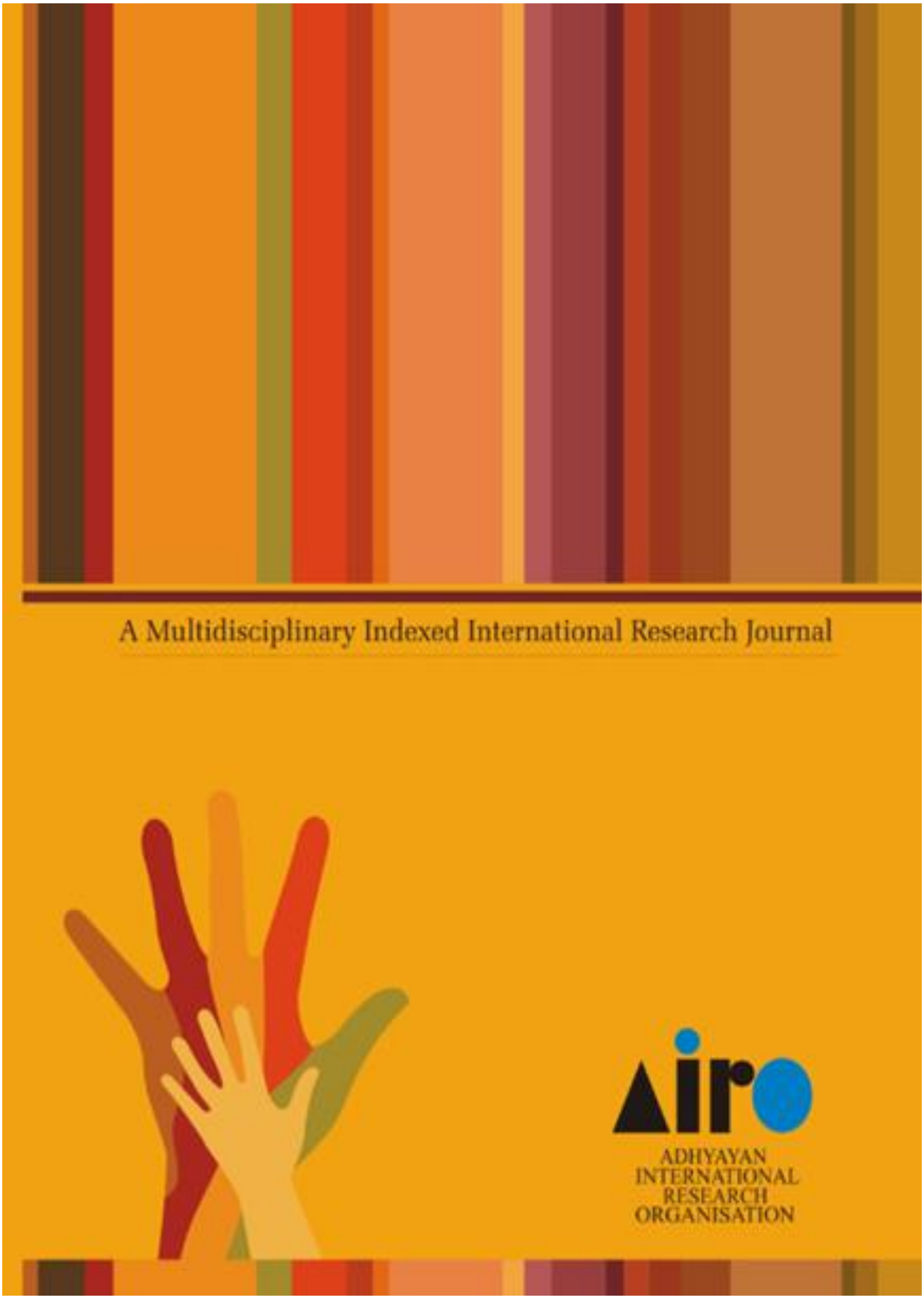
Airo International Research Journal
Volume XV, ISSN: 2320-3714
April, 2018
Impact Factor 0.75 to 3.19

ज्ञान-विज्ञान विमुक्तये
UGC Approval Number 63012



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COMPARATIVE STUDY TO DEVELOP THE PROPERTIES OF CONCRETE BY USING VARIOUS CATEGORIES OF STONE AGGREGATE

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Abstract

The role of coarse aggregate in concrete is central to this report. While the topic has been under study for many years, an understanding of the effects of coarse aggregate has become increasingly more important with the introduction of high strength concretes, since coarse aggregate plays a progressively more important role in concrete behaviour as strength increases. In normal-strength concrete, failure in compression almost exclusively involves de bonding of the cement paste from the aggregate particles at what, for the purpose of this report, will be called the matrix-aggregate interface. In contrast, in high-strength concrete, the aggregate particles as well as the interface undergo failure, clearly contributing to overall strength.

Keywords: *Mix proportion, compressive strength, workability, cements reduction, matrix aggregate.*

1. Introduction

It is well recognized that coarse aggregate plays an important role in concrete. Coarse aggregate typically occupies up to 70% to 80% of total volume of concrete, and research indicates that changes in coarse aggregate can change the strength and fracture properties of concrete. To predict the behaviour of concrete under general loading requires an understanding of the effects of aggregate type, aggregate size, and aggregate content. This understanding can only be gained through extensive testing and observation. There is strong evidence that aggregate type is a factor in the strength of concrete. Ezeldin and Aitcin (1991) compared concretes with the same mix proportions containing four different coarse aggregate types. They concluded that, in high-strength concretes, higher strength coarse aggregates typically yield higher compressive strengths, while in normal-strength concretes, coarse aggregate strength has little effect on compressive strength. Other research has compared the effects of limestone and basalt on the compressive strength of high-strength concrete (Giaccio, Rocco, Violini, Zappitelli, and Zerbino 1992). In concretes containing basalt, load induced cracks developed primarily at the matrix-aggregate interface, while in concretes containing limestone, nearly all of the coarse aggregate particles were fractured. Darwin, Tholen, Idun, and Zuo (1995, 1996) observed that concretes containing basalt coarse aggregate exhibited higher bond strengths with reinforcing steel than concretes containing limestone.

In this experiment, Plasticizer are added in various percentage by volume of concrete to know the optimum flexural strength and compressive strength in comparison to plain cement concrete. In order to examine the effects of polymers on mechanical properties of concrete, compressive strength, flexural strength, and tensile strength were investigated. Results showed that all polymer-concrete composites obtained compressive strength higher than the minimum design compressive strength of 60 MPa. Test results showed improvement of compressive strength for all polymer-concrete composites except PMCs. Compressive strength of PMCs was enhanced by adding an appropriate antifoaming agent. FRCs and FRPMCs increased compressive strength up to 14% and 16%, respectively. Latex polymer increases workability of the concrete and also decreases the possibility of segregation. By using latex in the mix the amount of superplasticiser can be decreased maintaining similar workability. Latex increases the air content in the mix as well. This phenomenon increases workability of the concrete. Mixing antifoaming agent can reduce the air content considerably and bring it to the acceptable range. PP fibres reduce workability of the concrete slightly. This can be compensated by adding superplasticiser to the mix. Air content in FRCs is in the acceptable rage, although it is higher than CC.

2. Scope of work

The purpose of this research is to compare the compressive strength, flexural strength, and fracture energy of normal and high-strength concretes with different aggregate types, sizes, and contents. Compressive strengths range from 15 MPa to 25 MPa. Fifteen batches strength concrete and 10 high-strength concrete) of 9 specimens each are under tested. Some data cannot be used due to errors during testing.

3. Literature review

Concrete aggregates obtained by crushing concrete with compressive strength ranging from 15 to 25 MPa. Based on the test results, it was concluded that the performance of the recycled concrete aggregate may be comparable to that of fresh base coarse aggregates. It was also stated that Ten Percent Fines test is suitable as an evaluation test for estimating the compressive strength of the parent material. 7 Shiou (2001) evaluated the physical and engineering properties of recycled concrete aggregate and developed specifications for the use of recycled concrete aggregate in pavement base course. Based on the results, it was recommended that Los Angeles abrasion loss should be less than 48% for the use of recycled concrete aggregate as a base material in flexible pavements. It was also recommended that the sodium sulphate test is not applicable for recycled concrete aggregate. Sean Mulligan (2002) carried out Soundness test (Freeze/Thaw and Los Angeles abrasion) on recycled concrete material and reported that with respect to the Soundness test by Freeze/Thaw, recycled concrete material is not nearly as sound or durable as virgin aggregates (limestone and gravel) for particle sizes greater than or equal to the #4 sieve (4.75-mm sieve). It was also stated that with respect to the Soundness test by Los Angeles abrasion, recycled concrete material is not as sound or durable as virgin aggregates (limestone and gravel). Amnon Katz (2003) investigated the properties of the recycled aggregates made from crushed concrete and reported that the properties of the recycled aggregates crushed at different ages were quite similar. It was also reported that the size distribution of the recycled aggregates was same for the various ages of crushing, as well as other properties such as water absorption, bulk specific gravity, bulk density, cement content and crushing value. Microstructure of recycled aggregate prepared from the crushing of old concrete was studied by Amnon Katz (2004) and it was found that: Recycled aggregate is covered with loose particles that may prevent good bonding between the new cement matrix and the recycled aggregate.

Old cement paste that remained on the natural aggregate was porous and cracked, leading to weak mechanical properties of the recycled aggregate. Bekir et al. (2004) studied the properties of waste concrete aggregates obtained by crushing natural concrete specimens of having cylindrical compressive strength 14 MPa and it was reported that

Specific gravity of waste concrete aggregates was lower than that of normal crushed aggregates due to the fact that there was a certain proportion of mortar over these aggregates. Water absorption ratio of waste concrete aggregate was found to be much higher compared with that of normal crushed aggregates and this was due to adhered mortar over these aggregates. Marta et al. (2004) studied the effect of attached mortar content on the properties of recycled concrete aggregate and it was summarized that: Quality of recycled concrete aggregate is lower than natural aggregate quality, due to the mortar which remains attached to natural aggregate. Usual mortar content is about 23 to 44% for 8/16 mm fraction and 33 to 55% for 4/8 mm fraction. Generally, amount of mortar attached to fine fraction is higher than to coarse fraction. The main properties unfavourably affected by mortar content are absorption, density and Los Angeles abrasion. Have absorption lower than 8%.Recycled concrete aggregates with mortar content less than 44% are expected to Recycled concrete aggregates with high mortar content seem to have higher sulphate and alkalis content. Fine fraction of recycled concrete aggregate has poor quality due to its higher mortar content and, it is not recommended to use fine recycled concrete aggregate for the production of new concrete.

Original concrete quality also have influence on recycled concrete aggregate quality and generally, the lower the strength of the original concrete, the lower will be the quality of the recycled concrete aggregate. A solution to control recycled concrete aggregate quality for production of structural concrete could be to control original concrete, rejecting those concretes with compressive strength lower than 25 N/mm2. Samples of coarse recycled concrete aggregate with high mortar content (more than 44%) or samples with a low mortar quality should be rejected.

4 Materials & Methodology

In this paper an attempt is made to find out and discuss mainly the mechanism use and the applications of various categories of stone aggregate which is gaining overall popularity because of its ease of handling, inexpensive cost, efficiency and satisfactory results. However, it would be appropriate to discuss in brief what the strength of plain cement concrete is, and by variation of stone aggregate, how they increased in strength within a bare minimum cost.

Aggregates

Aggregates which from an essential ingredient of concrete are inert granular materials such as sand, gravel or crushed stone. The account for 60 to 75 percent of the total volume of concrete and are divided into two categories viz. fine and coarse. The former generally consists of natural said or crushed stone passing through a 9.50mm sieve. Coarse aggregates are particules greater than 4.75 mm. The particle diameter generally ranges from 9.5 mm to 37.5 mm. Gravels constitute the majority of coarse aggregates used in concrete with crushed stone making up most of the remainder

Water

This is the most important component of concrete since it participates in the chemical reactions with cement and helps to give strength to the structure. The quality and composition of water is thus a very important factor. Generally, the pH of the water used for mixing should be between 6 and 8 and free from organic matter. Another method to determine the suitability of water for mixing is to compare it with compressive strengths of 7 and 28 days old concrete prepared using distilled water. The water is acceptable if the strengths are up to 92%. This test is usually done is coastal areas or marshy areas where the water is brackish in nature and of doubtful quality.

Sand

These are fine aggregates obtained from riverbanks, sea beds or lakes. Sand his already been dealt with in the section on aggregates.

Ordinary Portland Cement:

Ordinary Portland cement, 43 grade shall be

manufactured by intimately mixing together calcareous and argillaceous and/or other silica, alumina or iron oxide bearing materials, burning them at a clinkering temperature and grinding the resultant clinker so as to produce a cement capable of complying with this standard. No material shall be added after burning, other than gypsum (natural mineral or chemical, see Note), water, performance improver(s), and not more than a total of 1.0 percent of air-entraining agents or other agents including colouring agents, which have proved not to be harmful.

NOTE —

Chemical gypsum shall be added provided that the

Performance requirements of the final product as specified in this standard are met with.

a. **Water reducing agents**

These admixtures produce a concrete of given workability at lower W/C ratio than that of a control concrete containing no admixture. These help in producing a concrete of similar workability and strength development with lower water content without adversely affecting the durability or engineering properties of the concrete.

b. **Air Entraining agents**

These are organic materials usually in solution form, which when added entrain a controlled quantity of air in uniformly dispersed microscoic bubbles. The bubbles act as ball bearings and modify the properties of fresh concrete namely workability, segregation and finished quality.

c. **Accelerators and retarders**

Concrete accelerators increase the rate of hardening of cement and concrete mixes. The major material used is calcium choride and is mainly employed in cold weather. It is effective in maintaining satisfactory gain in strength of the concrete above and below freezing temperatures. In nonnal dosages of I to 2 per cent by weight of the cement, calcium chloride short ones the time of set of fresh concrete and increases the rate of strength-gain. In practice, a decrease in time of set is required for early finishing of floors or quick-setting in spray-type processes. As an accelerator of strength-gain calcium chloride can provide for early application of load. Unfortunately, calcium chloride has a number of said effects that are generally detrimental. These effects are not substantial and can often be overcome.

In ths present study, experimental concrete cubes of size 1500 mm x 150 mm in thickness of 150 mm and column size (300 mm x 400 mm height 1000 mm) both with PCC (plain cement concrete) and the polymer mixed with the PCC cubes are casted in module which are suspended in caring position for 7 (seven), and 28 (twenty-eight) days intervals. However, for better judgment column of size 300 x 450 x 1000 mm is casted for testing the strength after 18 (eighteen) days by hammer rebound process.

Ordinary Portland Cement:

Ordinary Portland slag Cement (OPC) of grade 43 Conforming to IS 455 – 1989 was used for the studies. Locally available quartzite aggregate with a maximum size of aggregate of 20 mm down size and a river bed sand (locally known as Balason/Mahananda Sand) were used as Coarse aggregate and coarse sand respectively.



Pakur Stone River Bed Stone Crusher Stone

Determination of Aggregate Impact Value – Impact test on Aggregate.

Determination of aggregate impact value – impact test on aggregate is done to carry out to-

- Determine the Impact value of the road aggregate.
- Assess their suitability in road construction on the basis of impact value.

Apparatus for Aggregate Impact test

The apparatus as per IS: 2386 (Part iv) – 1963 consists of

i) A testing machine weighing 45 to 60 kg. and having a metal base with a pointed lower surface of not less than 30 mm. in diameter. It is supported on level and plane concrete floor of minimum 45 cm. thickness. The machine should also have provisions for fixing its base.

ii) A cylindrical steel cup of internal diameter 102 mm. depth 50 mm. and minimum thickness 6.3mm.

iii) A metal hammer on top weighing 13.5 to 14.0 kg. , the lower end being cylindrical in shape, 50 mm. in long, 100 mm. in dia. With 2 mm. chamfer at the lower edge and case hardened. Free fall of hammer should be within 380 ± 5mm.

iv) A cylindrical metal measure having internal diameter 75 mm. and depth 50 mm. for measuring aggregate.

v) Tamping rod 100 mm. in diameter and 250 mm. long rounded at one end.

A balance of capacity not less than 500 g. readable and accurate up to 0.1 g.

Procedure of Aggregate Impact Test

The test sample consists of aggregates sized 10.0 mm 12.5 mm. Aggregates may be dried by heating at 100-110° C for a period of 4 hours and cooled.

(i) Sieve the material through 12.5 mm and 10.0mm IS sieves. The aggregates passing through 12.5mm sieve and retained on 10.0mm sieve comprises the test material.

(ii) Pour the aggregates to fill about just 1/3 rd depth of measuring cylinder.

(iii) Compact the material by giving 25 gentle blows with the rounded end of the tamping rod.

(iv) Add two more layers in similar manner, so that cylinder is full.

(v) Strike off the surplus aggregates.

(vi) Determine the net weight of the aggregates to the nearest gram(W).

(vii) Bring the impact machine to rest without wedging or packing up on the level plate, block or floor, so that it is rigid and the hammer guide columns are vertical.

(viii) Fix the cup firmly in position on the base of machine and place whole of the test sample in it and compact by giving 25 gentle strokes with tamping rod.

(ix) Raise the hammer until its lower face is 380 mm above the surface of aggregate sample in the cup and allow it to fall freely on the aggregate sample. Give 15 such blows at an interval of not less than one second between successive falls.

(x) Remove the crushed aggregate from the cup and sieve it through 2.36 mm IS sieves until no further significant amount passes in one minute. Weigh the fraction passing the sieve to an accuracy of 1 gm. Also, weigh the fraction retained in the sieve.

Compute the aggregate impact value. The mean of two observations, rounded to nearest whole number is reported as the Aggregate Impact Value.

Experimental findings of Aggregate Impact Test of given sample of coarse aggregate.

Observations: - 1) For Pakur Stone chips (Black in colour)

	Sample 1	Sample 2
Total weight of Aggregate of dry sample (W1)g.	672 g.	668 g.
Total weight portion passing 2.36 mm sieve (W2) g.	64 g.	66 g.
Aggregate Impact Value (%) = (W2/W1)x100	9.52 %	9.88 %

Mean Impact Value of two samples =(9.52 + 9.88)/2 = 9.7%

2) For River Bed Stone chips

	Sample 1	Sample 2
Total weight of Aggregate of dry sample (W_1)g.	456 g.	452 g.
Total weight portion passing 2.36 mm sieve (W_2) g.	61.10 g.	62 g.
Aggregate Impact Value (%) = (W_2/W_1)x100	13.39 %	13.71 %

Mean Impact Value of two samples = (13.39 + 13.71)/2 = 13.55 %

1) For Crushed Stone chips (Crusher)

	Sample 1	Sample 2
Total weight of Aggregate of dry sample (W_1)g.	416 g.	420 g.
Total weight portion passing 2.36 mm sieve (W_2) g.	61 g.	60.80 g.
Aggregate Impact Value (%) = (W_2/W_1)x100	14.66 %	14.47 %

Mean Impact Value of two samples = (14.66 + 14.47)/2 = 14.56 %

Result

As per pakur chips it founds exceptionally strong and river bed chips & crusher chips found strong in character. Hence we may exercise the both stone chips in form of concreting stage.

Recommended Aggregate Impact Test Values

Classification of aggregates, using Aggregate Impact Value is as given bellow:

Aggregate Impact value		Classification
< 20 %	---	Exceptionally strong
10 -- 20 %	---	strong
20 -- 30 %	---	Satisfactory for road surfacing
> 35 %	---	Weak for road surfacing

Opinion on Result:-

As per impact test value we find that the Pakur stone chips (Black in colour) as pper classification – "Exceptionally Strong" and the River Bed stone chips & Crusher stone chips by crusher falls under classification of "strong".

Hence, we may take all under experiment for Road Surface Concreting as well as Building concreting work.

Cube Test :-

Here in plain cement concrete the category of cement is used of grade 43 conforming to IS 516-1959 and various stone aggregate (such as pakur, local river bed and crusher chips) is used for cubical test. In present study experimental concrete cubes of size 150 mm x 150 mm both with PCC and various stone chips mixed with the PCC cubes are custed in module which are suspended in curing position for continuous 7 days then after curing the testing is carried out the same cube after interval of 7 days from ones to another (i.e. 7 day, 14 day and last 28 days) test is carried out.

Sl No	Category	Cube weight	Crushing pressure	Result in MPA
		7 days		
1	Pakur cement concrete	8.576 kg	475 kg	21.20
2	Crusher concrete cube	8.377 kg	455 kg	20.40
3	River bed concrete cubes	8.207 kg	450 kg	19.75
		14 days		
1	Pakur cement concrete	8.523 kg	560 kg	24.90
2	Crusher concrete cube	8.460 kg	455 kg	22.00
3	River bed concrete cubes	8.413 kg	430 kg	20.90
		28 days		
1	Pakur cement concrete	8.558 kg	620 kg	25.60
2	Crusher concrete cube	8.464 kg	580 kg	23.20
3	River bed concrete cubes	8.452 kg	520 kg	21.90

Conclusion:-

This paper described the results of an experimental study performed to gain insight into the performance of stone aggregate on concrete and its mechanism. In

variation of stone aggregate the influences of mechanical and structural properties are reported. As last the variation of stone aggregate shown its superiority of its finest and relatively less viscous. Referring to the test result it can be strongly express that by variation of stone aggregate the concrete composites enhance the concrete properties in terms of strength and durability.

ACKNOWLEDGMENT

I take this opportunity to express my cordial gratitude and

Deep sense of indebtedness to Er. Partha Sarathi Dutta Biswas, for the valuable guidance and inspiration throughout the Work. I express my gratitude and thanks to all the staff members of Civil Engineering Department for their sincere cooperation in furnishing relevant information to complete this Project well in time successfully. I extend a special word to my friends,

who have been a constant source of inspiration throughout my Project work.

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