International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-09, Issue-08, Nov 2023

Fly-ash Mixed Green High Performance Concrete

[1]Somsubhra De, Ph.D. Scholar, Civil Engineering Department, MAKAUT, WB.
sommailid1@gmail.com

[2]Arup Saha Chaudhuri, Associate Professor, Department of Civil Engineering, Techno Main Salt Lake, Kolkata.

ABSTRACT - Nowadays green buildings are a necessary component of securing sustainability, whereas concrete composites with the addition of siliceous fly ash (FA) can certainly be included in the sustainable and green concrete. Effective promotion of green concrete incorporating FA is required in order to minimize the environment threat due to FA waste disposal and reduce cement consumption Due to day to day increasing population and scarcity of resources, countries like India faces numerous difficulties. In order to overcome this hurdle many ideas are implemented in different fields respectively. Since, India is a developing nation and huge amount of concrete is manufactured in order to fulfill the need. To overcome the need and avoid pollution caused due to manufacturing of raw material Green Concrete is used. It is a type of concrete similar to conventional concrete and its production and usage as compared to other concrete requires less amount of energy and resources which results in less harm to environment. Green Concrete is generally made from recycled waste materials like fly ash etc. With the use of Green Concrete many benefits are obtained. Green Concrete as made from recycled or reused products has chances of failure if not prepared properly. Production of Green Concrete is quite economically high. By overcoming the above demerits, it can be used potentially as environmentally friendly.

Keywords: Green Concrete, Green High Performance Concrete, Fly-ash Mixed Green Concrete.

I. INTRODUCTION

Concrete is the most widely utilized building material in the world, mostly from an economic standpoint. Due to its structural strength, reinforced concrete has arisen as an option in contemporary building applications. However, the degradation of concrete buildings exposed to severe maritime conditions as a result of chloride-induced corrosion is a major worldwide issue about the durability of these structures. Developing materials with minimal ion permeability is the most effective method for preventing the invasion of foreign ions [1]. High Performance Concrete (HPC) is a category of concrete created for improved performance and uniformity requirements that cannot be met with regular materials and standard mixing techniques [2]. Recent efforts are oriented on the development of high-performance computing systems with better features and endurance [3]. Sustainable construction is gradually becoming challenging due to environmental and economic considerations. Because the main consumer of natural resources is the construction sector that produces a large mass of waste [4]. Concrete is an extensively used construction material that requires a large mass of ingredients and is, thus, costly. Around 5 % - 8 % of global carbon dioxide emissions are generated by the production of cement, which is an important component of a concrete mix [5]. Meanwhile, natural sands are used in concrete construction, and this utilization adversely affects the natural resources and river bed level [6]. Therefore, the optimization of the uses of cement and natural sands in concrete is a priority. Many available by-products and waste materials can be used in concrete, such as the FA, RHA, palm oil fuel ash, limestone waste, SD, slag, silica fume, fibers, glass and rubber waste [7]. The use of these by-products in concrete for waste management not only reduces the material cost but also the waste management cost [8].

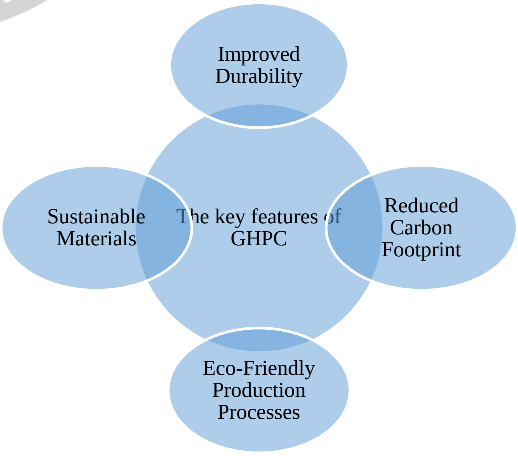
The ever-increasing demand for concrete has also increased the production and transport of cement which alarmingly increased the energy consumption and greenhouse gas emissions. It has also been estimated that worldwide cement production accounts for approximately 7% of the CO_2 emissions. Thus, conventional concrete renders a threat to the environment [9]. The partial or full replacement of cement by supplementary cementitious materials (SCM) like fly ash is one of the most feasible solutions for producing an eco-friendlier and sustainable concrete [10]. High Performance Green Concrete (HPGC)

 DOI : 10.35291/2454-9150.2023.0216

utilizes waste materials to produce an eco-friendly concrete with the required strength and durability, without compromising on its workability. The mix design of HPGC includes cement, water, fine and coarse aggregates together with waste materials (fly ash, GBBS, recycled concrete aggregate, crushed glass, etc.). The waste materials replace a particular component (aggregate or cement) of the concrete mixture partially or fully for the construction of HPGC structures [11]. Fly ash is a waste product of the coal based power plants and consists mainly of SiO2, Al2O3, Fe2O3, and CaO together with some impurities [12]. The desired properties in concrete can be obtained with large volume (>40%) of fly ash in concrete, which is relatively very economical [13]. However, studies have shown some drawbacks for fly ash concrete and the need for amelioration for better performance. Despite excellent resistance to deterioration, fly ash concrete exhibits high levels of calcium leaching [14]. Another major drawback reported is the delayed setting and lower initial strength development in concrete containing high concentrations of fly ash. Several attempts have been made to surpass the drawbacks of fly ash modified concrete through the incorporation of nano particles like nano-TiO2, nano-SiO2, and nano-CaCO3 [15]. Incorporation of nano-CaCO3 is found to accelerate the hydration of cement during its early stage setting, hardening and improve its strength [16]. It has been reported that nano-TiO2 could increase the rate of reaction and heat of hydration at early ages, enhances the antimicrobial activity by the destructing the microbes when the concrete structures are exposed to marine environments and thus contributes to extended durability. Studies on fly ash concrete modified by the addition of nano-TiO2 and nano-CaCO3 in 1:1 ratio showed that Nano phase modification greatly enhanced the properties of fly ash concrete [17].

The FA is a by-product with high pozzolanic properties produced in large quantities each year from the coal combustion in different industries. An optimum amount of cement can be replaced in concrete by the FA [18]. Because of the siliceous type, it reacts aggressively with calcium hydroxide and forms cementitious compound, thereby the strength of the concrete with an addition of the FA gets improved. The addition of the FA lowers the water demand in concrete mix, and thus results in less bleeding and little heat progression [19]. The FA has a high silica content and is highly amorphous in nature. The specific surface area of the FA is approximately 300 − 495 m^2/kg, which helps to produce a high-density concrete matrix [20], and thus the use of finer FA particles results in a higher compressive strength concrete than the use of coarser ones. Additionally, the FA enhances the density of concrete in the interfacial transition zone (ITZ) by reducing the permeable voids, which leads to a highly durable and high strength concrete. Besides, the reduced micro-voids along the ITZ results in the high fracture toughness of the siliceous FA-based concrete. Additionally, the FA-based concrete possesses better chloride penetration resistance than OPC concrete and an increased electrical resistivity [21]. The most concerning matter of the FA-based concrete is the low strength development rate at an early age due to a low reactivity; but it can gain strength over a long period. Moreover, an ordinary concrete slows down the strength gaining at around 56 days of curing, sometimes stopping altogether, but the FA concrete shows a gradual improvement in strength over a long period of time [22]. The improvement in strength depends on the class and fineness of the FA and other ingredients and admixtures. It is not possible to determine the optimum level of the FA addition for a global application, as the performance varies depending on the source, chemical composition and structure of the FA, and other ingredients in the concrete [23]. However, in literature, the optimum value of replacement of cement by the FA is said to be around 10 − 25 % wt. Moreover, the addition of these supplementary cementitious materials also reveals economic and environmental benefits by reducing the uses of natural limestone, energy consumption and carbon emission from cement production [24]. In addition, the mineral additives make sure a high degree of homogenization of the composites in the concrete mix, which leads to smaller internal micro-cracks [25], thus these mineral wastes are suitable for reinforced concrete designed for dynamic loading.

Green High Performance Concrete (GHPC) is a type of concrete that is specifically designed to have a reduced environmental impact compared to traditional concrete. It is made from sustainable materials and incorporates eco-friendly production processes. This type of concrete can offer several advantages over traditional concrete, including lower carbon emissions, reduced energy consumption, and improved durability.



Sustainable Materials: GHPC is made from a range of sustainable materials, including fly ash, slag, recycled aggregates, and silica fume. These materials are sourced from industrial by-products and waste streams, which reduces the amount of virgin materials required.

 DOI : 10.35291/2454-9150.2023.0216

Eco-Friendly Production Processes: The production of GHPC is designed to be environmentally friendly, with reduced energy consumption and lower carbon emissions. This is achieved through the use of alternative fuels, renewable energy sources, and optimized production techniques.

Reduced Carbon Footprint: GHPC has a lower carbon footprint than traditional concrete due to the use of sustainable materials and eco-friendly production processes. This can help reduce the environmental impact of construction projects and contribute to a more sustainable built environment.

Improved Durability: GHPC can have improved durability compared to traditional concrete, which can reduce the need for maintenance and repair. This can also help to reduce the overall environmental impact of a construction project.

II. LITERATURE REVIEW

Degradation of the environment is a big problem in developing countries. This is caused by solid waste that is not properly managed or thrown away. This study looks at what happens when silica mineral waste (eco sand) is used as an aggregate in a green high-strength concrete. Properties like workability, strength, mode of failure, and morphology were looked at. All of the concrete mixtures had low slump and compaction factors. However, the strength properties got better when eco sand was used instead of conventional fine aggregate. The eco sand concrete was stronger than the reference mixtures. This happened when the eco sand content was at its best, which was 25%. The shape and way the eco-sand concrete broke showed that there was a lot of compactness and parking of constituents in the matrix [26].

Alvin Harison, 2014 Investigated out to study the utilization of non-conventional building material (fly ash) for development of new materials and technologies. It is aimed at materials which can fulfill the expectations of the construction industry in different areas. In this study, cement has been replaced by fly ash accordingly in the range of 0% (without fly ash), 10%, 20%, 30%, 40%, 50% and 60% by weight of cement for M-25 mix with 0.46 water cement ratio. Concrete mixtures were produced, tested and compared in terms of compressive strength. It was observed that 20% replacement Portland Pozzolana Cement (PPC) by fly ash strength increased marginally (1.9% to 3.2%) at 28 and 56 d respectively. It was also observed that up to 30% replacement of PPC by fly ash strength is almost equal to referral concrete after 56 d. PPC gained strength after the 56 d curing because of slow hydration process.[27].

Dr S L Patil, 2012 Investigated out to study the utilization of fly ash in cement concrete as a partial replacement of cement as well as an additive so as to provide an environmentally consistent way of its disposal and reuse. This work is a case study for Deep Nagar thermal power plant of Jalgaon District in MS. The cement in concrete matrix is replaced from 5% to 25% by step in steps of 5%. It is observed that replacement of cement in any proportion lowers the compressive strength of concrete as well as delays its hardening. This provides an environmental friendly method of Deep Nagar fly ash disposal.[28]

In this paper, the effects of the types, amounts, and ways of adding mineral admixtures were studied on the pH values, electrical resistance of concrete, anodic polarization potential, and mass loss ratio of steel bars in concrete that had been through 50 cycles of immersion and drying. The test results showed that adding mineral admixtures lowered the pH values of the binder pastes in green high-performance concrete (GHPC), especially when two or three types of mineral admixtures were added at the same time (double- or triple-adding approaches). However, the final pH values were still above the critical breakage pH value of the passivation film on the steel bar surface (11.5). The double-adding and triple-adding methods also greatly increased the electrical resistance of concrete. This caused the start of corrosion to be delayed and the rate of corrosion of steel bars to slow down. When a lot of fly-ash replacement was used, steel bars were less likely to rust when mineral admixtures were added twice or three times instead of just once. All of the information in this paper showed how to stop or slow the corrosion of steel bars in concrete, especially in harsh marine environments [29].

III. METHODS

Trial I: (Preparation of M40 grade Green High Performance Concrete using 15% Fly Ash and 10% GGBS)

Green Concrete:

Green concrete is a concrete that is made of sustainable materials and is designed in such a way that the impact of the construction project on the environment is minimal. Green concrete is used in various ways in the construction project, so that the construction project is very sustainable. Green concrete is used in construction projects to replace traditional concrete. Green concrete can be used in both new construction and renovation projects. The use of green concrete in the construction project helps to reduce the overall carbon footprint of the project and it is much more environment friendly.

The main ingredients of green concrete preparation are recycled materials, fly-ash and cement. These ingredients are mixed with water to make a concrete mixture, which has the same strength and durability as traditional concrete mixing. This is because, green concrete is used in construction projects as a replacement for traditional concrete to reduce the impact of carbon on the environment.

 DOI : 10.35291/2454-9150.2023.0216

ISSN : 2454-9150 Vol-09, Issue-08, Nov 2023

Aggregate Replacements:

A] Coarse aggregate: For green concrete laboratory experiment we are taking 30% of coarse aggregate 20 mm size aggregate, 30% taking 10 mm size aggregate and remaining 40% coarse aggregate we are using recycled concrete aggregate. In this case, we will experiment in the laboratory so that the impact value of the coarse aggregates is not more than 45 percent while selecting the wastage recycled concrete aggregate of the demolished structure.

B] Fine aggregate replacement:

For laboratory experiment we are using 50% natural sand, 20% artificial sand or stone dust sand and remaining 30% we are using wastage foundry sand and industrial wastage glass and steel dust.

C] Cement replacement:

For laboratory experiment we are using OPC cement 53 grade. Here we are using 15% fly ash and 10% GGBS as replacement material of cement.

D] Water:

Clean water which is safe and potable for drinking was used for producing all types of mix.

E] Water-cement ratio:

For the laboratory experiment of M40 grade green high performance concrete, we have taken 0.40 water cement ratio.

F] Chemical admixture: In the laboratory experiment of M40 grade green high performance concrete we have used super plasticizer.

M40 grade fly ash mixed green high performance concrete's design stipulation:

i)Grade of concrete prepared for laboratory experiment: M40

ii)Grade of cement used for laboratory experiment: OPC 53 grade.

iii)Nominal size of coarse aggregate used for laboratory experiment: 20 mm & 10 mm.

iv)Workability of concrete mix prepared in laboratory: 25 to 50 mm (slump)

v)Method of concrete placing in laboratory: Completely normal condition

vi)Type of laboratory experiment supervision: Very good

vii)Specific gravity of cement used in laboratory: 3.15

viii)Specific gravity of coarse aggregate used in laboratory: 2.84 [I have done the experiment in basement of college campus on 2nd February, 2022]

ix]Specific gravity of fine aggregate used in laboratory: 2.67 [I have done the experiment in basement of college campus on 2nd February, 2022]

x]Fine aggregate used in laboratory: zone 1 (IS 383-1970)

DESIGN:

Step1:Target mean strength

$f_{ck}' = f_{ck} + 1.65s$ From Table 1 of IS 10262-2009

$= 40 + 1.65 \times 5$ standard deviation, s = 5N/mm^2

$f_{ck}' = 48.25$N/mm^2

Step2: Selection of water cement ratio

FromTable5ofIS456–2000

For M40 concrete, maximum w/c ratio = 0.45

Based on experience adopt water cement ratio=0.40

0.40<0.45

Step3: Selection of water content

From Table 2 of IS10262:2009 maximum water content for 20 mm aggregate = 186 liter (for 25 to 50mm slump range)

As super plasticizer is used, so we reduce 20% water content.

Based on trials with super plasticizer water content reduction of 20% has been achieved. Hence, the arrived water content = 186 × 0.80 = 148.8 ≈ 150 liter.

Step4: Calculation of cement content and fly ash:

Water-cement ratio = 0.40

Cement content= 150/0.40 = 375 kg/m^3

From Table 5 of IS 456-2000,

Minimum cement content for 'extreme' exposure condition = 360kg/m^3

375kg/m^3>360kg/m^3,hence O.K.

The following steps are being taken to find out the quantity of fly ash.

In this case the cementitious material content is increased by 10%.

So, cementitious material content = 375 × 1.10 = 412.5 kg/m^3 ≈ 413 kg/m^3

Water content = 150 kg/m^3

So, now water cement ratio = 150/412.5 = 0.36

In this case **15% fly ash content** of total cementitious material has been used = 413 × 15%

= 61.95 ≈ **62 kg/m^3**

Here **10% GGBS content** of total cementitious material has been used = 413 × 10% = 41.3 ≈ **41 kg/m^3**

Total cement (OPC) content = 413 – (62+41) = **310 kg/m^3**

Savings of cement for use of fly ash and GGBS = 375 – 310

 DOI : 10.35291/2454-9150.2023.0216

ISSN : 2454-9150 Vol-09, Issue-08, Nov 2023

= 65 kg/m^3

Step5: Proportion of volume of coarse aggregate and fine aggregate content

From Table3 volume of coarse aggregate corresponding to 20mm size aggregate and fine aggregate (Zone I) for water-cement ratio of 0.50 = 0.60.

In the present case water-cement ratio is 0.40. Therefore, volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As the water-cement ratio is lower by 0.10 the proportion of volume of coarse aggregate is increased by 0.02 (at the rate of -/+ 0.01for every ± 0.05 change in water-cement ratio). Therefore, corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.40 = 0.62.

NOTE-In case the coarse aggregate is not angular one then also volume of coarse aggregate may be required to be increased suitably, based on experience.

For pumpable concrete volume of coarse aggregate should be reduced by 10 percent.

Therefore, volume of coarse aggregate = 0.62×0.9 = 0.56

Volume of fine aggregate content = 1 - 0.56 = 0.44.

Step6: Mix calculations

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete = 1 m^3

b) Volume of cement = (Mass of cement / Specific gravity of cement)×(1/1000)

= (310/3.15)×(1/1000)

=0.098m^3

c) Volume of fly ash =(Mass of fly ash / Specific gravity of fly ash)×(1/1000)

= (62/2.1)×(1/1000)

=0.030m^3

d) Volume of GGBS=(Mass of GGBS / Specific gravity of GGBS)×(1/1000)

= (41/2.9)×(1/1000)

=0.014m^3

e) Volume of water =(Mass of water / Specific gravity of water)×(1/1000)

= (150/1)×(1/1000)

=0.150m^3

f) Volume of chemical admixture (super plasticizer) @ 2% by mass of cementitious material

=(Mass of admixture/Specific gravity of admixture)×(1/1000)

= (8.26/1.145)×(1/1000)

=0.008 m^3

g) Volume of all in aggregate={a-(b+c+d+e+f)}

=1–(0.098+0.030+0.014+0.150+0.007)

=0.701m^3

h) Mass of coarse aggregate = (g x Volume of coarse aggregate x Specific gravity of coarse aggregate x 1000)

=0.701x0.56x2.84x1000

=1114.87kg

i) Mass of fine aggregate =(g x Volume of fine aggregate x Specific gravity of fine aggregate x 1000)

=0.701x0.44x2.67x1000

=823.53kg

Step7:Mix proportions for trial number 1

i]Cement =310 kg/m^3

ii]Fly ash=62kg/m^3

iii]GGBS =41kg/m^3

iv]Water = 150 kg/m^3

v]Chemical admixture (Super plasticizer) = 8.8 kg/m^3

vi]Water-cement ratio = 0.36

vii]Fine aggregate = 823.53 kg/m^3≈ 824.00 kg/m^3

A] Natural sand (50%) = 412.00 kg/m^3

B] Artificial sand (20%) = 165.00 kg/m^3

C] Wastage foundry sand, wastage glass dust, steel dust etc. (30%) = 247.00 kg/m^3

Total = 824.00 kg/m^3

[For w/c ratio= 0.45]

viii]Coarse aggregate = 1114.87 kg/m^3≈ 1115.00 kg/m^3

A] 20 mm size aggregate (30%) = 334.50 kg/m^3

B] 10 mm size aggregate (30%) = 334.50 kg/m^3

C] Recycled concrete aggregate (40%) =446.00 kg/m^3

Total = 1115.00 kg/m^3

NOTE –(i)Aggregates should be used in saturated surface dry condition. If otherwise when computing the requirement of mixing water, allowance shall be made for the free (surface) moisture contributed by the fine and coarse aggregates .On the other hand, if the aggregates are dry, the amount of mixing water should be increased by an amount equal to the moisture likely to be absorbed by the aggregates. Necessary adjustments are also required to be made in mass of aggregates. The surface water and percent of water absorption of aggregates shall be determined according to IS2386.

(ii) The slump shall be measured and the water content and dosage of admixture shall be adjusted for achieving the required slump based on trial, if required. The mix proportions shall be reworked for the actual water content and checked

DOI : 10.35291/2454-9150.2023.0216

ISSN : 2454-9150 Vol-09, Issue-08, Nov 2023

for durability requirements.

(iii) Two more trials having variation of±10 percent of water-cement ratio in (ii) shall be carried out and a graph between three water-cement ratios and their corresponding strengths shall be plotted to work out the mix proportions for the given target strength for field trials. However durability requirement shall be met.

If 1 m^3 of concrete is prepared with the following ingredients –(i)Ordinary Portland Cement [OPC]

(ii)Fine aggregate. (iii)Coarse aggregate and

(iv)Water as used in Green High Performance Concrete with OPC the cost per m^3 of concrete would come as follows in 'A'.

A] Cost per m^3 for conventional concrete (M40):

Table No.1: Cost per m^3 for conventional concrete (M40)

SLNO	Material	Rate (Per Kg)	uantityKg/m^3	(Perm^3)
1	Cement (OPC)	8.00	270	2160.00
2	Fly-ash	1.20	115	138.00
3	Water (Water-cement ratio = 0.364)	0.50	140	70.00
4	Fine Aggregate (Natural Sand)	1.50	862	1293.00
5	Coarse Aggregate	0.60	1097	658.20
6	Super plasticizer	90.00	7.7	693.00
			Total =	5012.20 **[Y]**

IV. RESULTS

NATIONAL LABORATORY
For Soil Investigation and Building Materials Testing
المختبر الوطني
لفحص التربة ومواد البناء

TEST CERTIFICATE FOR CONCRETE CUBES

Contractor	M/s. Somsubhra De
Consultant	Not Given
Project Name:	Flyash Mixed Green High Performance Concrete
Project No. /Location:	Sharjah UAE
Structure:	Green High Performance Concrete
Place of making cubes	Site
Time of making cubes	Not Given
Name of Technician making cubes	Not Given
Method of Compaction	By Hand Using Tamping Rod
Cond.of Curing&Storage at Site	Water Curing
Certificate of Spec.Prep.&Curing.	N.G
Class of Concrete:	M40 Grade
Source of Concrete:	Not Given

Request No.	Shj/109540/23
Date:	25-06-23
Lot No.	Not Given
Lot Size.	Not Given
NO. OF SPECIMENS	3
ACTUAL AGE:	>90 day's
REQUIRED AGE:	90 day's
Receiving Date	25-06-23
Receiving Time	3:45
Samp. Certificate	Not Given
Sample Descpn	Concrete Cubes
Date of Casting	24-03-23
Date of Testing	25-06-23

MOISTURE CONDITION AT TESTING	MOIST					
CONDITION OF CURING AT LAB	Immersed in water for minimum 5 minutes					
NOMINAL SIZE mm	150x150x150					
Sender Reference – Specimens Symbol.						
Sender Reference – Specimen No.						
Lab Reference – Sample No.	109540					
Lab Reference – Specimen No.	1	2	3	--	--	--
CONDITION OF SPEC.WHEN RECEIVED	No Fault	No Fault	No Fault	--	--	--
APPEARANCE OF CONCRETE:	Normal	Normal	Normal	--	--	--
AVERAGE MEASURED DIMENSIONS – LENGTH (mm)	150	150	150	--	-*-	--
AVERAGE MEASURED DIMENSIONS – WIDTH (mm)	150	150	150	--	--	--
AVERAGE MEASURED DIMENSIONS – HEIGHT (mm)	150	150	150	--	--	--
SPECIMEN MASS (AS RECEIVED) kg	8.537	8.637	8.798	--	--	--
FAILURE LOAD kN	1347	1448	1508	--	--	--
FAILURE MODE	Satisfactory (A)	Satisfactory (A)	Satisfactory (A)	--	--	--
DENSITY (AS RECEIVED) kg/m3	2530	2560	2610	--	--	--
COMPRESSIVE STRENGTH N/ mm2	60.0	64.5	67.0	--	--	--

REMOVAL OF FINS:	No Fins
METHOD OF DETERMINING THE VOLUME :	BY Calculation.

Test Method	BS EN 12390-3:2019
Sampling Method	NG
Specimen Preparat.. Mtd.	NG
T. Method Variation	Nil

Sample Brought in By	Contractor
Remarks	The result related only to the Sample Tested.

We trust the above information will be of help to you

Tested By
IB + MA + GR

Checked By

Yours Faithfuly
For NATIONAL LABORATORY
General Manager

AR

Rev.02:FM # 06:15:05:02

SHARJAH (HEAD OFF.) : Tel.: 06 - 5436455, Fax: 06 - 5436993, P.O. Box: 34261
RAS AL KHAIMAH (Br.) : Tel.: 07 - 2332031, Fax: 07 - 2331367, P.O. Box: 30138
UMM AL QUWAIN (Br.) : Tel.: 06 - 7666238, Fax: 06 - 7660551, P.O. Box: 2370
E- mail: natinlab@eim.ae

OUTSTANDING QUALITY SINCE 1987
SHARJAH (HEAD OFF)

مكتب الرئيسي الشارقة : هاتف : ٠٦-٥٤٣٦٤٥٥ ، فاكس : ٠٦-٥٤٣٦٩٩٣ ، ص.ب : ٣٤٢٦١
رأس الخيمة فرع : هاتف : ٠٧-٢٣٣٢٠٣١ ، فاكس : ٠٧-٢٣٣١٣٦٧ ، ص.ب : ٣٠١٣٨
أم القيوين فرع : هاتف : ٠٦-٧٦٦٦٢٣٨ ، فاكس : ٠٦-٧٦٦٠٥٥١ ، ص.ب : ٢٣٧٠
البريد الالكتروني: natinlab@eim.ae

 DOI : 10.35291/2454-9150.2023.0216

According to the mix design of trial 1, I did the compressive strength test of Green High Performance Concrete cube at the National Laboratory, and got the appropriate result of the compressive strength test of concrete.

B] Cost per m^3 of M40 grade Green High Performance Concrete, in this case 15% Fly-ash and 10% GGBS have been used:

Table No.2: M40 grade Fly-ash Mixed Green High Performance Concrete (15% Fly ash and 10% GGBS used)

SLNO	Material	Rate (Per Kg)	Quantity Kg/m^3	Cost(Per m^3)
1	Cement(OPC)	8.00	310	2480.00
2	Fly Ash	1.20	62	74.40
3	GGBS	3.85	41	157.85
4	Super plasticizer	90.00	8.80	792.00
5	Natural Sand	1.50	412	618.00
6	Crush Sand	0.80	165	132.00
7	Wastage Foundry Sand	0.60	247	148.20
8	Coarse Aggregate(20mm)	0.60	334.50	200.70
9	Coarse Aggregate(10mm)	0.60	334.50	200.70
10	Recycled Concrete Aggregate	0.20	446.00	89.20
11	Water (Water-cement ratio =0.36)	0.50	150.00	75.00
			Total=	4968.05 **[X]**

Percent of savings per cubic meter of concrete

$$=[(Y-X)/X]\times 100$$

$$=\{(5012.20-4968.05)/4968.05\}\times 100$$

$$= 0.89\% \approx 1\%$$

From above it is inferred that if Green High Performance Concrete is made with 15% Fly ash and 10% GGBS the cost per cubic meter of Green High Performance Concrete compared to cost per meter cube of conventional concrete will be cheaper by 1% as shown in the calculation. The decrease in cost of 1% seems reasonable compared to the different benefits obtained by using Green High Performance Concrete in concrete projects.

V. CONCLUSION

In conclusion, the studies presented show that the utilization of eco-sand and fly ash as partial replacement of cement in concrete can provide a more environmentally sustainable option for construction. In this case we are using recycled concrete aggregate, and even after partial replacement of cement material, we are getting compressive strength like plain conventional concrete. Here recycled concrete aggregate, fly-ash and GGBS are being used in concrete preparation, so we can reduce the waste product of concrete and industrial waste product from nature. The use of eco-sand as fine aggregate in green high-strength concrete can improve strength properties while fly ash can be used as a partial replacement of cement without compromising compressive strength. Furthermore, the addition of mineral admixtures, particularly fly ash, can enhance the durability of concrete and prevent or slow down the corrosion of steel bars, especially in harsh marine environments. The utilization of alternative materials and the reduction of cement usage can help reduce carbon dioxide emissions and contribute to global sustainable development. In conclusion, the studies presented show that the utilization of eco-sand and fly ash as partial replacement of cement in concrete can provide a more environmentally sustainable option for construction. The use of eco-sand as fine aggregate in green high-strength concrete can improve strength properties while fly ash can be used as a partial replacement of cement without compromising compressive strength. Furthermore, the addition of mineral admixtures, particularly fly ash, can enhance the durability of concrete and prevent or slow down the corrosion of steel bars, especially in harsh marine environments. The utilization of alternative materials and the reduction of cement usage can help reduce carbon dioxide emissions and contribute to global sustainable development.

REFERENCE

[1] Seung-Jun Kwon, Han-Seung Lee, Subbiah Karthick, Velu Saraswathy, Hyun-Min Yang, Long-term

 DOI : 10.35291/2454-9150.2023.0216

ISSN : 2454-9150 Vol-09, Issue-08, Nov 2023

corrosion performance of blended cement concrete in the marine environment – A real-time study, Volume 154, Korea, Elsevier, 2017.

[2] M.F.M Zain, H.B Mahmud, Ade Ilham, M Faizal, Prediction of splitting tensile strength of high-performance concrete, Volume 32, Malaysia, Cement and Concrete Research, 2002.

[3] P.C Aïtcin, The durability characteristics of high performance concrete: a review, Volume 25, Canada, Cement and Concrete Composites, 2003.

[4] Iman Taji, Saeid Ghorbani, Jorge de Brito c , Vivian W.Y. Tam, Sohrab Sharifi, Ali Davoodi, Mohammadreza T avakkolizadeh, Application of statistical analysis to evaluate the corrosion resistance of steel rebars embedded in concrete with marble and granite waste dust, Volume 210, Iran, JCP, 2019

[5] Ayesha Siddika, Md. Abdullah Al Mamun, Rayed Alyousef, Hossein Mohammadhosseini, State-of-the-art- review on rice husk ash: A supplementary cementitious material in concrete, Volume 33, Australia, Journal of King Saud University – Engineering Sciences, 2021

[6] Md. Raquibul Hasan, Ayesha Siddika, Md. Parvez Ali Akanda, Md. Rabyul Islam, Effects of waste glass addition on the physical and mechanical properties of brick, Issue 1, Innovative Infrastructure Solutions, 2021.

[7] Henk M. Jonkers, Arjan Thijssen, Gerard Muyzer, Oguzhan Copuroglu, Erik Schlangen, Application of bacteria as self-healing agent for the development of sustainable concrete, Volume 36, Netherlands, Ecological Engineering, 2010

[8] Dima M. Kannan, Sherif H. Aboubakr, Amr S. EL-Dieb, Mahmoud M. Reda Taha, High performance concrete incorporating ceramic waste powder as large partial replacement of Portland cement, Volume 144, UAE, Construction and Building Material, 2017

[9] Mark Reiner, Stephan A. Durham & Kevin L. Rens, Development and analysis of high-performance green concrete in the urban infrastructure, Volume 3, IJSE, 2010

[10] Maria C.G. Juenger, Rafat Siddique, Recent advances in understanding the role of supplementary cementitious materials in concrete, Volume 78, USA, Cement and Concrete Research, 2015

[11] Vinita Viswakarma, R. P. George, D. Ramachandran, B. Anandkumar, & U. Kamachi Mudali, Studies of detailed Bio film characterization on fly ash concrete in comparison with normal and super plasticizer concrete in seawater environments, Volume 35, Environmental Technology, 2012.

[12] Navarro Ferronato and Vincenzo Torretta, Waste Mismanagement in Developing Countries: A Review of Global Issues. IJERPH, 2019

[13] Alvin Harison, Effect of Fly-ash on Compressive strength of Portland Pozzolana Cement Concrete. Volume 2, Allahabad, Jair, 2014.

[14] Dr. S L Patil, Utilization of fly ash in cement concrete as a partial replacement of cement. Volume 2, Jalgaon District, IJAERS, 2012.

 DOI : 10.35291/2454-9150.2023.0216