# PERFORMANCE OF DURABILITY CHARACTERISTICS ON HIGH STRENGTH CONCRETE USING NANO CLAY, RED MUD AND SILICA FUME ADMIXTURES

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***Abstract*—** The paper deals with the performance of durability characteristics using Nano clay, red mud and silica fume to produce a high strength concrete. This study is mainly concentrated on the durability characteristics of HSC with some percentage replacement of cement by red mud, nano clay and silica fume. The cement was replaced with 75% to 60% at 2.5% interval by mineral admixture such as red mud, nano clay and silica fume. Water cement ratio is kept constant for all mixtures. The main aim of paper is to be found out the acid and chloride resisting capacity of the specimens. The result shows that the combination of third sample produced 20% more resisting capacity of acid and chloride immersion compared with other samples from the experimental.

***Keywords-*** Durability, Nano clay, red mud, silica fume, Glass fibre, strength, workability, HSC

## 1. INTRODUCTION

Concrete is the most important and widely used construction material. The strength of concrete has a direct relation with its durability. Hence, the concrete should possess the ability to resist weathering action, chemical attacks, abrasion, deterioration, etc. Durable concrete retains its the original form, quality and serviceability even when exposed to aggressive environments. Over recent years, concrete durability researches are being conducted by technologists for saving the structures from cited cause and for maintaining the sustainability of the globe.

Concrete is a matrix consisting of a binder, fine aggregates, coarse aggregates and water, in specified proportions. Approximately 70% - 80% of the concrete volume is occupied by aggregates [1]. In Malaysia, the extensive use of aggregates from year to year in concrete production [2] as a result of rapid development in construction has led to negative impact to the environment. The high demand of industry for granite aggregates supply causes drastic depletion of natural resources which damaged the environment [3] thus causing ecological imbalance [4]. The depletion of granite aggregate would cause the local industries to depend on imported aggregates and that will lead to higher cost of production. Therefore, the use of alternative aggregates in concrete production is seen as one of the solutions to the serious depletion of granite aggregates problem in the future. The availability of laterite aggregates in Malaysia [5] has inspired researchers to integrate this red brown colour aggregates as mixing ingredient in concrete. Earlier researcher, Caldeira [6] revealed that content of laterite aggregate used as partial coarse aggregates replacement influences the compressive strength of concrete. However, it is possible to produce concrete with the targeted strength by adding 20% of laterite aggregate as partial coarse aggregates replacement [7]. Study conducted by Kamaruzaman and Muthusamy [8] discovered that concrete containing laterite aggregates exhibits better strength

development when subjected to water curing as compared to air curing and natural weather curing. In terms of moisture absorption properties, concrete containing laterite aggregates up to 50% replacement is classified in terms of quality as high quality concrete as plain concrete [9].

From the above literature review found out the resisting capacity of concrete specimens using various admixtures. The Nano clay, red mud, silica fume and Glass fibre are used in this study.

## 2. EXPERIMENTAL STUDY

### *2.1 Materials*

The materials used for coarse aggregate, natural sand, nano clay, red mud, silica fume and 53 grades ordinary Portland cement. The sand and coarse aggregate used for locally available. The slilica fume and red mud were replaced by 10 % constant for cement and nano clay used various % of cement at 2.5% interval. The materials details as shown in table 1.

**Table 1: Materials proportion in percentage**

| Sample no | Cement in % | Red mud in % | Silica fume in % | Nano clay in % | F.A in % | C.A in % | Superplasticizer in % | Glass fibre in % |
|---|---|---|---|---|---|---|---|---|
| S1 | 75 | 10 | 10 | 5 | 100 | 100 | 0.8 | 0.5 |
| S2 | 72.5 | 10 | 10 | 7.5 | 100 | 100 | 0.8 | 0.5 |
| **S3** | 70 | 10 | 10 | 10 | 100 | 100 | 0.8 | 0.5 |
| S4 | 67.5 | 10 | 10 | 12.5 | 100 | 100 | 0.8 | 0.5 |
| S5 | 65 | 10 | 10 | 15 | 100 | 100 | 0.8 | 0.5 |

Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. The silica fume is collected from ELKEM INDIA(P) LTD, Mumbai. Red mud is obtained from aluminum industry. Super plasticizers, also known as high range water reducers, are chemicals used as admixtures where well-dispersed particle suspensions are required. ASTM C 494 type F as a high range water reducing admixture (CONPLAST SP 430) was used.

**Table 2 Physical properties on binding materials**

| Test conducted | Results | | | |
|---|---|---|---|---|
| | Cement | Red mud | Silica fume | Nano clay |
| Specific gravity | 3.15 | 3.10 | 2.76 | 2.95 |
| Standard consistency (%) | 29 | 32 | 34 | 27 |
| Fineness(Specific surface) in $m^2/kg$ | 225.6 | 220.2 | 229.5 | 230.10 |

### *2.2 Specimens casting and testing.*

Initially the concrete characteristic strengths were observed from conventional concrete specimens ( without immersed acid and chloride solution ) such as cubes, cylinders, and prisms as recommended in IS 516-1959. The experimental results and characteristics are noted in Table6. Each sample nine specimens were casted with different mix combination at 7, 14 and 28 days. The optimum strength obtained at 28 days water curing in conventional specimens (without immersed acid and chloride solution). The matured conventional specimens were compared with 30 and 60 days acid, chloride solution immersed concrete specimens. It proved that the chloride immersed concrete specimens were 20% more resisting capacity than acid immersed concrete specimens.

| Description of specimens | Duration of specimens immersed in Hcl and Mg Sulphate solution | | |
|---|---|---|---|
| | 0 | 30 | 60 |

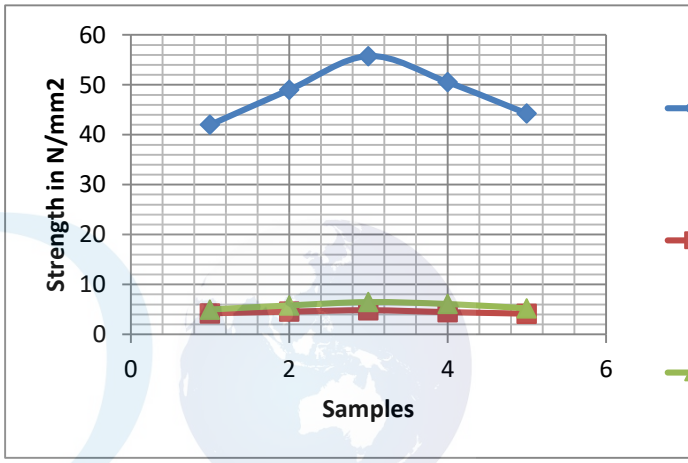


**Figure 1 Strength of various samples in N/mm$^2$**

*2.3 Acid and Chloride Resistance tests.*

The ingredients and preliminary tests were conducted for five different mix combinations. Based on the optimum strength mix proportional choose for comparing the acid and chloride resisting capacity were studied. For this acid and chloride resistance test, cube specimens of 6 nos. were cast additionally in each sample. After 28 days of water curing the specimens were dried in the atmosphere for 36 hours weighed (initial weight) and then kept immersed in 2% HCl diluted solution and 2% Magnesium chloride diluted solution as per the Table 3.

**Table 3 Details of Experimental Program**

| | day | days | days |
|---|---|---|---|
| CC specimens in nos | 3 | 3 | 3 |
| GPC specimens in nos | 3 | 3 | 3 |

**Figure 2 Compressive test and Immersed in Acid and Chloride solution**

The weight loss of sample 1 to sample 5 specimens after acid immersion and chloride immersion for 30 and 60 days were studied and compared. Based on the comparison the sample 3 specimens have more strength were compared and found out from this experimental. From figure 3 shows that the weight loss due to acid and chloride immersion in sample 3 were 16% and 20% less than the other samples.

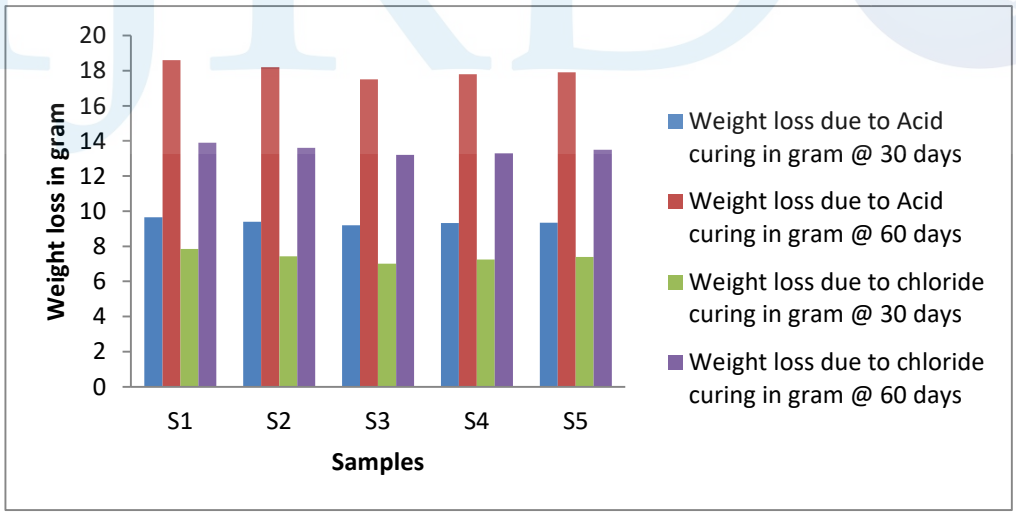


**Figure 3 Weight loss due to Acid and Chloride curing @ 30 and 60 days**

The cube compressive strength loss of sample 1 to sample 5 specimens after acid immersion and chloride immersion for 30 and 60 days were studied and compared. Based on the comparison the

sample 3 specimens have more strength were compared and found out from this experimental. From figure 4 shows that the strength loss due to acid and chloride immersion in sample 3 were 18% and 22% higher than the other samples.

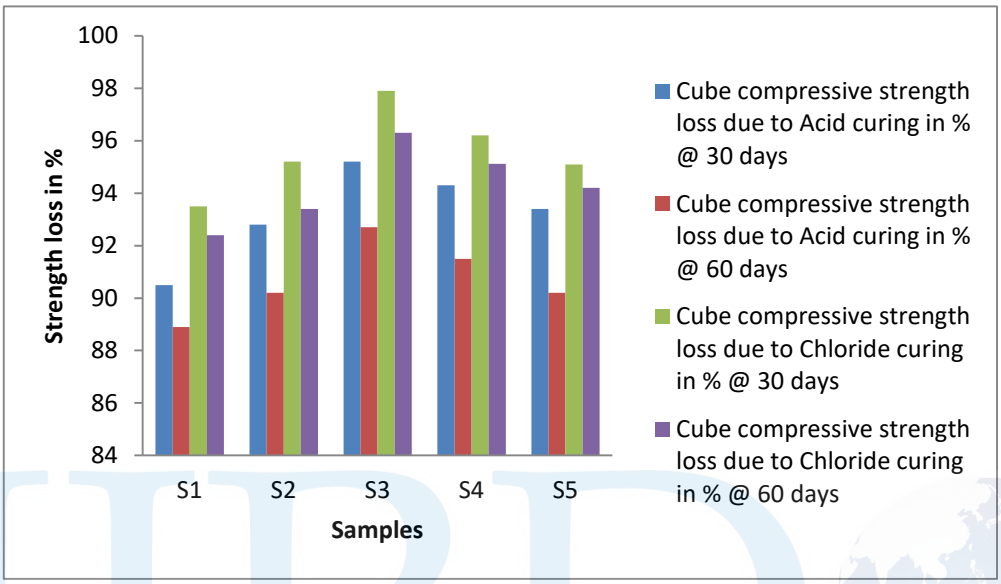


**Figure 4 Cube compressive strength loss due to Acid and Chloride curing @ 30 and 60 days**

## 3. RESULTS AND DISCUSSION

Based on the laboratory test it has been observed that strength of concrete is increasing with addition of admixtures. The various tests that are conducted to test the strength and durability characteristics and their results correlate with the study and derive positive result and improvement.

- The weight loss of sample 1 specimens after acid immersion for 30 and 60 days were 9.65 gram and 18.6 gram and after chloride immersion for 30 and 60 days were 7.85 gram and 13.9 gram respectively shown in Fig. 1.
- The weight loss of sample 2 specimens after acid immersion for 30 and 60 days were 9.40 gram and 18.2 gram and after chloride immersion for 30 and 60 days were 7.42 gram and 13.6 gram respectively shown in Fig. 1.

- The weight loss of sample 3 specimens after acid immersion for 30 and 60 days were 9.20 gram and 17.5 gram and after chloride immersion for 30 and 60 days were 7.0 gram and 13.2 gram respectively shown in Fig. 1.
- The weight loss of sample 4 specimens after acid immersion for 30 and 60 days were 9.32 gram and 17.8 gram and after chloride immersion for 30 and 60 days were 7.25 gram and 13.3 gram respectively shown in Fig. 1.
- The weight loss of sample 5 specimens after acid immersion for 30 and 60 days were 9.35 gram and 17.9 gram and after chloride immersion for 30 and 60 days were 7.40 gram and 13.5 gram respectively shown in Fig. 1.
- The loss of cube compressive strength of sample 1 specimens after acid immersion for 30 and 60 days were 90.5% and 88.9% and after chloride immersion for 30 and 60 days were 93.5% and 92.4% respectively shown in Fig. 2.
- The loss of cube compressive strength of sample 2 specimens after acid immersion for 30 and 60 days were 92.8% and 91.5% and after chloride immersion for 30 and 60 days were 95.2% and 93.4% respectively shown in Fig. 2.
- The loss of cube compressive strength of sample 3 specimens after acid immersion for 30 and 60 days were 95.2% and 91.7% and after chloride immersion for 30 and 60 days were 97.9% and 96.3% respectively shown in Fig. 2.
- The loss of cube compressive strength of sample 4 specimens after acid immersion for 30 and 60 days were 94.3% and 90.5% and after chloride immersion for 30 and 60 days were 96.2% and 95.12% respectively shown in Fig. 2.
- The loss of cube compressive strength of sample 5 specimens after acid immersion for 30 and 60 days were 93.4% and 91.5% and after chloride immersion for 30 and 60 days were 95.1% and 94.2% respectively shown in Fig. 2.
- Based on the above test results, the combination of sample 3 specimens having more resisting capacity of acid and chloride solution. The specimens were tested as per IS 516-1959

## 4. CONCLUSION

From the research results it was concluded that Sample no. 3 cube specimens withstands more load carrying capacity after acid and chloride immersion than the conventional elements. In this research, the Sample no.3 mix combinations are cement 70%, red mud 10%, nano clay 10% and silica fume 10% endures durability and increase the life of the structures. Thus, it can be concluded that the red mud, nano clay and silica fume were good replacing material for producing high strength concrete.

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