International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in

Vol.3., Issue.6., 2015
(Nov.-Dec.,)

RESEARCH ARTICLE

ISSN: 2321-7758

A COMPARATIVE STUDY OF MECHANICAL PROPERTIES OF M25 GRADE LOW COST CONCRETE WITH CONVENTIONAL CONCRETE

J PAVITRA[1], Dr. T SURESH BABU[2]

[1]Student,M.Tech,Department of Civil Engineering, Visvodaya college of engineering, Kavali

[2] Professor and Head, Department of Civil Engineering, Visvodaya, Engineering college ,Kavali

J PAVITRA

ABSTRACT

Concrete pavement has long been considered an environmentally and economically sustainable pavement choice for its longevity. This hallmark of concrete pavements ensures that the desirable performance characteristic of the pavement remains essentially intact for several decades. Concrete pavement mixtures incorporate industrial byproducts i.e., (fly ash and silica fumes) which lower the disposal needs, reduces the demand on virgin materials, and conserves natural resources. The design and properties of this type of concrete, which could be applied by using conventional equipment, are presented in this project. The technical characteristics of the concrete which includes local Fly Ash and Silica Fumes are well described including durability performance observation. The usage of these industrial by products to replace the cement is because the production of cement emits carbon dioxide gas in to atmosphere by increasing the effect of global warming.

To enhance the strength properties of the ordinary Portland cement (OPC), industrial by products such as Fly Ash and Silica Fumes can be utilized. The effect of Silica Fumes and Fly Ash as a partial replacement of Ordinary Portland Cement on compressive strength, split tensile strength and stress strain behavior of concrete has been studied. To study these properties of concrete, it was categorized in to two groups with two water cement ratios of 0.3 and 0.35. Five types of mix proportions were used to cast the test specimens for both groups. The replacement levels of OPC by silica fumes were 0%, 10%, 20%, 25%, and 30% where replacement levels by Fly Ash were 0%, 10%, 20%, 25% and 30%. All these specimens are tested for 28 days strength. 20% of silica fumes and 20% of fly ash where found to be optimum for maximum compressive strength, maximum split tensile strength at low cost than that of conventional concrete which reduces the consumption rate of cement by 173 kg per cubic meter. Hence by reducing usage of amount of cement the cost of construction can be decreased which leads to low cost concrete pavements with high efficiency.

1 INTRODUCTION

In conventional method of concrete pavement construction natural resources like sand, stone metal are used which causes ecological imbalances. The use of Fly Ash and silica fumes in concrete pavement construction will save such resources. The costly ingredient in concrete is cement; some portion of the cement is replaced by silica fumes and fly ash which results in reducing the cost of the concrete without any change in strength. The usage of industrial wastages such as Fly Ash and Silica Fumes will solve the problem of disposal and automatically reduces the cost of the pavement construction. Properly designed and constructed concrete structures are favorable compared to the other material like steel and timber. So we can obtain low cost concrete mix with partial replacement of mineral admixtures such as Fly Ash and Silica Fumes.

1.1 METHODS OF INCORPORATING MINERAL ADMIXTURES IN CONCRETE

The mineral admixtures such as silica fumes and fly ash can be introduced in to concrete by two methods. They are

- A blended cement containing fly ash and silica fumes may be used in place of ordinary Portland cement.
- Fly ash and silica fumes may be introduced as an additional component at the concrete-mixing stage.

In this project we use mineral admixture as blended cement containing fly ash and silica fumes used in place of ordinary Portland cement. Thus admixtures have generally been considered to be a replacement for cement, rather than a component that complements the functions of the cement, sand, or water. The trend now is to consider the components of fly-ash, silica fumes concrete as a whole and to treat it as a unique material without reference to an equivalent plain-concrete mixture.

1.2 MECHANICSM IN THE CEMENT-MINERAL ADMIXTURE SYSTEM

Mineral admixtures enhances the properties of concrete by several physical mechanisms, including increasing the strength of the bond between the paste and aggregate by reducing the size of the CH crystals in the region by: (1) providing nucleation sites for the CH crystals so they are smaller and more randomly oriented, and (2) reducing the thickness of the weaker transition zone. Physical mechanisms also include increasing the density of the composite system due to the filler packing effect and by providing a more refined pore structure. For the above mechanisms to take place, it is essential that admixture particles be well dispersed in a concrete mixture.

2 LITERATURE SURVEY

Manmohan and Mehta studied that durability to chemical attack is improved with the use of most fly ash and slag mainly due to the pore refinement of concrete made with such materials. Experiments have shown that cement pastes containing10-30% low calcium fly ash causes significant pore refinement in the 28 to 90 day curing period.

Gebler and Klieger said that High dosages of silica fume can make concrete highly cohesive with very little aggregate segregation or bleeding. With little or no bleed water available at the concrete surface for evaporation, plastic cracking can readily develop, especially on hot, windy days if special precautions are not taken. Proper curing of all concrete, especially concrete containing supplementary cementing materials should commence immediately after finishing. At seven-day moist cure or membrane cure should be adequate for concretes with normal dosages of most supplementary cementations materials. As with Portland cement concrete, low curing temperatures can reduce early-strength gain. The impact resistance and abrasion resistance of concrete are related to compressive strength and aggregate type. Supplementary cementing materials generally do not affect these properties beyond their influence on strength. Concretes containing fly ash are just as abrasion resistant as Portland cement concretes without fly ash.

L.Lam, Y.L. Wong, and C.S. Poon in their studied entitled Effect of fly ash and silica fume on compressive and fracture behaviors of concrete had concluded enhancement in strength properties of concrete by adding different percentage of fly ash and silica fume.

Roy, found that the hydration rates are greatest in silica fumes paste, followed by OPC pastes and fly ash pastes it was found that the degree of reaction of silica fumes is much greater than fly ash pastes even at 90 days primarily due to silica fumes high specific area and that the overall reaction with class c ash is greater than the class F after a few days.

Campbell, strum, and Kosmatka, The amount of carbonation is significantly increased in concretes with a high water-cementing materials ratio, low cement content, short curing period, low strength, and a highly permeable or porous paste. The depth of carbonation of good quality concrete is generally of little practical significance. At normal dosages, fly ash is reported to slightly increase carbonation, but usually not to a significant amount in concrete with short (normal) moist-curing period

3 SCOPE AND OBJECTIVE

- The scope of this paper is to study the effect of mineral admixtures on strength characteristics of low cost concrete.
- The objective is to study the mechanical characteristics of concrete such as compressive strength split tensile strength and modulus of elasticity by varying the percentage of mineral admixtures i.e., fly ash and silica fumes with 0,10 ,20, 25, 30 percentage replacement at two water-cement ratios of 0.3 and 0.35.

4 MATERIALS USED

The materials used in this project are

4.1 CEMENT: Cement used in this investigation was 53 grade OPC conforming IS 12269:1987

4.2 FINE AGGREGATE: In this project is locally available river sand which is conforming to Zone II of IS: 383-19707 was used as fine aggregate with specific gravity.

4.3 COARSE AGGREGATE: In this project we are considering angular shaped aggregate of maximum size , 20 mm are tested as per IS: 383-1970. It is crushed granite stone obtained from the local quarry having specific gravity of 2.76.

4.4 FLY ASH Fly ash is a byproduct of the combustion of pulverized coal in thermal power plants. A dust-collection system removes the fly ash, as a fine particulate residue, from combustion gases before they are discharged into the atmosphere. The types and relative amounts of incombustible matter in the coal used determine the chemical composition of fly ash. More than 85% of most fly ashes is comprised of chemical compounds and glasses formed from the elements silicon, aluminum, iron, calcium, and magnesium.

4.5 SILICA FUMES: Silica Fumes, also known as micro silica or condensed silica fume is another material that is used as artificial mineral admixture. It is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. In the manufacture of silicon or ferrosilicon alloy, high purity quartz is reduce in electrical arc furnace which results in the production of Silica Fumes.

Silica Fumes that we have used in this project work was contributed by 'AASTRA CHEMICALS' in CHENNAI. Its properties are mentioned below.

5 EXPERIMENTAL PROGRAM

5.1 COMPRESSIVE TSRENGTH TEST OF CONCRETE:

1. After 28 days of curing period the specimens are removed from the curing tank and wipe out the excess water from the surface.
2. Let the specimen dry in atmospheric temperature for 24 hrs.before testing.
3. The air dried specimen is placed in the compressive strength testing machine in such way that the load of the machine is applied on the opposite faces of the cylinder.
4. The cylinder is positioned properly on the base plate of the machine.
5. The piston of the machine is adjusted so that it touches the top surface of the specimen.
6. Load is applied gradually without any impacts at a rate of 140kg/cm^2 /minute until the specimen fails.
7. At the point of failure note down the maximum load value.

Compressive strength of concrete = $\frac{load\ in\ N}{area\ in\ mm^2}$ = ……… N/mm^2

Compressive strength at 28 days =……N/mm^2

5.2 SPLIT TENSILE TEST

1. After 28 days of curing period the specimens are removed from the curing tank and wipe out the excess water from the surface.
2. Let the specimen dry in atmospheric temperature for 24 hrs. before testing.
3. The air dried specimen is placed in the compressive strength testing machine in such way that the load of the machine is applied on the opposite faces of the cylinder.
4. The cylinder is positioned properly on the base plate of the machine.
5. The piston of the machine is adjusted so that it touches the top surface of the specimen.
6. Load is applied gradually without any impacts at a rate of $140kg/cm^2$ /minute until the specimen fails.
7. At the point of failure note down the maximum load value.

Tensile Strength = $2P/\pi DL$=……… N/mm^2

5.3 IMPACT STRENGTH TEST

1. After 28 days of curing period the specimens are removed from the curing tank and wipe out the excess water from the surface.
2. Let the specimen dry in atmospheric temperature for 24 hrs. before testing
3. The air dried specimen is placed in the holder of the impact strength setup, on the top face of the cylinder a steel ball is placed with the help of a stand.
4. Then with the rammer of weight 4.5 kg and free fall of 450cm blows are given on the steel ball.
5. Through the ball the load is transferred to the cylinder as impact.
6. Note down the number of blows required by the rammer up to the point of failure of the specimen.

   Impact Strength = nρgh =……… Nm

5.4 DURABILITY OF CONCRETE

Durability means life service. It represent the life time of designed structures. According to ACI committee 20, durability of Portland cement concrete is defined as its ability to resist weathering action, chemical attack, abrasion, or any other process of detoriation; it means concrete doesn't losses their quality and give good serviceability of the structure when exposed to the atmosphere.

In this project we are casting cylinders for both conventional concrete and low cost concrete. We cast impact cylinders among them half are placed in the acid curing for 28 days. The testing is done after 28 days and calculates how much strength is loss.

6 EXPERIMENTAL RESULTS

6.1 FINAL TEST RESULTS

6.1.1 Compressive Strength Results

The results obtained by testing the total 10 specimens of 28 days by considering the average of the test results for conventional concrete and for each mix of concrete. The results are tabulated below:

Table 6.1 compressive strength of M 25 concrete at 28 days

S NO	DESIGNATION	W/C ratio	AVERAGE COMPRESSIVE STRENGTH(N/mm2)
1	CONVENTIONAL CONCRETE	0.3	39.6115
		0.35	36.21
2	80% CEMENT +10% FLY ASH +10%SILICA FUMES	0.3	25.745
		0.35	34.2
3	60% CEMENT +20% FLY ASH +20%SILICA FUMES	0.3	18
		0.35	31.672

4	50% CEMENT +25% FLY ASH +25%SILICA FUMES	0.3	12.449
		0.35	23.201
5	40% CEMENT +30% FLY ASH +30%SILICA FUMES	0.3	11.883
		0.35	23.766

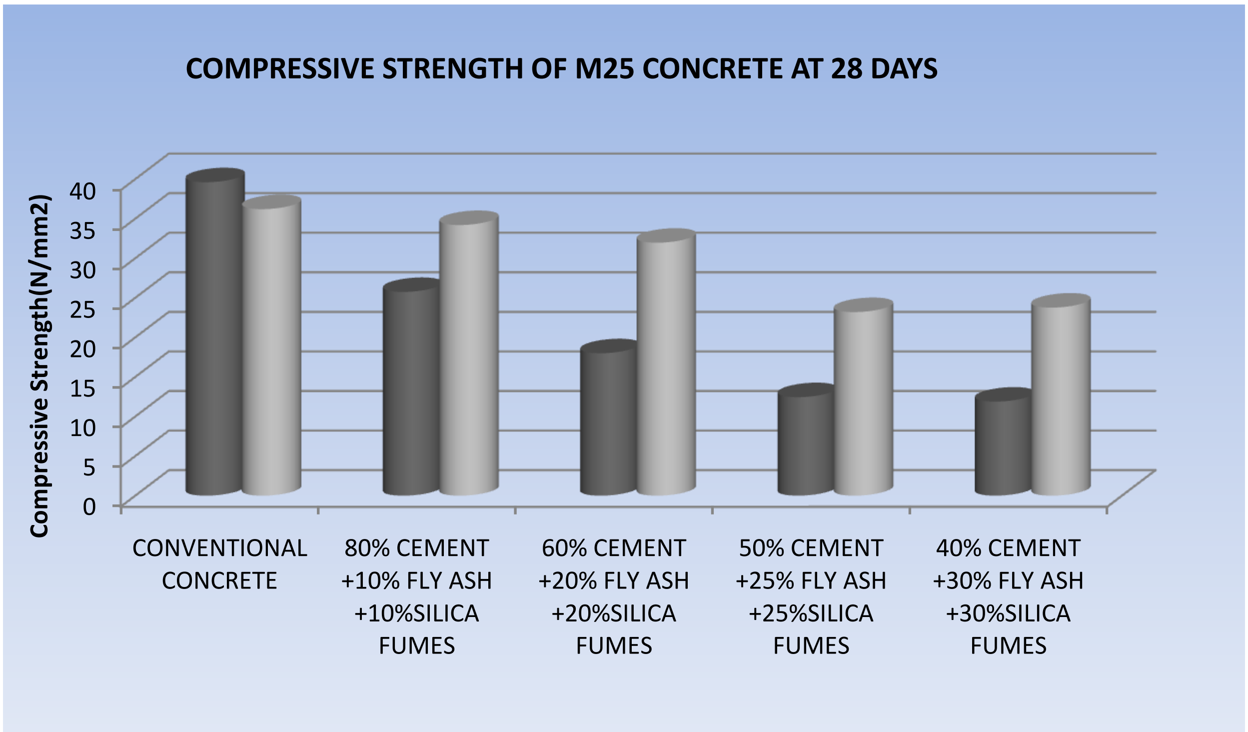

Fig 6.1 graph representing 28 days compressive strength of concrete

6.1.2 Impact Strength

The results obtained by testing the total 10 specimens of 28 days by considering the average of the test results for conventional concrete and for each mix of concrete. The results are tabulated below:

Table 6.2Impact strength of concrete

S NO	DESIGNATION	W/C ratio	AVERAGE IMPACT STRENGTH(N/mm2)
1	CONVENTIONAL CONCRETE	0.3	29.8
		0.35	29.9
2	80% CEMENT +10% FLY ASH +10%SILICA FUMES	0.3	29.5
		0.35	29.353
3	60% CEMENT +20% FLY ASH +20%SILICA FUMES	0.3	29.353
		0.35	29.055
4	50% CEMENT +25% FLY ASH +25%SILICA FUMES	0.3	29.055
		0.35	28.757
5	40% CEMENT +30% FLY ASH +30%SILICA FUMES	0.3	28.906
		0.35	28.608

Vol.3., Issue.6., 2015
(Nov.-Dec.,)

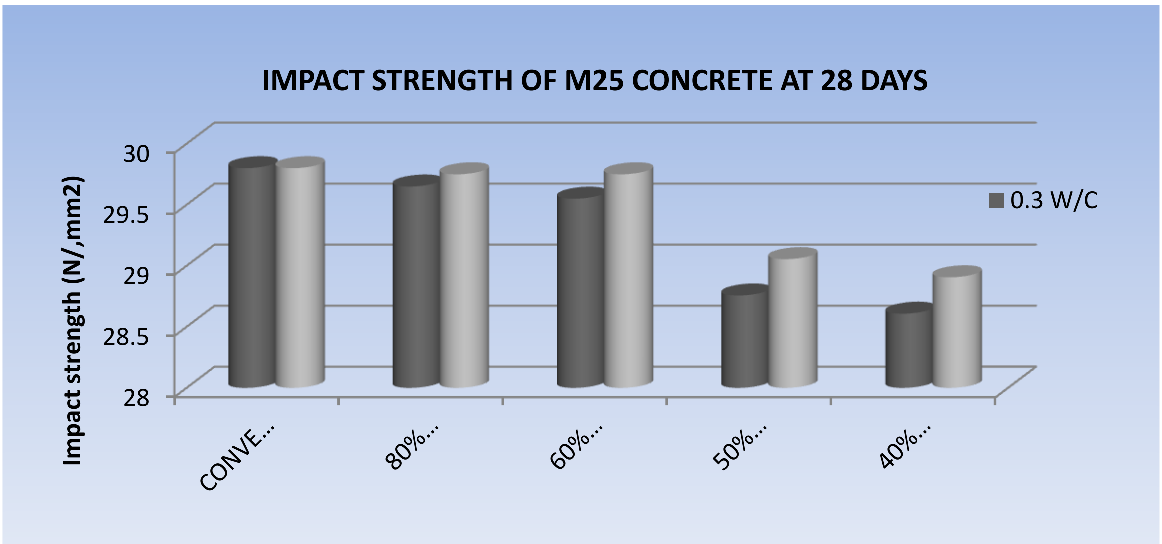

Fig68.2 Graph representing 28 days impact strength of concrete

Table 6.3 Impact strength of concrete in acid curing

S NO	DESIGNATION	W/C ratio	AVERAGE IMPACT STRENGTH(N/mm2)
1	CONVENTIONAL CONCRETE	0.3	29.502
		0.35	29.651
2	80% CEMENT +10% FLY ASH +10%SILICA FUMES	0.3	29.204
		0.35	29.353
3	60% CEMENT +20% FLY ASH +20%SILICA FUMES	0.3	29.055
		0.35	29.204
4	50% CEMENT +25% FLY ASH +25%SILICA FUMES	0.3	28.906
		0.35	29.055
5	40% CEMENT +30% FLY ASH +30%SILICA FUMES	0.3	28.608
		0.35	28.757

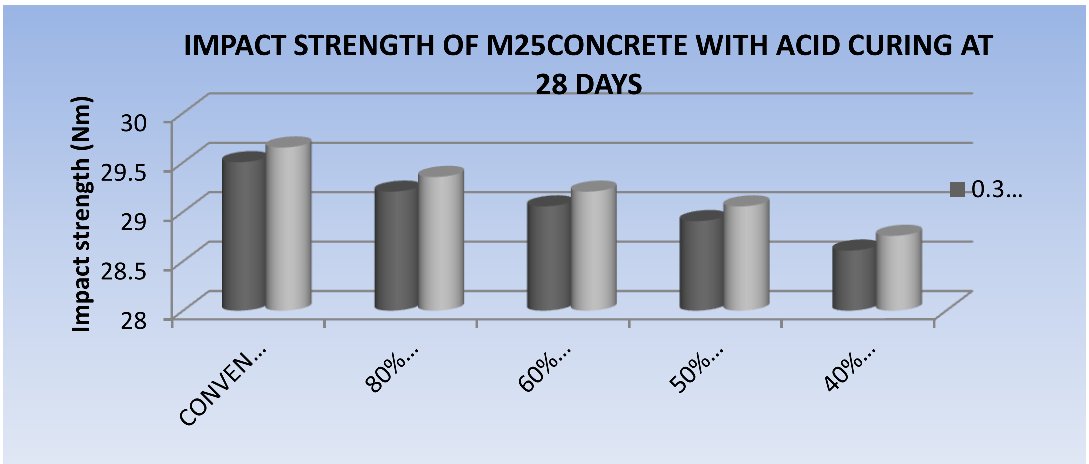

Fig 6.3 Graph Representing Impact Strength of Concrete with Acid Curing

6.1.3 SPLIT TENSIE STRENGTH

The results obtained by testing the total 10 specimens of 28 days by considering the average of the test results for conventional concrete and for each mix of concrete. The results are tabulated below

Table 6.6: Tensile Strength of M 25 Concrete at 28 Days

S NO	DESIGNATION	W/C ratio	AVERAGE TENSILE STRENGTH(N/mm2)
1	CONVENTIONAL CONCRETE	0.3	3.96
		0.35	4.031
2	80% CEMENT +10% FLY ASH +10%SILICA FUMES	0.3	3.5
		0.35	3.76
3	60% CEMENT +20% FLY ASH +20%SILICA FUMES	0.3	3.3
		0.35	3.79
4	50% CEMENT +25% FLY ASH +25%SILICA FUMES	0.3	2.829
		0.35	3.01
5	40% CEMENT +30% FLY ASH +30%SILICA FUMES	0.3	2.688
		0.35	2.617

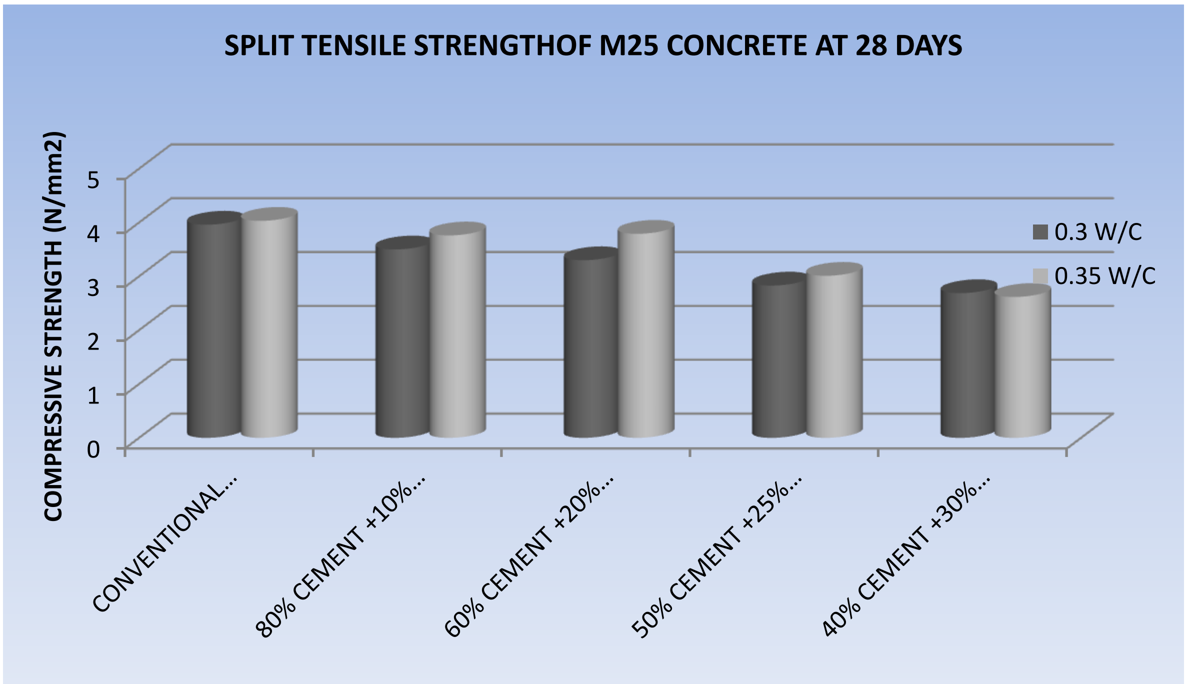

Fig 6.4 Graph Representing tensile Strength of Concrete

7 CONCLUSIONS

1. Based on the experimental investigations, mechanical properties of concrete like compressive strength, tensile strength durability aspects and stress strain behavior of low cost concrete (with fly ash and silica fumes). The following conclusions are drawn
2. At 28 days the compressive strength of conventional concrete and low cost concrete of mix (60% cement+20% Fly Ash+20% Silica Fumes) is similar to that of the target compressive strength of M25 mix.
3. The tensile strength of the above mix reaches the maximum value of the target tensile

strength of $0.75\sqrt{f_{ck}}$ of M25 conventional concrete.

4. The impact value of the low cost concrete and conventional concrete, differs by 0.01% only which can be neglected.
5. The usage of industrial wastages such as Fly Ash and Silica Fumes will solve the problem of disposal and automatically reduces the cost of the pavement construction. Properly designed and constructed concrete structures are favorable compared to the other material like steel and timber. So we can obtain low cost concrete mix with partial replacement of mineral admixtures such as Fly Ash and Silica Fumes. For the construction of the concrete pavements.

REFERENCES

[1]. Bakker, R.F.M. 1983. Permeability of blended cement concrete. In *Fly Ash, Silica Fume, Slag and Other Mineral Byproducts in Concrete*, Vol. 1, SP-79, Malhotra, V.M., Ed., pp. 589–605.

[2]. ACI Committee 232, Use of Fly Ash in Concrete, ACI 232.2R- 96, American Concrete Institute, Farmington Hills, Michigan.

[3]. ACI Committee 232, Use of Raw or Processed Natural Pozzolans in Concrete, ACI 232.1R-00, American Concrete Institute, Farmington Hills, Michigan, 2000.

[4]. Carette, G.G. and Malhotra, V.M. 1992. Long-term strength development of silica fume concrete In *Proceedings of the 4th International Conference on the Use of Fly Ash, Silica Fume, Slag, and Natural Pozzolans in Concrete*, May 3–8, Istanbul, Turkey, Malhotra, V.M., Ed., pp. 1017–1044. American Concrete Institute, Farmington Hills, MI.

[5]. Detwiler, R.J. and Mehta, P.K. 1989. Chemical and physical effects of silica fume on the mechanical behaviour of concrete. *ACI Mat. J.*, 86(6), 609–614.