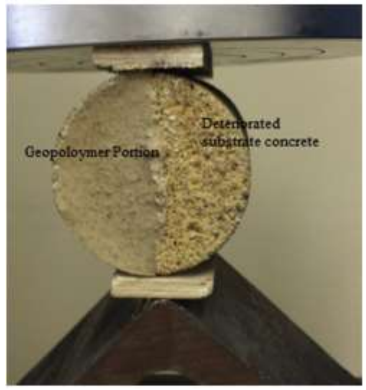


Fig. 10. Cylindrical split tensile test.(13)

Table: 7 Bond strength Quality. (17)

Bond strength, MPa	Quality
≥2.1	Excellent
1.7 to 2.1	Very good
1.4 to 1.7	Good
0.7 to 1.4	Fair
0 to 0.7	Poor

Table: 8 Results of Splitting test.(13)

Spec. No.	Days cured	Cross section area (mm^2)	Bond strength (MPa)
Geopolymer mortar with cement mortar without immersion			
1	3	5161	4.2
2	3	5161	3.4
3	3	5161	3.3
Geopolymer mortar with deteriorated cement mortar by immersed in 0.5 M HCl for one day			
1	3	5161	0.94
2	3	5161	1
3	3	5161	1
Geopolymer mortar with deteriorated cement mortar by immersed in 0.5 M HCl for three days			
1	3	5161	0.89
2	3	5161	0.94
3	3	5161	0.92
Geopolymer mortar with deteriorated cement mortar by immersed in 0.5 M HCl for five days			
1	3	5161	0.35
2	3	5161	0.38
3	3	5161	0.58

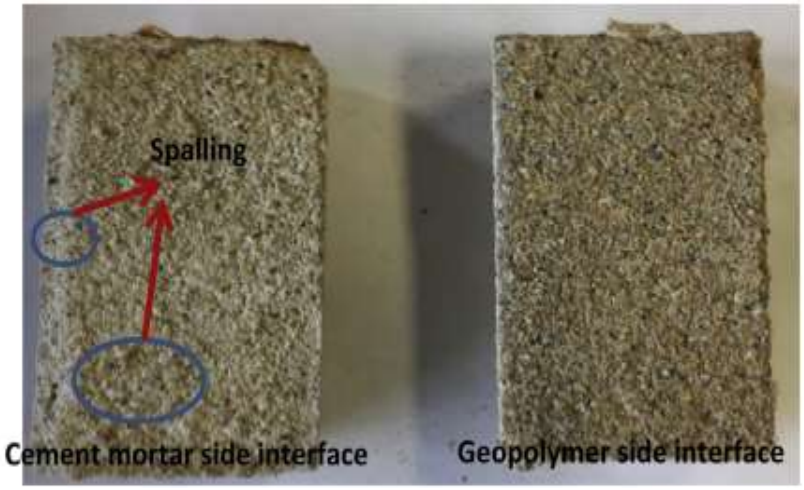


Fig:11 Failure Mode between Metakaolin-based Geopolymer mortar and conventional cement mortar.(13)

Metakaolin Geopolymer (Repair Material) shows higher bond strength compared with other repair material which is available in market. The author conducted (Low roughness and High roughness) between mortar substrate and geopolymer repair material Figure 12 shows the test results of Low and High Roughness State.

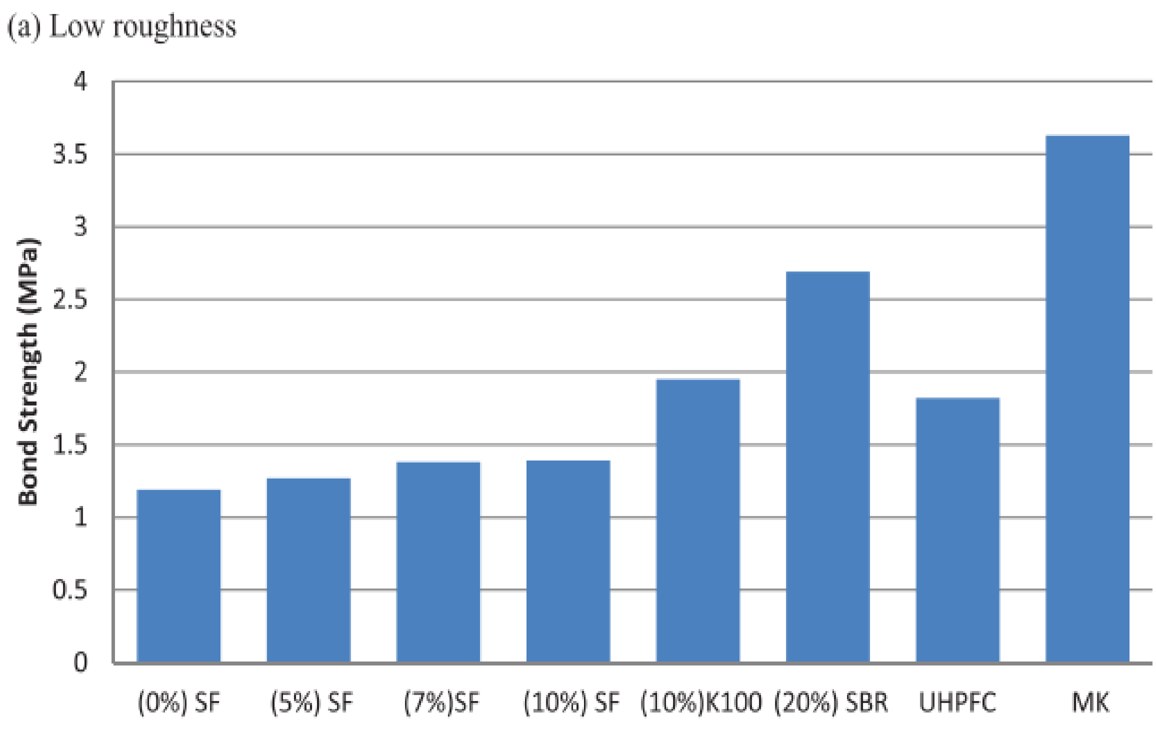
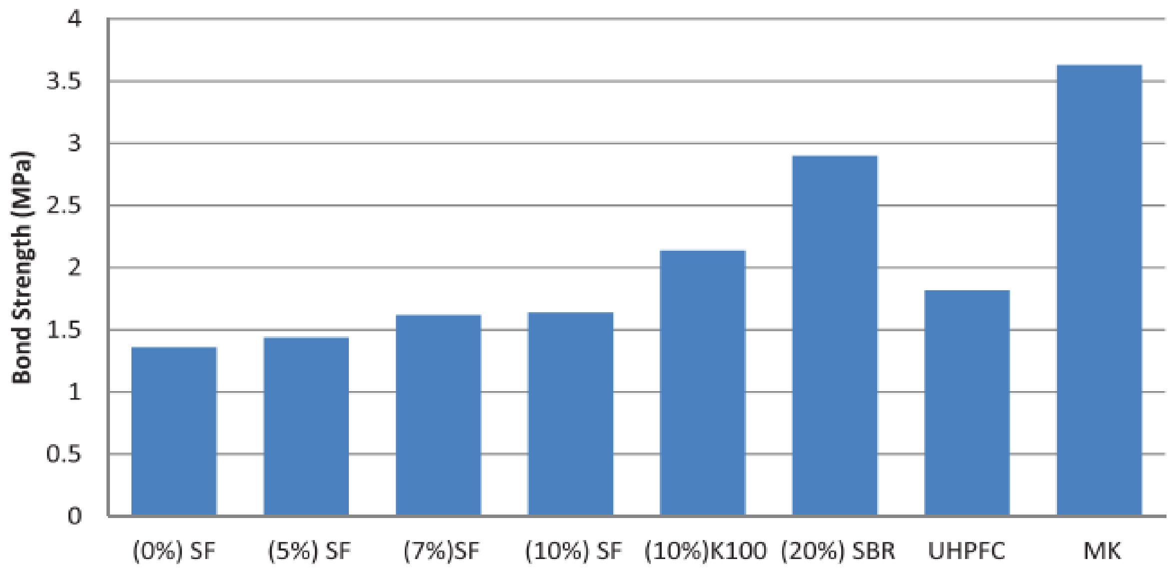


Figure: 12 Bond strength of different repair material by splitting test : (a) Low Roughness, (b) High Roughness.(13)

(b) High roughness



2.11 Slant Shear Test

The author investigated the bond strength between cement mortar substrate and geopolymer mortar by slant shear test with 30° and 45° angle interface surface as per the ASTM C882/C882 M-13a. The slant shear test results for 3 samples with line of interface at 30° is 15.6 Mpa, on the other hand 45° line of interface the split test result were 42.2 Mpa The failure mode pattern were given below in the figue:13and 14

Figure:13 Failure mode of slant shear test with line of interface at 30° between Metakaolin based Geopolymer Mortar and conventional mortar.(13)

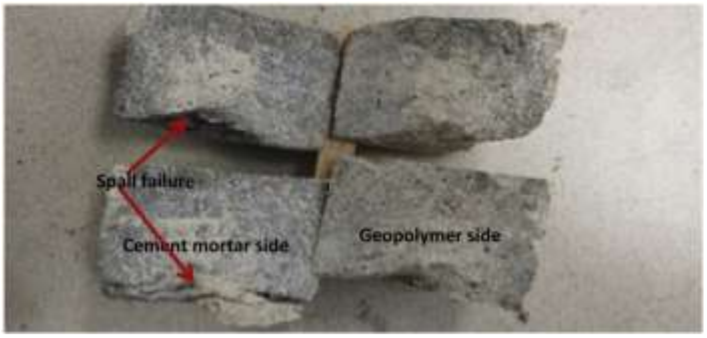


Figure:14 Failure mode of slant shear test with line of interface at 45^o between Metakaolin based Geopolymer Mortar and conventional mortar.(13)

Tanakorn et al (2015) investigated the utilization of high calcium fly ash Geopolymer Mortar containing ordinary Portland cement for use as PCC repair material, shear bond strength was evaluated using Slant Shear Test of plain cement concrete substrate and Geopolymer mortar (Repair material), with a shear angle of 45^o as shown in Figure:15. The Geopolymer mortar was half filled with slant into a (50x50x125) mm prism; the shear bond strength was the ratio of maximum load at failure and the bond area. The results of shear bond strength were the average of five samples reported in figure 16. From the results the highest shear bond strength of 24.2 Mpa was obtained with 14M NaOH Geopolymer with 10% Portland cement (14M 10PC mix).The results confirmed that the high shear bond strength of mixes with high NaOH and high PC. This indicates the suitability of GPM containing PC as additive for use as an alternative Repair Material.

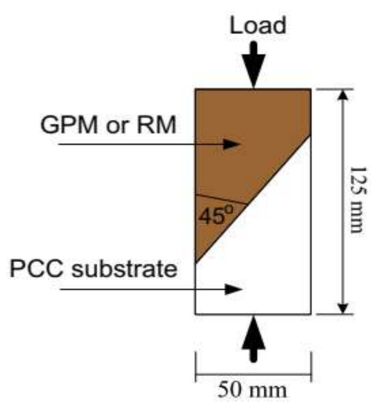


Figure: 15 Test set up of slant shear specimens.(14)

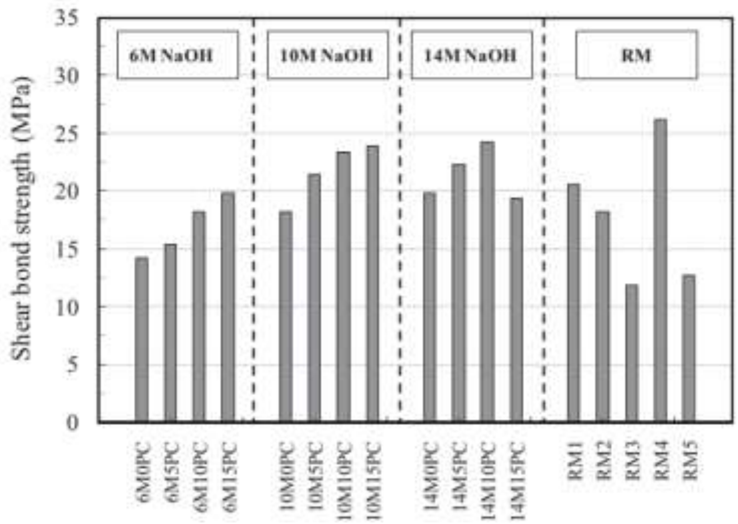


Figure 16 Shear bond strength of GPM or RM with interface line at 45^{o} to the vertical.(14)

Ghasan F et al (2016) reported the effect of Metakaolin substituted Granulated blast furnace slag on the early strength of Geopolymer mortars for potential use for repair material. Splitting tensile strength was performed on both control mortar and Geopolymer mortar, the tensile strength of all samples were cured at ambient temperature reveled on increase with increasing curing time. All the Geopolymer mortar samples were compared with control samples (OPC). Split tensile strength of geopolymer with an age of one day exhibited 2.95 Mpa which is almost 10 times greater than control samples (OPC). The results are reported in the figure: 17

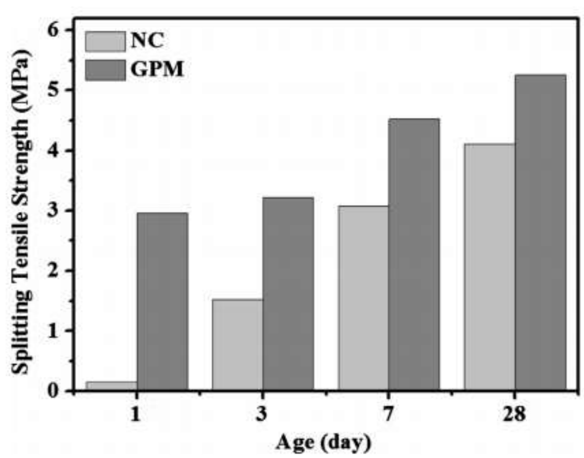


Figure:17 Curing time dependent development of early split tensile strength of GPMs as compared to OPC mortar.(15)

The bond strength was determined using slant shear bond test using cylinder specimens of (100mmx200 mm) dimension with interface line angle of 30^{o}. The Results of Geopolymer mortar bond strength are compared to OPC mortar as shown in Figure: 18 and Figure: 19 illustrates the typical bond failure of a slant shear sample. Where the bond surface was found to be still intact. The attainment of high bond strength of such geopolymer mortar indicates their ability as an alternative potential repair material.

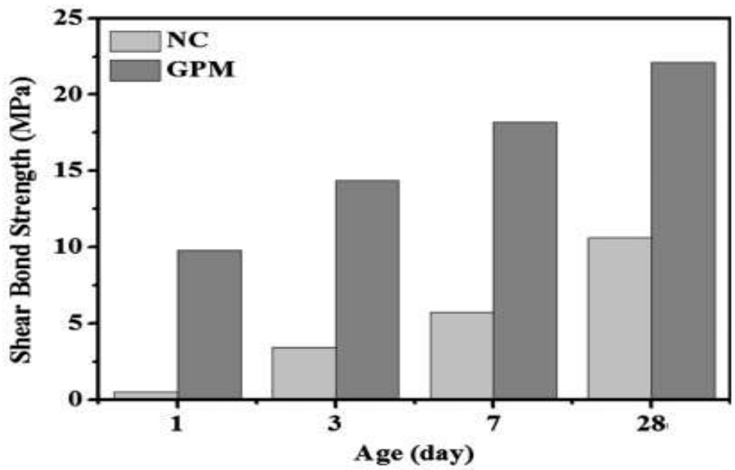


Figure: 18 Shear bond strength between OPC (NC) and GPMs with interface line at 30° to vertical. (15)

Figure: 20 Typical failure modes of Geopolymer mortar.(15)

2.12 Rapid Chloride Penetration Test

Bassam. A et al (2013) investigated the characteristics between normal concrete substrate as old concrete and ultra high performance fibre concrete as a repair material. Author performed the Rapid Chloride Penetration Test to ascertain the potential of chloride resistance of the composites. The test was conducted as per ASTMC 1202-94, on the test specimens of size 50mm thick and 100mm diameter cores of cylinders, A direct current of 60V DC was maintained across the ends of the specimens for a period of 6 hours. The Rapid Chloride Penetration Test was performed on both normal concrete and ultra high performance fibre concrete, the test setup were shown in Figure:21.The results were shown in Figure :22 below. From the results RCPT confirms ultra high performance fibre concrete has low permeability than the Normal concrete, this ensures that improved resistance of the composite against chloride penetration. This Phenomenon could increase the service life of the repaired structure.

Figure: 21 a) RCPT, b) composite specimen NC/UHPFC.(16)

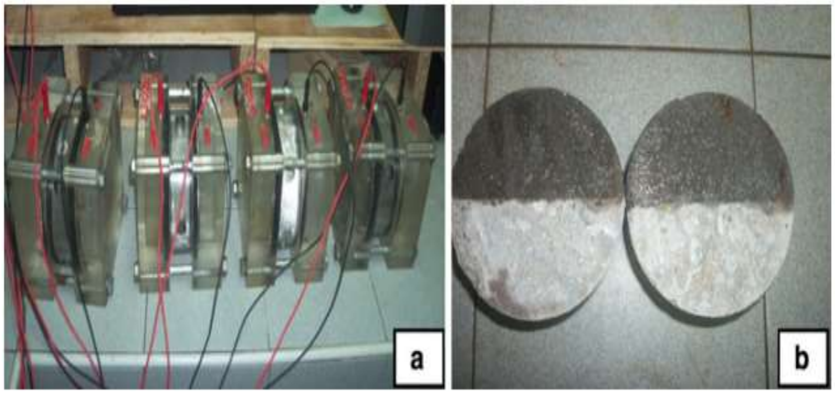
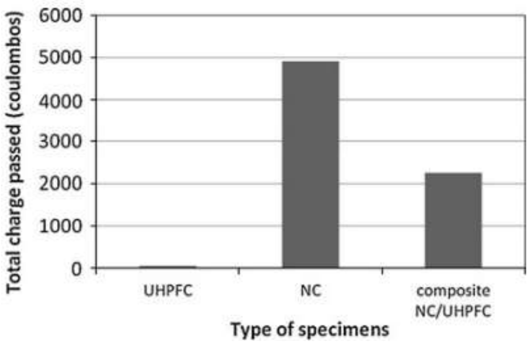


Figure: 22 Comparison of the Rapid chloride permeability.(16)



3. Conclusion

This paper presents brief overview of the compatibility of repair materials and the systems with concrete substrate. The term compatibility of the repair material presents the parameters mainly on Dimensional compatibility, bond compatibility; structural and mechanical compatibility, permeability compatibility, chemical compatibility and electrochemical compatibility should be considered in the design of repair materials. The important test for a repair material such as creep, shrinkage, modulus of elasticity, co-efficient of thermal expansion are reviewed by different authors. The bond compatibility is the next important test in the design of repair materials splitting tensile strength, slant shear strength test are discussed as per the standards and limitations; permeability compatibility like rapid chloride penetration test was another durability criterion in designing repair material. While selecting a repair material the selected material should be always superior to the existing parent material (substrate concrete). This paper concludes that a Researcher or Engineer should follow the compatibility test reviewed in the paper before applying the repair material at site.

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