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Experimental Investigation on Influence of Halloysite Nano Clay on Strength of Cement Mortar

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ABSTRACT

The use of nanomaterials in cement mortar can increase its mechanical qualities and performance. Previously, the only materials utilized in construction were cement and sand with aggregates. Compressive strength and modulus of elasticity are often high in cementitious components, whereas tensile strength, toughness, and ductility are low. Additional strengthening chemicals are employed to compensate for this. It all started with the use of plasticizers, and as research progressed, we moved on to the use of nanomaterials as a strength gain alternative. Because of their binding capabilities and amazing strength, nanomaterials such as carbon nanotubes (CNTs) have been discovered to be suitable reinforcing agents. CNTs, on the other hand, are not thought to be safe for humans or the environment. It's due to their toxicological potential. Halloysite, a nanomaterial, has emerged as a safe option as the study of nano composites has progressed. Halloysite is a low-cost, naturally occurring nanomaterial that is environmentally beneficial. It's also safe for humans and the environment. It has become the next excellent material for nano cement paste due to its increased aspect ratio, simple dispersibility in polymer matrices, and most importantly, its abundant availability. Experiments on nanomaterials, namely halloysite nano clay and carbon nano tubes with cement mortar, are highlighted in this work.

Keywords: - carbon nanotubes, SWCNT, MWCNT, HNC, compression strength, strength gain

1. INTRODUCTION

Because of its ease of binding, Portland cement has been the most widely used cement in the construction industry in civil engineering for centuries. The hydration process, which makes cement bind and hard to give mechanical strength to the concrete or cement mortar, is formed by mixing cement with water. There are several properties that are responsible for the strength of the cement mortar or concrete, such as water-cement ratio, porosity, bonding between cement and aggregates, and so on, but mainly the chemical reactions.As a result, boosting the structure's strength necessitates altering the cement's composition. If some kind of nanoscale bonding can be developed between CSH and nano sized material, then the strength of the cement concrete can be increased from the new nano composites. Nanotechnology is the new fashion for almost all industries. When it comes to construction, what matters is improving the structure's strength, thus incorporating nanotechnology in the field of construction.

Although high prices for nanomaterials currently restrict the use of nanomaterials for development, the price of nanomaterials is likely to decline in the near future. The advent of novel nano-sized fibres, such as carbon nanotubes (CNTs), has opened up a new arena for nano-sized concrete reinforcement. Self-aggregation of nano [articles due to van der Waals forces, which increase particle size and un-reacted pockets, which reduces the benefits of nanomaterials, is one of the major drawbacks of incorporating nanomaterials in concrete. These carbon nano tubes CNTs are defined as tubular structures made of one or two layers of graphite sheets.

Cement is a introduction material commonly used due to its low cost and high compressive strength. Contemporary Civil engineering is absolutely putting new conditions concerning the quality of engineering materials. Advanced technological factors name for higher performing cement-based materials with stepped forward strength and sturdiness for use in civil engineering projects. Cementitious materials are normally characterized as quasibrittle materials, with low strength and low strain capacity, and long-term durability of structures depends on cementitious materials. Addition of Halloysite nano clay (HNC) in the cementitious materials may additionally moreover provide extraordinary strength increase as well as controlling cracks.

CNTs have a high aspect ratio ranging from 1,000: 1 to 2,500,000: 1 and very small diameters, which helps to bridge cracks between compounds and prevents them from spreading further, resulting in the creation of next generation crack-free structures. The effects of NS (Nano Silica) particles on cement paste were investigated, and it was discovered that NS affected the cement paste by filling voids in the cement matrix, reducing the porosity of the cement matrix, and increasing the strength of the cement concrete. It was also discovered that adding NS to the cement increased the hydration process. The first uniform dispersion of carbon nanotubes in a cement matrix, which is extremely difficult due to the forces involved (van der Waals force).Individual members tend to move out when subjected to load due to poor bonding of CNTs with the cement matrix. As a result of the vibration energy breaking the nano tube chunks and pushing them apart, the sonication technique has become a common means to distribute the nano tubes in the cement matrix. According to Stokes law, the carbon nano tubes will settle in the liquid after some time. After sonication, some form of agent is required to maintain the CNTs distributed. To promote better bonding between CNTs and cement components, ethanol and methyl cellulose have been routinely employed as dispersants.

The compressive and tensile strength properties of cement paste reinforced with HNC were examined in this work. Few researchers have demonstrated the improvement in mechanical characteristics of singly reinforced nano composites in recent studies. Molds were prepared based on the size, and the cement mortar was prepared with the foreign material, i.e. HNC or CNTs, with different compositions and for different curing times.

After the curing time, the moulds were removed, and the specimens were ready to be tested for mechanical strength. After the test, the broken specimens were taken for the study of morphology of the hardened concrete or hardened cement mortar. SEM scanning electron microscopy is used for this.

2. PRELIMINARY TESTS

2.1 Cement

Ordinary Portland cement of grade 53 was used for the whole project. The physical standards of the cement was evaluated according to IS: 12269-1987.

SL. No	Property	Value
1	Specific gravity	3.08
2	Fineness of cement	4.23%

2.2 Fine aggregates

The M sand which are used for the experimental analysis comprise of three batches. First the sand which passes through 2mm and retained on 1mm. Secondly, which passes through 1mm and retained on 500 microns. Thirdly, the sand which passes through 500 microns and retained on 60 microns.

SL. No	Property	Value
1	Specific gravity	2.55
2	Bulk density	1.9 g/cm²

3. METHODOLOGY

In this project, the compression strength test was carried out with a 70mmX70mmX70mm cube, whereas the tensile strength test was carried out with briquettes moulds. The examples were cast using OPC 53 grade cement and sand passing through 2.0mm and retaining at 90 micron Is sieve. HNC was added to the specimens in doses of 0.5 wt%, 0.75 wt%, 1 wt%, and 1.25 wt% of the cement weight. The W/C ratio was set at 4.5 at random. After that, the moulds were left to air dry for 24 hours. For both compression and tensile strength testing, the moulds were removed and maintained under the boxes for water curing for 7, 4, and 28 days.

Figure 1. Cube moulds

Figure 2. Briquet moulds

Figure 1. Compression testing machine

Figure 2. Briquet machine

4. RESULTS

4.1. Tensile stress in N/mm2 (7 Dayas)

Percentage of HNC	Tensile Strength
NM	1.84
0.5	1.12
0.75	1.44
1	2.32

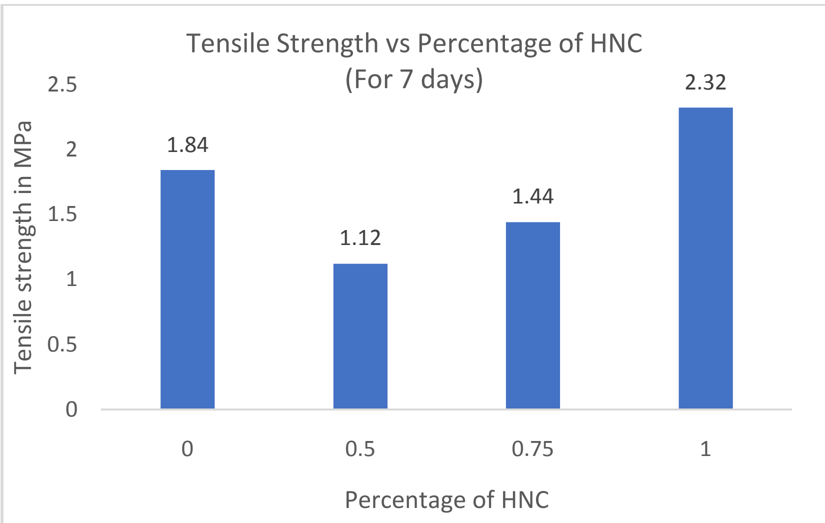


Figure 3. Percentage of HNC vs Tensile stress

4.2. Tensile stress in N/mm2 (14 Days)

Percentage of HNC	Tensile Strength
0	2.87
0.5	2.5
0.75	2.9
1	2.39

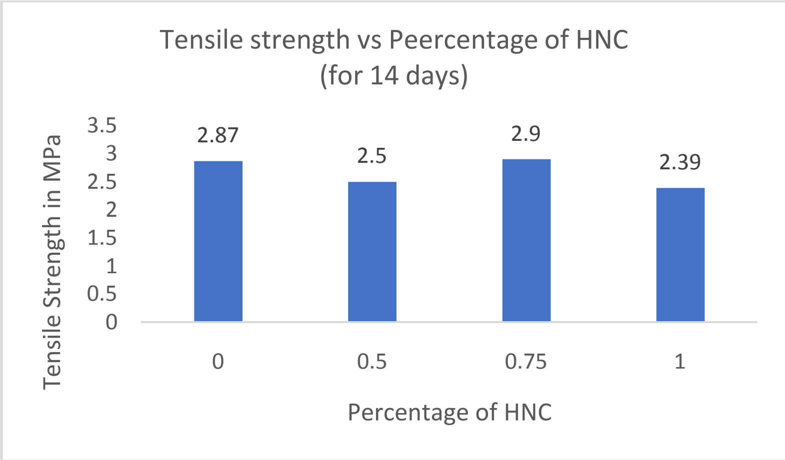
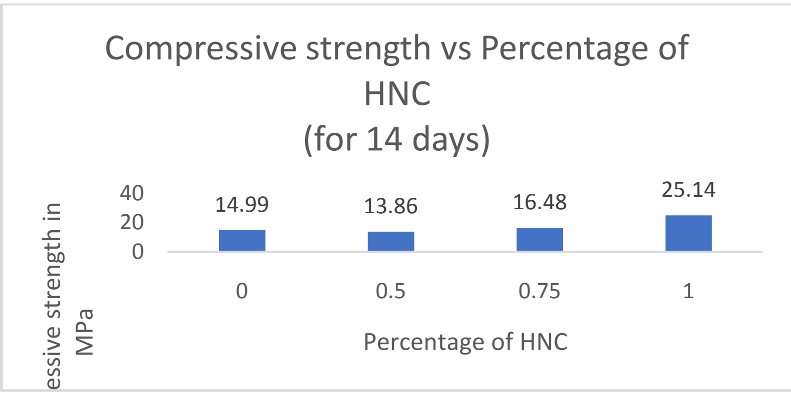


Figure 4. Tensile strength vs Percentage of HNC

4.3. Compressive stress in N/mm2 (14 Days)

Percentage of HNC	Compressive stress
0	**14.99**
0.5	**13.86**
0.75	**16.48**
1	**25.14**



5. CONCLUSSIONS

1. After 7 days of curing composite with 1wt% HNC showed 28.9 % increase in Tensile strength.
2. After 14 days of curing composite with 0.75% HNC showed only 1.04% increase in Tensile strength.
3. After 14 days of curing composite with 1wt% HNC showed 68% increase in compression strength.
4. Hence, the composite with HNC showed increased mechanical strength compared to nominal mix.

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