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Investigations on Finding Mechanical Strength of Concrete by using Additive K^{100}

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Abstract:
K_{100} is a liquid version of KALMATRON is a chemically active admixture that increases the cementations value and volume of cement paste.. $K_{1OO}$is a cost- effective solution that provides a transformation of conventional concrete mix to High Performance concrete. K_{1OO}makes concrete strong and durable without the need of any other admixture or supplement materials for future applications. The efficacy of use of the K_{100} in concrete industry has brought revolution in research and development for last two decades. Engineers and scientists have conducted tests to ascertain the properties and the mechanical strengths by preparing concrete with K_{100} and other admixtures at various proportions. Present research envisages the study and properties of self-compacting concrete and determining their mechanical strength (Compressive) by using K_{100} in concrete by using Digital Compression Testing Machine at various mixed proportions. The properties and strengths of K100 used concrete were found optimum.

Keywords: Concrete, Kalmatron, Compressive strength, curing.

I. INTRODUCTION

The Kalmatron concept was discovered by Dr. Alex V. Rusino in 1982, resulting in the theory about different mechanisms of cement grain decay-hydration, which gave rise to numerous technologies for repair and building of new structures with highest performance of durability. First production began in1992. Experimental approval of the Kalmatron® theory “Rusino’s Osmotic Oscillator” was published by the Dundee University, Scotland, in 1990. Patents and trademarks of Kalmatron®,K100®, and Krete100® are registered in the USA and internationally. Specifications of the products are provided and published by the U.S.A. official specified ARCAT

• Kalmatron® Corporation is the manufacturer and supplier of its products for the building industry on the world market by appointed agencies and companies. The intense pace of construction, repair and reconstruction of buildings and structures of different purposes put the problem of security at the forefront durability of concrete and reinforced concrete structures. Failure to comply with the requirements for durability during design, construction, exploitation of structures, influence of aggressive factors of the external environment (air, groundwater, minus climatic temperatures, etc.), often in combination with poor quality construction works leads to premature destruction of building structures. Under the influence of the environment there is a destruction of the protective layer of concrete structures, exposure and corrosion of reinforcement, leaching and reducing the strength of concrete. Especially these processes are intensively taking place in places where the production technology was violated during construction works, resulting in failure to provide the design strength of concrete, technological seams concrete had looseness, shells. Removal of damage by ordinary concrete mixes is not durable due to the low adhesion of new concrete to the main concrete and subsequent shrinkage newly built concrete. It is practically impossible to eliminate the damage in this way underground structures, since access to these structures is limited. Analysis of experimental materials and practical experience with the secondary protection accumulated in recent years has shown that the most economical, promising and widely used in practice for the protection of reinforced concrete building structures are integral capillary systems based on mineral and polymer compositions [1].Protective materials produced in the CIS include: Kalmatron, Calmoflex,Aquatron-6, Hydroteks-K and others. Analogues of these materials in foreign practice are Penetron and Ksaypex (USA).These coatings are crack-resistant. They can be used to protect reinforced concrete structures that allow the formation of cracks in the process of exploitation. Components of the coating penetrate deeply into concrete with a solid front filled with capillaries, micro cracks hardly soluble crystals.

High performance concrete is a concrete mixture, which possess high durability and high strength when compared to conventional concrete. This concrete contains one or more of cementious materials such as fly ash, Silica fume or ground granulated blast furnace slag and usually a super plasticizer. The term ‘high performance’ is somewhat pretentious because the essential feature of this concrete is that it’s ingredients and proportions are specifically chosen so as to have particularly appropriate properties for the expected use of the structure such as high strength and low permeability. Hence High performance concrete is not a special type of concrete. It comprises of the same materials as that of the conventional cement concrete. The use of some mineral and chemical admixtures like Silica fume and Super plasticizer enhance the strength, durability and workability qualities to a very high extent. High Performance concrete works out to be economical, even though it’s initial cost is higher than that of conventional concrete because the use of

High Performance concrete in construction enhances the service life of the structure and the structure suffers less damage which would reduce overall costs. Strong, economical and takes the shape of the form in which it is placed, but it is also aesthetically satisfying. However experience has shown that concrete is vulnerable to deterioration, unless precautionary measures are taken during the design and production. For this we need to understand the influence of components on the behavior of concrete and to produce a concrete mix within closely controlled tolerances. American Concrete Institute defines High Performance Concrete as "A concrete which meets special performance and uniformity requirements that cannot always be achieved routinely by using only conventional materials and normal mixing, placing and curing practices". The requirements may involve enhancements of characteristics such as placement and compaction without segregation, long-term mechanical properties, and early age strength or service life in severe environments. Concretes possessing many of these characteristics often achieve High Strength, but High Strength concrete may not necessarily be of High Performance .

II. PRIOR APPROACH

KALMATRON® KF-B IS A REMEDIAL PROTECTIVE COMPOSITION

Dr. Alex Rusinoff, Ph.D,S.P. KALMATRON® KF-B protective composition is designed in 1982 to 1994 for the restoration of strength, impermeability and corrosion resistance properties of any cementitious structure. The product is patented in the USA under the #5,728,428 Maintenance and restoration of concrete structures is a new field in the concrete science. It is almost a medical type of problem of structure regeneration that is emerging at the interface of physics and chemistry. It is the stage at which first hypotheses, practical solutions and numerous discrepancies in the understanding of the same uncontrollable processes of concrete maturing and aging would come to life. And no sooner the scientists had managed to find the next "philosopher's stone" than it became clear that it could help in redefining the problems and were only good for a given application [1; 5]. This paper is not an exception. KALMATRON K_{100} developed within the range of capabilities inherent in its formulation. The gist of this formulation is a simple relay sequence of reactions of cement stone phase shift: penetrating the old concrete, dissolving all that can be dissolved to any possible extent, spreading out within concrete voids, and hardening as one solid. And this is the real distinction from other products, even they have claim the same brand and properties. It is known that concrete does not have enough time to achieve complete maturing of its structure. This time is available during the relay sequence reactions, beginning with cement hydration. Restoration of concrete is based on dissolution of starting meta-stable binders. The rate and extent of dissolution depend on energy performance of a solvent and degree of breakage of bonds between the binder and aggregate. Dissolution products form supersaturated solutions from which more thermodynamically stable new hydrate formations are built. These new hydrate formations are characterized by a lower solubility, greater surface area and higher density [4]. It is clear that it is not possible to provide a universal protective composition because concrete would have an unpredictable degree of wear depending on its initial properties, operating conditions and age by the moment the repair has to be performed. Since it does not seem possible to estimate with a statistic confidence even the ratio between crystalline and amorphous phases in cement stone of real structure, one cannot provide a calculation theory to estimate the overhaul interval with a fair degree of probability for non-cyclic processes [1;4]. Requirements Imposed Upon Protective Cover Compositions

1. Compatibility with the material of a structure to be protected. The composition should become property of the
material and cannot depend on its initial characteristics.
2. Functional permeability to assure moisture and temperature equilibrium between concrete or mortar of the
structure and the ambient environment, while providing a structural barrier against corrosive media.
3. Uniform distribution of properties of a protective composition over the area or body of a structure to be protected.

Impermeability and Resistance of KALMATRON $K_{100}$to any Aggressive Media

The concept of impermeability of capillary and porous bodies is normally associated with the maximum possible pore filling both on the surface side (daubing and adhesive proofing) and within the pore system (guniting and filling composition). However, with the complete insulation of the capillary and porous system, the values of osmotic and crystallization pressures (7) that are as high as 2·107 N/m2 (200 Atm) in concrete containing structural moisture may cause catastrophic consequences if concrete voids are not open into atmosphere. The same applies to the filling methods if the compositions used for filling harden at once as is the case of gypsum compositions or silica. For this reason, the time and depth of concrete structure penetration with KALMATRON® KF-B are so important. The effect of osmotic pressure during diffusion of dissociating salts in cement stone described in the general form by Vant Hoff equation for osmosis (11). Therefore, the possibility of separation of the solution according to areas of molecular penetration (for water and weak solutions) and for ion penetration assures a deep penetration of concrete structure with KALMATRON® KF-B. For concrete with a density below of 2200 Kg/m3 the penetration depth is at least 150 mm, and it ranges from 10mm to 50mm for concrete with density of up to 2400 Kg/m3. This effect allows the conventional preparation of structures, involving cleaning up to a structurally perfect depth, to be dispensed with. It only takes to wet the surface with water. KALMATRON® KF-B solution diffuses with the inter-structural water, which is a diamagnetic fluid, will lose the dipolar orientation of molecules as a consequence of dissociation of charges of opposite polarity. In other words, the diamagnetic elasticity of water disappears. This will result in a weakening of the water thrust effect upon the pore and capillary walls (the electrolytic relaxation of the cement stone structure), and concentration of the solutions will rapidly come to an equilibrium. Strength "decreases" during tests, and permeability of concrete remains unchanged since pores are not yet filled with new formations, and the reaction pressure in the pores is equal to zero:

"Negative" strength values in 28-day tests are, therefore, no more than a part of the process during which the actual concrete strength is gained. Further observations show a 25% to 30% strength increase. During diffusion the salts are accumulated in gel pores, concentration of structure solutions C2 increases to cause an osmotic compression of the structure with a negative pressure Pk. In this case, permeability and "strength" are improved since the reactive pressure on the pore walls is negative: to cause an increase in concentration of the initial solution C1, and the osmotic pressure will then develop tensile stress in cement stone structure to result in a material "strength increase" of up to 50% and a decrease in permeability, because the density of pour filling also becomes greater: from mutually opposed reaction forces. It is for this reason that the use of unbalanced compositions to improve concrete permeability results in destruction in 3 to 5 years. Similar to high-density insulating layers, they are also dangerous from the point of view of reliability because of the uncontrollable effect of ambient temperature. The exponentially expressed temperature ln | t | in (14) will sway the structure season by season to a sudden collapse. Stability of concrete characteristics is due to an unstable equilibrium of mutually strained phases of cement stone. For this reason, short-term data on an increase in strength of immature structures obtained in testing concrete with any additives cannot be relied upon because the force the osmotic and crystallization pressures have opposite effect during different periods that depends on hygrothermal equilibrium with the ambient environment. A weak correlation between strength and permeability of concrete, as shown above, facilitates operations aimed at reducing permeability. The problem is to estimate the difference between osmotic pressure values at the phase boundaries and rates of formation of crystal areas in concrete(Fig. 5). This is accomplished by oversizing the volume of the gel component of cement stone with ions of strong electrolytes that decoagulate the gel so as to create the sieve effect for ion and molecular solutions. Impermeability to liquids with high parting surface such as alkalis, acids and oil products can be assured either by presence of gases in the capillary and porous system of concrete (Jamen's effect) or by making the liquid surface area comparable with the total surface area of the whole system. Therefore, the type of a new formation crystal in the concrete pores is more important, and the degree of density of pour filling is not so critical, because the wetting surface area has a stronger effect that the extent to which pores are filled. Formation of calcium hydroxochloro aluminate (acicular crystal hydrates) and sodium hedroxocholoro-aluminates (laminar crystal hydrates). The development of these crystals along the optical axis within concrete pores is not possible because their strength is low at the maturing stage, and they are either broken down at the contact with the pore walls or change the direction of growth which is important for durability and safety of the restored structure. It has been shown in the crystallization theory that the rate of formation of crystal nuclei within a unit of volume depends on the degree of oversaturation C1/C2. At the same time, it also depends to a no lesser extent on the specific interphase energy m that is defined by the chemical potential (16) of the entire thermodynamic the value of which is fairly controlled by the quantity of moles of dissolved electrolyte salts n and the volume of pore moisture Vh. By putting (15) to (14), the value of stresses built up by the osmotic pressure and crystal nuclei obtained from dissolved products of the clinker in the old cement stone can be easily estimated. The comparison of calculations with the experimental data showed a narrow area of admissible ion force values for concrete and allowed a correlation to be established between the chemical potential of an aqueous solution of the protective composition and permeability of concrete. KALMATRON® KF-B proved as the most reliable in making concrete less pervious when the concrete has either a poor development of the pore structure or defects of load, corrosion or temperature and shrinkage origin. It should be noted that, since this composition has a high concrete penetration capability, the integrity of the cover layer is not an imperative, which is important especially for structures in which the surface is exposed to destructive mechanical or hydraulic factors.

III. OUR APPROACH

Materials and methods:

Kalmatron K_{100}:
K100 is an Admixture used with any cement containing mixes. It is based on the combined properties of KF-A & KF-SEA with the difference that K100 is a liquid with faster properties performance. This is a liquid version of KF-A as chemically active admixture to cement-containing mixes that increases the cementations value and volume of cement paste. Physical state: Liquid. Odor: Characteristic (slight).Color: Light-lime. PH: 12- 13. Melting point: Not applicable. Density: 1050- 1175 kg/m3.Flammability: Not flammable. Solubility: K100 is soluble during the mixing with the concrete batch.Other information: Melting point, freezing point, boiling point, flash point, evaporation rate, explosive limits, vapor pressure and density, partition coefficient, autoignition temperature, decomposition temperature, viscosity, explosive properties and oxidizing properties are all not applicable.

Cement: Cement used in the present study was Portland grey cement (OPC) 53 grade confirming IS 12269 (1987) having specific gravity 3.12, fineness value as retained on 90micron sieve is 4% and 320 m2/Kg, soundness tested by LE-Chaelier's Apparatus found less than 10mm, Initial and final setting time 30 and 580 minutes respectively and satisfying the average compressive strength was tested as per IS code 4031 –part 6.

River sand (Fine aggregate): Local available dry sand (river) belonging to Zone II of IS code 383-1970 was used as fine aggregate with physical properties as specific gravity (2.61), fineness modulus 2.7 and % of water absorption was 1.5.

Hard Granite Chips (Coarse aggregate): Locally available crusher aggregates of black hard granite confirming to IS 383-1970 was used for the mix of green concrete having properties 10mm and 20mm aggregates Sp. Gr. 2.67, % of water absorption 1.5% each.

Water: Ordinary portable water was used for mixing (W/C ratio as 1: 0.50).and curing concrete confirming to IS -1984-(5).

Mix design: To determine the appropriate quantity
of ingredients of concrete, methods adopted for the design mix can be Trial-Error Method, as per IS 456/2010 & IS 10262-2007, Indian Road Congress, IRC 44 Method, ACI Committee 211 Method and high strength concrete mix design. The design mix of the M20 concrete should have target strength for mix proportion (IS 456 – 2000) was as: ( ) ⁄ Where Target av. compressive strength at 28 days, Characteristic compressive strength at 28 days, Standard deviation (S = 4N/mm²).Present mix Proportions adopted in preparation of M20 concrete was

cement =372 kg, water =186 kg, local river sand = 582 kg and black H.G. coarse aggregate = 1228 kg where the mix design ratio was C: FA: CA = 372: 582:1228 =1: 1.56: 3

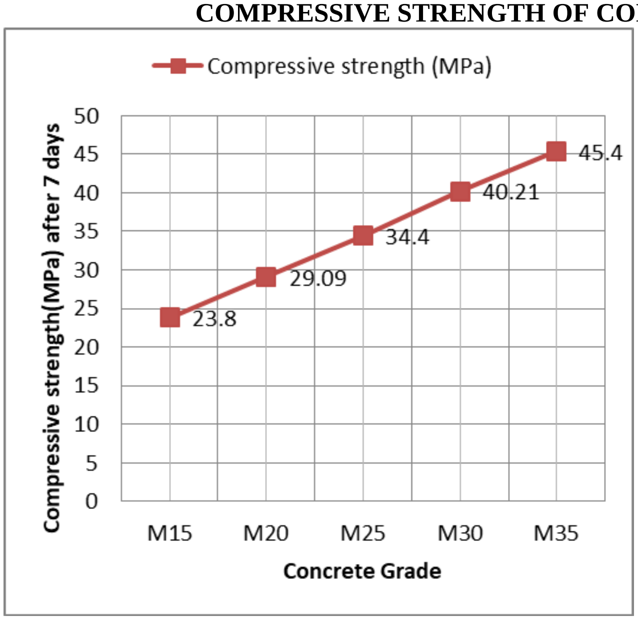
Self-curing concrete: It has been pointed out earlier that curing doesn't mean application of water it also mean creation of condition for promotion of uninterrupted and progressive hydration. It is also pointed out that quantity of water normally mixed for making concrete is sufficient to hydrate the cement content.

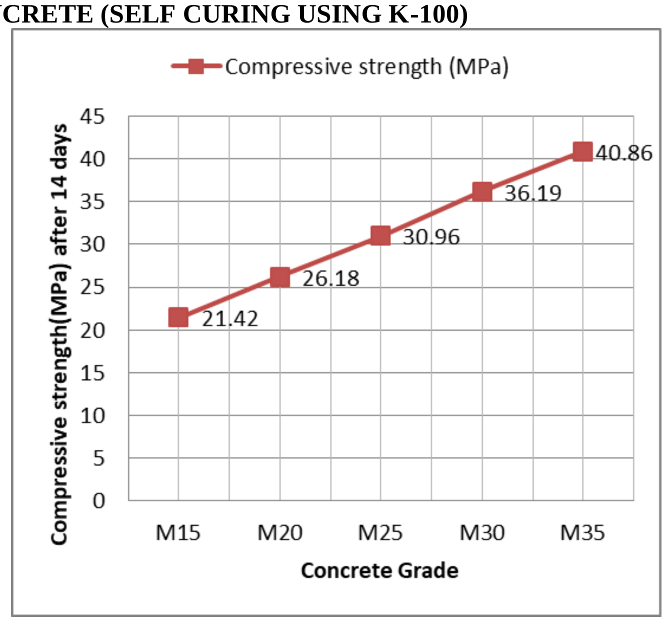
Self-Curing Concrete has high flow ability of concrete blended by pozzolanic materials,K_{100} and other materials that augment properties of concrete like strength, workability, low permeability, durability, resistance to segregation due to chemical action and other properties of $\mathbf{K_{100}}$. Present study was conducted for Material tests, slump test for green concrete, compressive strength after 7days, 14days and 28days curing of the conventional concrete and the blended concrete cubes in different grades of concrete.

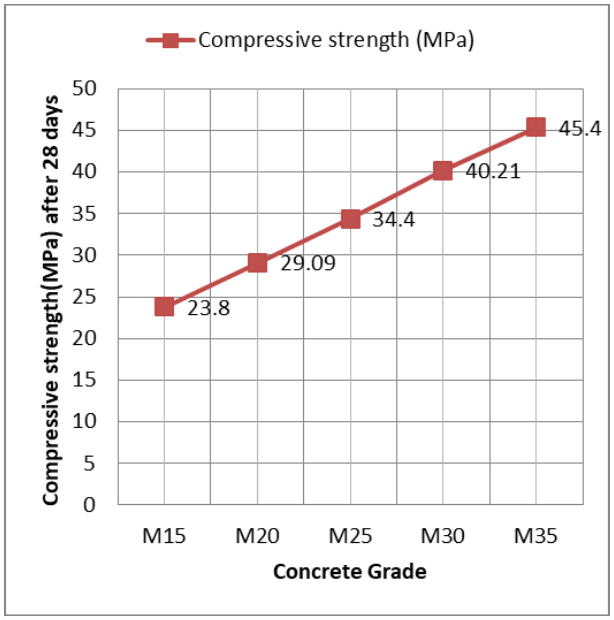
Grade of Concrete	Compressive Strength in normal Concrete			Compressive Strength in varying percentage with adding 1.0 % of k-100			Strength with varying percentage with adding 1.5 % of k-100		
	7 days	14days	28days	7 days	14days	28days	7 days	14days	28days
M-15	18.2	19.24	21.38	17.62	18.66	20.73	17.89	18.95	21.5
M-20	22.6	23.87	26.53	21.87	23.16	25.73	22	23.52	26.13
M-25	27.5	29.17	32.41	26.72	28.29	31.43	27.1	28.73	31.92
M-30	32.4	34.35	38.17	31.47	33.32	37.02	31.95	33.83	37.59
M-35	36.8	38.92	43.25	35.66	37.76	41.95	36.21	38.34	42.6

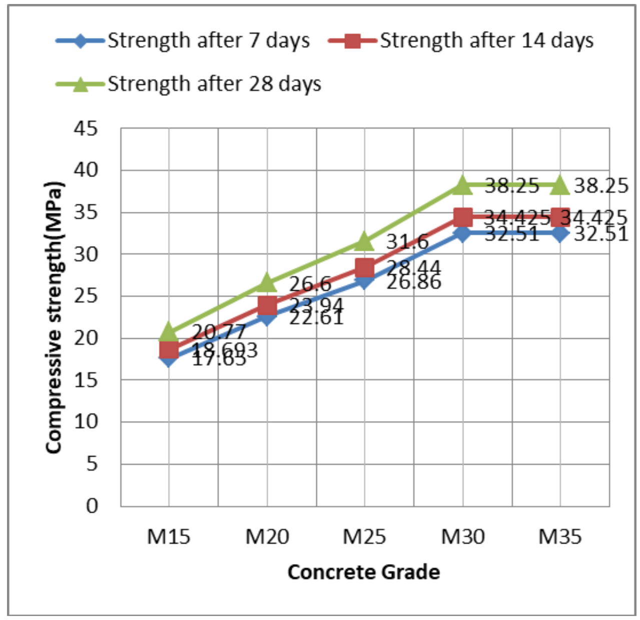
Grade of Concrete	Strength with varying percentage with adding 2.0 % of k-100			strength with varying percentage with adding 2.5 % of k-100			strength with varying percentage with adding 3 % of k-100		
	7 days	14days	28days	7 days	14days	28days	7 days	14days	28days
M-15	20.23	21.42	23.8	18.32	19.40	21.55	19.31	20.90	22.31
M-20	24.73	26.18	29.09	22.75	24.08	26.76	23.21	24.89	26.98
M-25	29.24	30.96	34.4	29.24	30.96	34.40	29.65	30.98	35.10
M-30	34.18	36.18	40.21	34.18	36.19	40.21	34.68	37.90	40.80
M-35	38.59	40.6	45.4	37.05	39.23	43.59	38.05	40.10	45.19

COMPRESSIVE STRENGTH OF CONCRETE (SELF CURING USING K-100)









IV. CONCLUSION

The strength investigation is mainly based on the adequate strength of concrete found by self-curing in the absence of water. The higher strength has been found tested by mixing of additive k100 in a varying percentage basis in an enhancing manner .It is a tremendous admixture found suitable where there is shortage of water & temperature is very high i.e. up to 400°C and -50°C temperature .The compressive strength is found higher while using the admixture along with consumption of material (water: cement) is less in comparison for which this material may be recommend to be used for concrete in various structural works. There are no shrinkage cracks as the material is highest resistant to chemical & different climatic conditions

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