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Construction Mechanics of Nano Pva Modified Fiber Cement Soil

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Abstract: Because of the characteristics of the materials and the limitations of the use environment, the durability of cement-based materials is insufficient. The freeze-thaw damage of cement-based materials is the most serious in the south. Based on the above background, the main purpose of this paper is to study the frost resistance of nano and PVA modified fiber cement-based composites. In this research, varied amounts of PVA fiber and nano particle are mixed with a fixed amount of water, superplasticizer, and sand in a cement-based composite. Then, using the quick freezing method, the relative dynamic elastic modulus of each sample is determined. The frost resistance of single PVA fiber and nano PVA fiber cement-based composites is examined, and the influence of nano-SiO2 and PVA fiber on cement-based composites is investigated. Frozen resistance has an impact. The findings of the experiments suggest that adding PVA fiber to cement-based composites improves their frost resistance significantly. With the addition of nano silica to PVA fiber cement-based composites, the frost resistance of PVA fiber cement-based composites is increased. When nano silica content is high, when the content of nano silica is 2.5% and PVA fiber is 0.4%, the frost resistance of cement-based composite is the best.

1. Introduce

Shrinkage break is one of the most well-known deformities of concrete based building materials. It won't just diminish the strength and toughness of concrete based materials, yet in addition speed up the erosion of interior support. Fiber can actually work on the elasticity of concrete based composites, hinder early plastic breaking and break proliferation, and work on the break opposition and sturdiness of concrete based composites. Among many fibers, polyvinyl alcohol fiber has high tensile strength, and the cement-based composite material prepared by polyvinyl alcohol fiber has high toughness and bending strength, so polyvinyl alcohol fiber cement-based composite materials have attracted much attention. With the advancement of material science, nanoparticles are broadly utilized in concrete based building materials due to their enormous explicit surface region, little molecule size, high surface energy and exceptional nano impact, which are utilized to work on the mechanical properties and solidness of concrete based building materials.

Liu s has fostered a liquefy turning process involving ionic fluids as the medium. The liquefy turned antecedent fiber shows fractional cyclization structure. The construction and properties of liquefy turned PAN antecedent fiber were investigated by filtering electron magnifying instrument, Fourier change infrared spectroscopy, differential checking calorimetry, X-beam diffraction, thermogravimetry, bright spectroscopy, buoyancy innovation, sound speed direction, straight thickness and elasticity. Santoro f proposed a method for in-situ detection of cell-material interface at any desired position. Based on focused ion beam milling and scanning electron microscope imaging, the cell membrane material interface was resolved at a resolution of 10 nm. By studying how the cell membrane interacts with topographic features such as nanoscale protrusions or protuberances. Liu H C effectively pre-arranged lignin, polyacrylonitrile and carbon nanotube composite filaments by gel turning. The impacts of lignin and carbon nanotubes on the actual design and security of the antecedent were examined by wide-point X-beam diffraction, infrared spectroscopy and warm properties. Qariouh h can obtain a good ultem1000 / carbon fiber coating by electrophoretic deposition. The deposition amount of polymer is well controlled, and the deposited film has a good appearance. A variety of carbon fiber composites can be made by this method.

Nematollahi B supported the generally fragile low calcium (F-grade) fly debris based polymer framework with irregular arranged short polyvinyl liquor (PVA) fiber (2% v/V). The framework and composite properties of the created fly debris based EGCS were assessed, including the functionality, thickness, compressive strength, network break properties (counting flexible modulus, break sturdiness and composite break tip durability) and uniaxial malleable way of behaving of the new grid. By adding 3 mm diameter polyethylene particles (6% of the total volume) into the mixture, felekolu KT compared the effect of the pre-existing defect size distribution correction on the deflection hardening behavior. Felekolu KT determined the size distribution of natural defects in bead free composites by cross-section analysis. The crack number and crack width distribution of the specimen under bending load are studied, and the possible reasons for the change of multiple cracks and deflection hardening behavior caused by the correction of crack size distribution are discussed. Bao Xin Q concentrated on the harm of pva-ecc radiates under low speed sway stacking. To reproduce different effect energy, a progression of drop ball sway tests were completed under various weight and stature of falling mallet. The impact effect of pva-ecc beam and mortar beam is compared. Polyvinylidene fluoride (PVDF) film sensor is combined with piezoelectric ceramic based intelligent aggregate for impact monitoring, including impact initiation and crack evolution. Zhang J studied the effect of adding steel fiber other than PVA fiber on the compression, bending and tensile properties of the composite. In the test, Zhang J used two kinds of ordinary portland cement (OPC) and calcium sulphoaluminate cement (SAC) with ultra-high early strength as cementitious materials.

In this paper, in keeping the proper measure of water, superplasticizer and sand, the impact of PVA fiber content on the ice opposition of concrete based composite materials is contemplated; the impact of the substance of nano particles on the ice obstruction of concrete based composite materials; the impact of the substance of nano particles and PVA fiber on the ice opposition of concrete based composite materials; and The outcomes show that the ice opposition of concrete based composites is improved all the more clearly by nano PVA changed fiber.

2. Nanoparticle and PVA fiber

2.1 Cement Based Composite Materials

Cement based reinforced materials can be divided into three categories: 1) metal fiber; 2) inorganic fiber, such as asbestos, man-made mineral fiber; carbon fiber; 3) organic fiber. The size of synthetic fiber mainly includes polypropylene fiber, polyethylene fiber, natural plant fiber, etc.

(1) Steel fiber

Steel fiber is widely used in engineering. The fiber content accounts for 20 ‰ of concrete volume, the flexural strength increases by 2.5 ~ 3 times, the toughness increases by more than 10 times, and the tensile strength increases by 20% ~ 30%. Steel fiber can also be used to manufacture variable cross-sections of various shapes to improve the adhesion between steel fiber and cement substrate. With the gradual increase of steel fiber content, the consistency of mixture also increases, resulting in poor dispersion, long mixing time and difficult molding. However, the steel fiber is relatively expensive, which leads to the high cost of concrete, which is difficult to be popularized in ordinary engineering.

(2) Glass fiber

Glass fiber built up cement would not just make be able to full utilization of the great compressive strength and great solidness of concrete materials, yet in addition give full play to the upsides of high rigidity of glass fiber, significantly working on the durability and strength of concrete grid, so it has been broadly utilized in substantial asphalt. In addition, glass fiber contributes to the public welfare of cement and the improvement of mold manufacturing level. It is convenient for people to manufacture various components, especially some complex thin-walled components. These products have light weight, fire resistance, high strength, water resistance and other excellent performance, widely used in various fields. However, after exposed to the atmosphere for a period of time, the strength and toughness of glass fiber reinforced concrete (GFRC) will obviously decrease, and due to the lack of alkalinity, it is mainly used for structural reinforcement.

(3) PVA fiber

Polyvinyl alcohol (PVA) fiber, also known as vinylon fiber, is a synthetic fiber made of high-quality polyvinyl alcohol with high degree of polymerization through advanced technologies such as dry wet spinning. Its main characteristics are high strength, high elastic modulus, good wear resistance, good acid and alkali resistance. Compared with cement fly ash and other cementing materials, polyvinyl alcohol fiber has no harm to the environment and human body in the process of production and use. It is a green building material in the new century.

Polyvinyl alcohol fiber as cement-based reinforcement material has the following advantages:

a) The construction is convenient and simple, and has no harm to human body and environment.

b) High elastic modulus and tensile strength.

c) In the molecular structure formula, there are - c-oh groups and - OH groups in the hydration products of cement to form hydrogen bonds.

d) It has non-circular and irregular cross-section, and the irregular surface is conducive to the interface bonding with cement matrix.

e) Good acid and alkali resistance, corrosion resistance, suitable for different types of cement, can adapt to a variety of harsh environments.

f) it has a certain degree of hygroscopicity and can be dispersed uniformly in the gel matrix.

In the late 1990s, Professor LIVC of the University of Michigan successfully developed engineering cement-based composites (ECC). The polyvinyl alcohol fiber reinforced material was designed by means of micromechanics and fracture mechanics. It has the characteristics of strain hardening and multi crack cracking. ECC is a typical representative of fiber reinforced cement-based materials. It is composed of cement, fine aggregate, water, mineral admixture and chemical admixture. The hardened ECC has the characteristics of ultra-high toughness, high tensile strength and remarkable strain hardening. Under the axial tension, several fine cracks can be produced to realize steady-state cracking. Under saturated cracking condition, the crack width is less than 100μm, the crack spacing is less than 3 mm, the compressive strength reaches 70 MPa, the peak compressive strain is 0.43%, and the ultimate direct tensile strength is higher than 5 MPa and more than 15 MPa bending tensile strength. The strain capacity of ECC is 200-400 times of that of ordinary concrete, and the weight of ECC is 0.4 times of that of ordinary cement-based materials.

2.2 Structural Failure Probability

The failure probability of structural components corresponds to the solution probability of Z < 0, expressed by P_x; the reliability probability of structural members corresponds to the solution probability of Z > 0, expressed by P_y, and the formula is as follows:

$$P_x = \int_{z<0} \ldots \int f_N(n_1, n_2, \ldots n_m) dn_1 dn_2 \ldots dn_m \tag{1}$$

$$P_y = 1 - P_x \tag{2}$$

The general form of structural reliability and failure probability calculation method is derived. When there are only two variables of structural resistance I and load effect J, these two variables may be of arbitrary distribution type. The formula is as follows:

$$P(i - \frac{di}{2} \le I \le i + \frac{s}{2}) = f_i(i)di \tag{3}$$

$$P(I < j) = \int_0^i f_I(j)dj \tag{4}$$

By multiplying formula 3 and formula 4, the integral is as follows:

$$P_f = \int_0^{\infty} f_I(I)\left[\int_0^I f_J(j)dj\right]di = \int_0^{\infty} F_J(i) f_I(i)di \tag{5}$$

The formula of failure probability is as follows:

$$P_x = 1 - P_y = \int_{-\infty}^{\infty} [1 - F_I(i)] f_y(i)di \tag{6}$$

The above formula of failure probability is an accurate formula when the structural variables are independent of each other. The formula is also applicable to the case that the function is nonlinear and the random variables are related. For the variables that obey other types of distribution, we can first convert the variables that obey the normal distribution into the variables that obey the normal distribution, and then use the above formula to calculate the reliability index of the structure. The calculated results are approximate values, which have reference value for engineering design.

2.3 Nanoparticles

(1) Nano ultrafine calcium carbonate

The molecule size of ultrafine calcium carbonate is in the scope of 1 ~ 100nm. It is primarily utilized in elastic, plastics, coatings and different businesses, and the most developed industry is the plastic business. It is principally utilized for PVC plastic sol and high-grade plastic items for auto internal fixing. It can work on the rheological property of plastic masterbatch and work on its formability. Simultaneously, as a plastic filler, it has the capacity of fortifying and hardening, can further develop the bowing modulus and bowing strength of the plastic, further develop the warm distortion temperature and layered soundness of the plastic, and cause the plastic to have warm hysteresis. Furthermore, in the covering business, it can enormously work on the thixotropy of the framework, fundamentally work on the launderability, bond, stain opposition, surface completion and strength of the covering, and has great enemy of settlement impact.

The fundamental creation techniques for calcium carbonate are actual strategy and synthetic strategy. The actual strategy is that the crude metal is straightforwardly squashed into calcium carbonate powder by mechanical handling. The items arranged by this strategy as a rule have enormous molecule size and wide circulation, and are by and large utilized as fillers for medium and low-finished results. Synthetic technique is a strategy to get calcium carbonate by controlling response conditions and compound responses between substances. Calcium carbonate delivered by compound strategy has little molecule size, limited dissemination and controllable gem shape. Its properties are clearly better compared to that of calcium carbonate ready by actual technique.

As of now, most endeavors use carbonization strategy to deliver nano calcium carbonate. As per the different carbonization techniques, it very well may be partitioned into persistent splash carbonization and discontinuous gurgling carbonization.

Persistent shower carbonization is the standard of putting the lime milk pressure atomizer on the highest point of the carbonization tower and atomizing it consistently into little drops. Carbon dioxide gas is shot out from the lower part of the pinnacle. The contact between them is carbonized. This strategy as a rule involves a few carbonization towers in series with various interaction stages. The arrangement got from the initial carbonization tower goes into the subsequent carbonization tower for carbonization response, and the arrangement acquired from the subsequent carbonization tower keeps on entering the third carbonization tower for carbonization response until the completed nano calcium carbonate is gotten. This technique is a nonstop carbonization process with high creation limit and simple control of item quality. Nonetheless, the gear venture is huge and the functional application is less.

Irregular gurgling carbonization is the most generally utilized carbonization technique with mature innovation, moderate hardware venture and straightforward activity. A specific centralization of lime milk is siphoned into the carbonization tower, and a specific convergence of oven gas is presented from the lower part of the pinnacle for gurgling and carbonization. To make the response quick, the gas merchant is typically introduced in the carbonization tower at the base, and the instigator and perplex plate are introduced in the carbonization tower, which can work on the quality and hotness move impact of the framework, make the oven gas all the more equally enter the lime milk, and further develop the response speed.

(2) Nano silica

Nano silica is a non-metallic material, white powder. Nano silica has the characteristics of non-toxic, large specific surface area, small particle size and stable chemical properties. Nano silica is widely used in biomedicine, catalyst, ceramic materials and chemical analysis.

Nano silica is a non-metallic material, white powder. Nano silica has the attributes of non-poisonous, enormous explicit surface region, little molecule size and stable synthetic properties. Nano silica is broadly utilized in biomedicine, impetus, clay materials and synthetic investigation.

1) Surface actual adjustment primarily alludes to the adsorption and covering treatment of nano materials. The outer layer of Nano-SiO2 is great, and it is not difficult to work on the security and mechanical properties of materials by adsorption, covering or covering. There is no ionic bond or covalent bond between nano silica and modifier. The degree of dispersion of silica nanoparticles largely determines the degree of aggregation between particles. In order to prevent the aggregation between particles, surfactants are usually coated on the surface of nano silica. Although the surface physical modification process is simple, the modification efficiency is low due to the weak interaction between nanoparticles and modifier.

2) Surface chemical modification refers to the chemical reaction between modifier and hydroxyl groups on nano-SiO2. The modifier is grafted onto nano-SiO2 particles to keep their own characteristics and other special properties. The common methods of surface chemical modification are coupling agent method, alcohol esterification method and surface grafting polymerization method

a) Surface grafting polymerization is a method of grafting organic polymer onto the surface of silica. The main purpose of grafting polymer onto nano materials is to reduce the surface energy of particles, improve the dispersion of particles in organic phase, and enhance the stability of particles in organic phase. The method of graft polymerization is to graft the initiator group onto the surface of nano silica, and then polymerize the organic monomer onto the surface of nano silica through initiator, so as to complete the graft polymerization modification. The coupling grafting method is to graft polymer onto the surface of nano silica, which mainly depends on the chemical reaction between the active group in the polymer and the hydroxyl or unsaturated residual bond on the surface of nano particle.

b) Alcohol esterification alcohol esterification is the dehydration and condensation reaction of hydroxyl groups on nano silica and fatty ethanol to generate water and siloxane under certain pressure and temperature, and then the required groups are grafted onto nano silica. The esterification condition of alcohol is high temperature and high pressure. The alkyl chain of alcohol has great influence on the modification of materials. This method is especially suitable for the esterification of nano silica with a large number of hydroxyl groups, which are replaced by alkoxy group (RO) of esterifier. Although the esterification of alcohol is simple, it has not been widely used because of the few kinds of modifiers and simple esterification method.

c) Coupling agent method is the most commonly used and widely used method in the modification of nano silica. As a material with two different characteristic groups, coupling agent can combine different functional groups together.

3. Comparison Experiment of Nano-Pva Modified Fiber Cement Matrix Composites

3.1 Experimental Equipment

The materials used in the experiment are: Ordinary portland cement, nano ultrafine calcium carbonate, nano silica, PVA fiber, quartz sand, superplasticizer, first grade fly ash and tap water.

3.2 Experimental Design

In order to study the influence of PVA fiber content, nano particle content and type on the durability of cement-based composite materials, the fixed proportion of water mixed binder and lime sand ratio were used in the experimental design. The mixing ratio of PVA fiber content and nano particle content calculation theory was changed respectively, and some parameters of mixing ratio test were modified to determine the final test mixing ratio. In this paper, PVA fiber was used in the experiment. The volume content of PVA fiber was 0,0.2%, 0.4% and 0.6% respectively. In this paper, nano silica and nano calcium carbonate are used. The content of nano silica is 0,1.5%, 2.0%, 3.5% and nano calcium carbonate is 0,2.0%. The amount of each material is shown in Table 1:

Table1: Amount of various materials in 1 m3 nano particle and PVA fiber reinforced cement-based composites

Mix number	Experiment number	Cement / kg	Fiber volume fraction (%)	Fiber content / kg	Nanoparticles / kg	Sand/ kg
1	K-0-0	700	0	0	0	600
2	A-0.2-0	700	0.2	1.82	0	600
3	A-0.4-0	700	0.4	3.64	0	600
4	A-0.6-0	700	0.6	5.46	0	600
5	AN-0.6-1.5	691.25	0.6	5.46	9.75	600
6	AN-0.6-2.0	683.75	0.6	5.46	16.25	600
7	AN-0.6-3.5	677.25	0.6	5.46	22.75	600
8	AN-0.6-1.5(C)	690.25	0.6	5.46	9.75	600
9	N-0-2.0	690.25	0	0	9.75	600
10	N-0-2.0(C)	690.25	0	0	9.75	600

The number k in Table 1 indicates ordinary concrete. The number a indicates the cement-based composite with PVA fiber. The number n represents the cement-based composite with nano silica. The number (c) indicates the cement-based composite with nano calcium carbonate.

4. Performance Comparison of Nano Pva Modified Fiber Cement-Based Composites

4.1 Freeze thaw cycle resistance of PVA modified fiber cement based composites

The thawing cycle test is carried out according to the quick freezing method in the test code for hydraulic concrete. After 24 days of curing under standard curing conditions, the specimens were taken out from the curing room. The examples were absorbed water at 20 ± 3 ℃ for 4 days, and the surface dampness was cleared off with a perfect towel. The underlying powerful flexible modulus of the example was estimated as the underlying worth of ice obstruction assessment. Then put the test piece into the test box, put the box into the freeze-thaw test box and inject clean water to keep the water surface in the box about 20 mm higher than the top surface of the test piece. The radiator fluid arrangement is utilized as the freezing and defrosting vehicle for the temperature estimating example, which is put in the focal point of the freeze-defrost box to begin the freeze-defrost test. The quick freeze-defrost test was done in immersed water. The dynamic elastic modulus of the specimen was measured every 25 freeze-thaw cycles. After the measurement, the two ends of the specimen were interchanged and put into the test box again, and water was added to continue the test. The freeze-defrost test can be halted assuming one of the accompanying three circumstances happens: 1) 250 freeze-defrost cycles; 2) the overall unique versatile modulus diminishes to 60% of the underlying worth. The exploratory outcomes are displayed in Fig. 1:

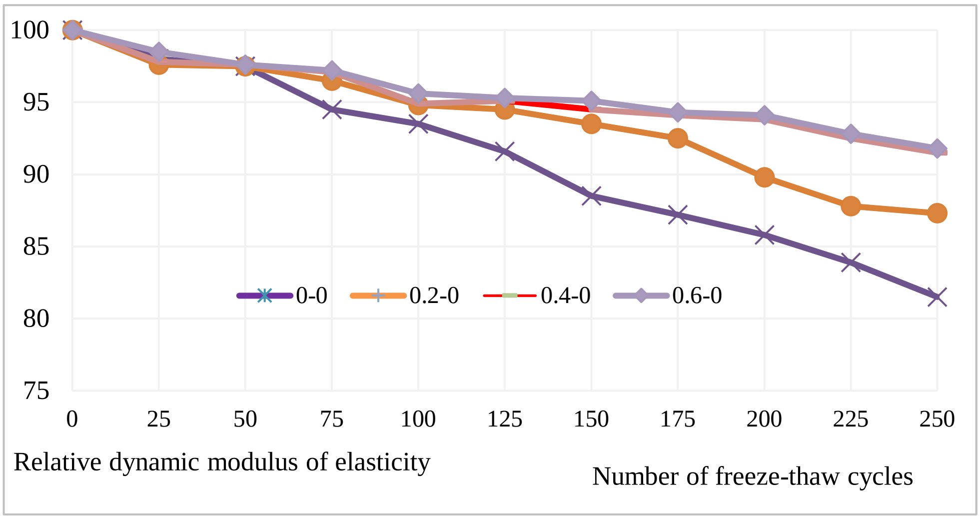

Figure 1: Effect of PVA fiber on frost resistance (undoped SiO_2)

Figure 1 shows the connection between the overall unique versatile modulus and freeze-defrost patterns of concrete based composites with various PVA fiber content. It very well may be seen from Figure 1 that a specific measure of polyvinyl liquor fiber can further develop the ice opposition of concrete based composite materials. After 250 freeze-defrost cycles, the overall unique flexible modulus of the composite is 81.5%. Whenever the volume content of PVA fiber increments from 0 to 0.6%, the overall unique versatile modulus of concrete based composites increments with the increment of PVA fiber content. After 250 freeze-defrost cycles, the overall unique flexible modulus is 91.6%, expanded by 10.1%.

Before the freeze-thaw test, the surface of all specimens was smooth without pits. With the development of the test, a certain number of small holes appear on the surface of cement-based materials without PVA fiber. Due to the water in the air hole in the mortar on the surface of the test piece freezes during the freeze-thaw cycle, the surface hardened cement paste shows massive spalling under the action of expansion stress. However, the surface of the cement-based composite with PVA fiber has no obvious change during the freeze-thaw cycle. The overlapping of PVA fibers in the cement matrix hinders the overflow of internal air, increases the air content in the cement matrix, increases the air content in the cement matrix, and relieves the hydrostatic pressure and osmotic pressure in the process of low temperature cycling. In addition, due to the small diameter of PVA fiber, the large number of fibers per unit mass and the small fiber spacing, the energy loss in the process of freeze-thaw damage of cement-based composites is increased, and the expansion cracking of cement-based composites is effectively restrained, which is beneficial to the improvement of frost resistance of cement-based composites.

4.2 F reeze T haw C ycle R esistance of P va F iber Cement-Based C omposites W ith D ifferent Nano-Sio2 Content

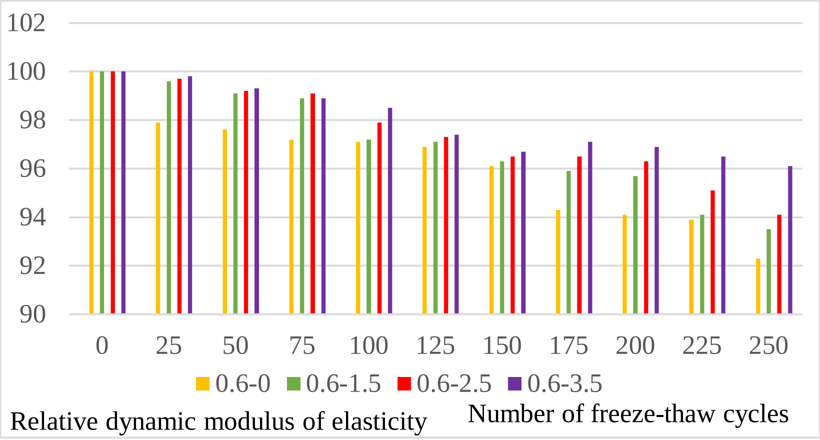

Figure 2: Effect of nano silica on frost resistance (0.9% PVA fiber)

Figure 2 shows the connection between the overall powerful versatile modulus and freeze-defrost patterns of PVA fiber concrete based composites with various nano-SiO2 content. It very well may be seen from Fig. 2 that subsequent to adding nano-SiO2, the overall unique flexible modulus of PVA fiber concrete based composite materials under different freeze-defrost cycles is expanded to shifting degrees. After 250 freeze-defrost cycles, the general unique versatile modulus of PVA fiber supported concrete based composites with 1.5%, 2.5% and 3.5% nano-SiO2 are 93.5%, 93.9% and 96.1%, individually, and are more noteworthy than 91.6% after 250 freeze-defrost cycles. It tends to be seen that in a little reach (⩽ 3.5%) nano-SiO2 can further develop the ice obstruction of PVA fiber concrete composite, and the higher the substance of nano-SiO2, the better the ice opposition.

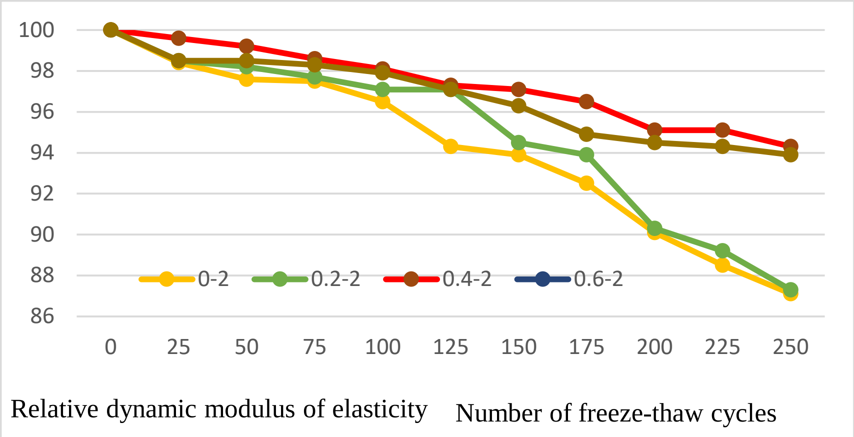

Figure 3: Effet of PVA fiber on frost resistance (2.5% SiO_2 *)*

Figure 3 shows the connection between the general unique flexible modulus and freeze-defrost patterns of concrete based composite materials with various PVA fiber substance when the substance of Nano-SiO2 is 2.5%. It tends to be seen from Figure 3 that when the substance of Nano-SiO2 is 2%, inside the scope of PVA fiber content in this test, with the increment of PVA fiber volume content, when the substance of Nano-SiO2 is 2%, The overall powerful flexible modulus of concrete based composite materials increments right away and afterward diminishes at each freeze-defrost cycle. Whenever the volume part of PVA fiber is under 0.4%, the overall powerful versatile modulus of concrete based composite material increments with the increment of PVA fiber content. The overall unique flexible modulus of concrete based composite material after 250 freeze-defrost cycles comes to 94.5%, while when the fiber content is 0.6%, the general powerful versatile modulus is 93.9%, which is higher than 87.3% of the example without fiber after 300 freeze-defrost cycles. Along these lines, PVA fiber can further develop the ice obstruction of Nano-SiO2 concrete based composites.

4.3 Freeze Thaw Cycles of Nanocomposites

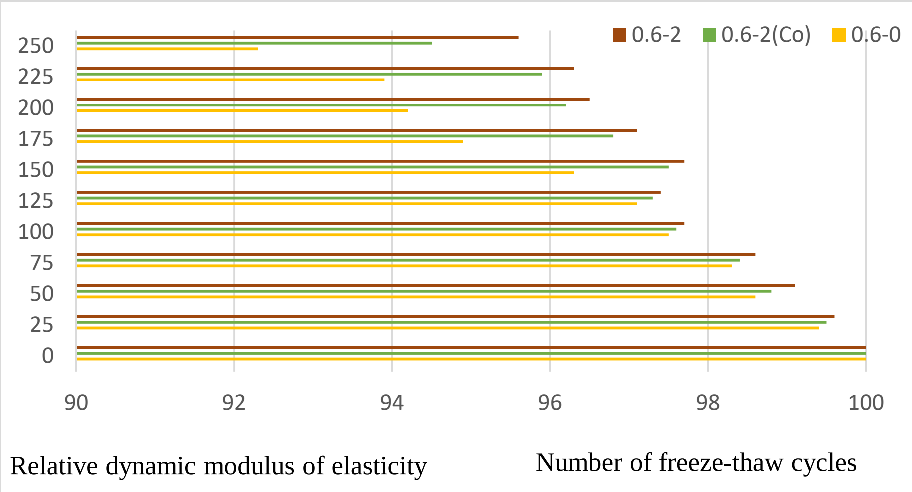

Figure 4: PVA fiber cement based composites

The connection between the powerful modulus of nanocomposites and freeze-defrost cycles is displayed in Fig. 4. It tends to be seen from Figure 4 that the two nano calcium carbonate and nano silica can further develop the ice opposition of concrete based composite materials partially, yet nano-SiO2 is somewhat better compared to Nano-CaCO3 in further developing the ice obstruction of concrete based composite materials. After 250 freeze-defrost cycles, the overall unique versatile modulus of the concrete based composite containing 2% Nano-CaCO3 and nano-SiO2 are 95.6% and 94.5% individually after 250 freeze-defrost cycles, which are 3.1% and 2.0% higher than those of the concrete based composite with 0.9% PVA fiber after 250 freeze-defrost cycles. Contrasted and Nano-CaCO3, the overall unique versatile modulus of the concrete based composite expanded by 1.1% after 250 freeze-defrost cycles.

The exploratory outcomes show that the expansion of PVA fiber can altogether further develop the ice obstruction of concrete based composites. Because of the little measurement fiber, countless filaments per unit mass and little dividing, the energy misfortune during the time spent freeze-defrost harm increments. The concrete based composite can really limit the development and breaking of the concrete based composite material, and further develop the ice obstruction of the concrete based composite material. Adding nano silica into PVA fiber built up concrete based composite can clearly further develop its ice obstruction. Also, in the scope of exploratory substance (≤2.5%), the ice obstruction of concrete based composite is upgraded with the increment of Nano-SiO2 content. PVA is added into the nano-SiO2 concrete based composite The outcomes show that the ice opposition of concrete based composites can be worked on in a specific scope of fiber content, and when the volume content of PVA fiber is 0.4%, the ice obstruction of concrete based composites can be improved enormously. The expansion of nano particles can likewise further develop the freeze-defrost obstruction of concrete based composites. The improvement impact of nano silica is superior to that of nano calcium carbonate.

5. Discuss

In this paper, the freeze-thaw resistance of nano PVA modified fiber cement-based composites was studied. In the experiment, the freeze-thaw resistance of nano PVA modified fiber cement-based composite was studied under the condition of fixed amount of water, superplasticizer and sand.

All specimens were smooth before freeze-thaw test.

With the progress of the experiment, a certain number of small holes appear on the surface of cement-based materials without PVA fiber. During the freeze-thaw cycle, due to the water freezing in the pores of the mortar on the surface of the specimen, the expansion pressure is generated, and the massive spalling of the surface hardening cement slurry occurs under the expansion stress. During the freeze-thaw cycle, the surface of the cement-based composite with PVA fiber has no obvious change. The random overlapping of PVA fibers in the cement matrix hindered the internal air leakage, increased the air content in the cement matrix, and reduced the hydrostatic pressure and osmotic pressure during the low-temperature cycle. The trial results show that with the increment of PVA fiber content, the ice opposition of concrete based composites is clearly upgraded with the increment of PVA fiber content.

The cement-based composites with 0.6% PVA fiber and 0,1.5%, 2.5% and 3.5% nano silica are added. With the increase of nano silica content, the frost resistance of PVA modified fiber cement composites can be improved. When the content of silica is 2.5%, the frost resistance of cement-based composites with different PVA fiber contents of 0.2%, 0.4% and 0.6% are obtained. With the increase of PVA fiber content, the frost resistance of nano PVA fiber cement-based composites has a critical value, which is 0.4-2.5. The content of PVA fiber and nano silica is 0.4% and 2.5% respectively. When the content of PVA fiber is more than 0.4%, the improvement effect of PVA fiber on the frost resistance of cement-based composites is weakened. Therefore, when the content of PVA fiber is 0.4%, the frost resistance of nano PVA modified fiber cement composite is the largest. Nano silica is better than nano calcium carbonate in frost resistance of cement-based composites.

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