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Green concrete using industrial waste of marble powder quarry dust and fly ash

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***Abstract*—Concrete is by far the most widely used construction material worldwide. Its huge popularity is the result of a number of well-known advantages, such as low cost, general availability, and wide applicability. But this popularity of concrete also carries with it a great environmental cost. The billions of tons of natural materials mined and processed each year, by their sheer volume, are bound to leave a substantial mark on the environment. Most damaging are the enormous amounts of energy required to produce Portland cement as well as the large quantities of CO2 released into the atmosphere in the process.**

This paper summarizes the various efforts underway to improve the environmental friendliness of concrete to make it suitable as a "Green Building" material. Foremost and most successful in this regard is the use suitable substitutes for Portland cement, especially those that are byproducts of industrial processes, like fly ash, ground granulated blast furnace slag, and silica fume. Also efforts to use suitable recycled materials as substitutes for concrete aggregate are gaining in importance, such as recycled concrete aggregate, post-consumer glass, tires, etc.

The paper discusses some of the economic drivers which determine the degree of commercial success. Simply deposing of waste materials in concrete products is unlikely to succeed except in unusual situations. But by identifying and exploiting specific properties inherent in various waste materials or byproducts, it is possible to add value to such materials and increase their chances of success in a market-driven economy of supply and demand. Also, the emergence of the Green Building movement in North America is already changing the economic landscape and the factors that influence resource utilization.

Keywords*—*sustainable development; green buildings; supplementary cementations materials; recycling; recycled concrete aggregate

I. INTRODUCTION

Currently India has taken a major initiative on developing the infrastructures such as express highways, bridges, power projects and industrial construction, etc., to meet the requirements of globalization, in the construction of buildings and other structures concrete plays an important and rightful role and a large quantum of concrete is being utilized. Concrete is an affordable and reliable material, which is extensively used throughout in the infrastructure of a nation's construction, industrial, transportation, defence, utility and residential sectors, it has become a huge industry.India produces about more than 170 million cubic meters of concrete annually. The most of economy is invested in construction sector. With growing industry waste proportion is being increased. World's more than 7% co2 emission is attributed to concrete industry. There is extreme need to find alternative technique to produce cost effective concrete material. Thus for sustainable development it is recognized that considerable improvements are essential in productivity, product performance, energy efficiency and environmental performance. Green concrete has nothing to do with colour. It is not in green colour. It is concept of thinking environment into concrete considering every aspect from raw materials manufacture over the design to structural design, construction and service life. At about more than 300 million tonnes of industrial waste are produced by industries like paper and pulp, mining, marble dust. This waste is used as a substitute for cement for producing green concrete. Green concrete is very often also cheap to produce. Waste can be used to produce new product or can be used as a admixture so that natural sources are used more efficiency and the environment is protected from waste deposits. To avoid pollution and reduce the waste material, the present study is carried out.

II. USE OF CEMENT SUBSTITUTES

A primary goal is a reduction in the use of Portland cement, which is easily achieved by partially replacing it with various cementations materials, preferably those that are byproducts of industrial processes. The best known of such materials is *fly ash*, a residue of coal combustion, which is an excellent cementations material. As shown in Table 1 [4], the utilization rates vary greatly from country to country, from as low as 3.5% for India to as high as 93.7% for Hong Kong. The relatively low rate of 13.5% in the US is an indication that there is a lot of room for improvement.

The use of fly ash has a number of advantages. It is theoretically possible to replace 100% of Portland cement by fly ash, but replacement levels above 80% generally require a chemical activator. We have found that the optimum replacement level is around 30%. Moreover, fly ash can improve certain properties of concrete, such as durability. Because it generates less heat of hydration, it is particularly well suited for mass concrete applications. Fly ash is also widely available, namely wherever coal is being burned. Another advantage is the fact that fly ash is still less expensive than Portland cement. Maybe most important, as a by-product of coal combustion fly ash would be a waste product to be disposed of at great cost, if we don't make good use of it. By utilizing its cementations properties, we are adding value to it, we "beneficiate" it – a major aspect of green building construction.

A.QUARRY DUST:

The consumption of cement content, workability, compressive strength and cost of concrete made with quarry dust were studied by researcher Babu K.K. *et al*.[2]. The mix design was proposed by Nag raj *et al.* [] shows the possibilities of ensuring the workability by wise combination of rock dust and sand reported significant increase in compressive strength, modulus of rupture and split tensile strength when 40% of sand is replaced by Quarry Dust in concrete.

B.MARBLE POWDER:

In India the extractive activity of decorative sedimentary carbonate rocks, commercially indicated as Marble and Granite is one of the most thriving industry. Marble waste powder is an industrial waste containing heavy metals in constituent. Marble powder has a very high Blaine fineness value of about 1.5m_2/g with 90% of particles passing 50 µm sieves and 50% under 7 µm [8]. The maximum compressive and flexural strength were observed for specimens containing a 6% waste sludge when compared with control and it was also found that waste sludge up to 9% could effectively be used as additive material in concrete.

C.FLY ASH:

This paper presents 100% fly ash based binder system (FAHB) for green concrete (eGC) production. The FAHB requires two powders (ASTM class C fly ash and ASTM class F fly ash), which are activated at the ready-mix producers' facility with two non-caustic activator liquids (A1 and A2). This provides a flexibility to tailor the performance to suit the application needs. Nine non-air entrained eGC mixes with FAHB as binder in a range of 297 kg/m3 (500 lbs/y3) to 534 kg/m3 (900 lbs/y3) are presented in this paper along with one non-air entrained PCC mix with Portland cement content 445 kg/m3 (750 lbs/y3). The results of mechanical properties for all mixes such as compressive strength, flexural strength, splitting tensile strength, modulus of elasticity are presented. The relation between Water to Binder ratio (W/B) and compressive strength is established for eGC mixes and compared to Abram's Portland cement W/C ratio theory. The eGC samples are air cured at 23 ±2oC (72 ±3oF) while PCC samples are wet cured per ASTM C 192 guidelines until the test.

III. USE OF RECYCLED MATERIAL

Concrete debris is probably the most important candidate for reuse as aggregate in new concrete. On the one hand, vast amounts of material are needed for aggregate. On the other hand, construction debris often constitutes the largest single component of solid waste, and probably the largest fraction of this is concrete. Using such debris to produce new concrete conserves natural resources and reduces valuable landfill capacity at the same time. In Europe and Japan, such recycling is already widely practiced [5,6], whereas in the US, it is being accepted only slowly, because the economic drivers are not yet strong enough. But they are improving. The disposal of demolished concrete involves costs, which are likely to go up. Available sources of suitable virgin aggregate are being depleted, such as gravel pits on Long Island, and opening new sources of virgin material is getting increasingly difficult because of environmental concerns. Since the cost of transportation is the main component of the cost of bulk material like sand and gravel, it may not take much of a shift to turn the economics in favour of recycling and reuse.

Turning recycled concrete into useful or even high-quality aggregate poses well-known technical challenges [5]. There are contaminants to be dealt with, high porosity, grading requirements, as well as the large fluctuations in quality. Not all applications require high-strength concrete, though. Recycled

concrete aggregate is likely to be quite adequate for some projects, while for others, a blend of new and recycled aggregate may make most economic and technical sense.

A.Authors and Affiliations:

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B. figures and tables:

TABLE I. Physical Properties of Raw material

Properties ***material***	***Bulk*** **density** ***(kg/m3)***	***Fineness modulus***	***Specific gravity***	***Dry Moist. content***
Marble powder	1118	2.04	2.212	1.59
Quarry Dust	1750	2.35	2.5-2.6	2.10

Chemical Properties of Raw material

TABLE II. Coal-Ash Production and Utilization (1995) [4]

Country	**Million Tons Produced**	**Million Tons Utilized**	**%**
China	91.1	13.8	15.1
Denmark	1.3	0.4	30.8
Hong Kong	0.63	0.59	93.7
India	57.0	2.0	3.5
Japan	4.7	2.8	59.6
Russia	62.0	4.3	6.9
USA	60.0	8.1	13.5

Fly ash also has some disadvantages. First, there is the relatively slow rate of strength development. But this is irrelevant in applications where high early strength is not required. More significant is the wide variability of its chemical composition and quality, which is the main reason for the low utilization rates. It may be rejected for as trivial a reason as its color: One concrete block manufacturer we have worked with had to discontinue the use of fly ash, because he could not control the color of his product. Customers generally prefer a consistently uniform color.

Ground granulated blast furnace slag (GGBFS) is another excellent cementitious material. It also is the by-product of an industrial process, in this case the steel industry. Here the optimum cement replacement level is somewhere between 70 and 80%. Like fly ash, also GGBFS can improve many mechanical and durability properties of concrete and it generates less heat of hydration. For many applications it is now recommended to use a blend of Portland cement, fly ash, and GGBFS. Yet, slag is not as widely available as fly ash. The US steel industry is only a faint image of what it was only a few decades ago, and as a result, the slag marketed in some East Coast states is being imported from Italy. Because of its excellent attributes, the cost of slag is comparable to that of Portland cement, so that there is no advantage in this respect.

TABLE III. PHYSICAL PROPERTIES OF RAW MATERIAL

Properties material	**Bulk density (kg/m3)**	**Fineness modulus**	**Specific gravity**	**Dry Moist. content**
Marble powder	1118	2.04	2.212	1.59
Quarry Dust	1750	2.35	2.5-2.6	2.10

Perhaps the greatest success story in beneficiating an industrial byproduct is that of condensed silica fume, a by-product of the semiconductor industry. This siliceous material improves both strength and durability of concrete to such an extent that modern high-performance concrete mix designs as a rule call for the addition of silica fume. Even though the material is difficult to handle because of its extreme (submicron) fineness, its benefits are so obvious that its cost considerably exceeds that of cement. In fact, it is now available not only as a by-product of the semiconductor industry, but also produced specifically for the concrete industry.

C. Characterization of Waste:

TABLE III. CHEMICAL PROPERTIES OF RAW MATERIAL

Properties material	***MnO***	***Na2O***	***MgO***	***K2O***	***Al2O3***	***CaO***	***SiO2***
Marble powder	0.08	2.08	8.74	2.33	4.44	1.58	64.86
Quarry Dust	0.08	3.0	0.33	5.14	13.63	1.28	75.25
OPC	0.85	0.85	2.15	0.85	5.5	63.5	21.25

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