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Strength Analysis of Concrete by Partial Replacement of Hyposludge and Granite Powder

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ABSTRACT: The production of cement, the main binder used in concrete, is known to have a significant environmental impact due to its high carbon footprint. The hyposludge and granite powderas partial replacements for cement in concrete has emerged as a good solution to reduce the impact on environment. This report investigates the strength analysis of concrete using industrial waste materials such as hyposludge and granite powder. Laboratory experiments were conducted to prepare concrete mixtures with varying percentages of industrial waste materials and to test their compressive and flexural strengths. The results demonstrate that the incorporation of industrial waste materials can improve the strength and durability of concrete while reducing it's carbon footprint. The report concludes that the use of industrial waste materials in concrete can be an effective and sustainable solution for reducing the environmental impact of construction practices.

I. INTRODUCTION:

Cement is the primary binding material used in concrete itincreases greenhouse gas emissions and has a significant environmental impact. Research has focused on developing sustainable solutions that can reduce the environmental impact of construction practices while maintaining or improving the quality and performance of concrete. For this problem solution is the use of industrial waste materials as partial replacements for cement and fine aggregates in concrete. This report investigates the strength analysis of concrete using industrial waste materials.

II. RELATED WORK

Previous research has investigated the use of industrial waste materials, including hyposludge and granite waste, as partial replacements for cement in concrete.

One study by Devaraj et al. (2018) They Investigated the hyposludge as a partial replacement for cement in concrete. The study found that hyposludge can be used as a partial replacement for cement up to a certain percentage, beyond which the strength of the concrete decreased. The optimum percentage of hyposludge was found to be 5% of the cement content.

A study by Singh et al. (2021) They investigated the effects of using a combination of hyposludge and granite waste as partial replacements for cement in Concrete.The compressive strength has increased with the addition of the waste materials up to a certain percentage, beyond which the strength decreased. The optimum percentage of hyposludge and granite waste was found to be 5% and 15% of the cement content, respectively.

Overall, the previous research suggests that the use of hyposludge and granite waste as partial replacements for cement in concrete can improve its strength and durability while also reducing the environmental impact of construction practices. Further research is needed to determine the optimum percentages of hyposludge and granite waste for specific applications and to investigate

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Research Objectives

1. Investigate the effects of hyposludge and granite waste on Flexural Strength and Compressive Strength.
2. Determine optimum percentage of hyposludge and granite waste as partial replacements for cement in concrete.
3. Analyse effects of hypo sludge and granite waste on workability of concrete.
4. Evaluate tensile strength of concrete with addition of hyposludge and granite waste.
5. Compare environmental impact and cost-effectiveness of concrete using hyposludge and granite waste as partial replacements for cement with traditional concrete.

Materials:

1. Cement: Portland cement is commonly used as a binding material in concrete.
2. Aggregates: Coarse aggregates(Size-20mm) and Fine aggregates(M sand).
3. Water: Water is used to form cement paste that binds the aggregates together.
4. Hyposludge: Hyposludge is a by-product of the paper industry and it is used to replace in cement partially.
5. Granite waste: Granite waste is a by-product of the granite industry and it is used to partially replace in fine aggregates.
6. Admixtures: Chemical admixtures such as plasticizers, retarders, and accelerators may be used to improve the strength, workability and durability.

The strength analysis of concrete using hyposludge and granite waste can be performed using the following methodology:

1. Collect and prepare the materials: Hyposludge and granite waste should be collected and processed to meet the required specifications. The hyposludge should be dried and sieved to remove any impurities. The granite waste should be crushed into fine particles.
2. Prepare the concrete mix: The concrete mix should be prepared by mixing the hyposludge and granite waste with cement, sand, and water in the desired proportions. The mix should be thoroughly mixed to ensure uniformity.
3. Casting of specimens: The concrete mix should be cast into standard cylindrical or cube-shaped specimens. The specimens should be vibrated to ensure compaction and eliminate any voids.
4. Curing: The specimens should be cured in a moist environment at a temperature of 28°C ± 1°C for 7,14,28 days. The Curing process ensures the proper development of strength in the concrete.
5. Testing: After the curing period, the specimens should be tested for compressive strength and tensile strength. The compressive strength test is conducted using a Compression testing Machine, while the tensile strength test can be performed using a split tensile strength test machine.
6. Analysis of results: The test results should be analysed to determine the strength of the concrete. The results should be compared with the strength properties of conventional concrete.

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Basic Tests on Materials

Sl.no	Experiment Name	Result
1	Sp.gr of coarse aggregate	2.63
2	Sp.gr of fine aggregate	2.48
3	Sp.gr of cement	3
4	Sieve Analysis of fine Aggregates(fineness modulus)	5%
5	Specific gravity of Granite Dust	2.75
6	Impact Test	18.86%
7	Los Angeles Test Of Abrasion	29.88%
8	Water Absorption Test of coarse aggregate	15.03%
9	Slump Cone	27mm

Mix Design

a) Design

i. Compressive strength required in the field at 28 days is 30 N/mm^2

ii. Max Size of Aggregates: 20mm.

b) Target Mean Strength of Concrete = 30+ (1.65*5) =38.25 N/mm^2.

c) Water-Cement.

But minimum W/C is =0.40 .Hence W/C = 0.40.

d)Water Content (IS-10262, Table-4, P.no 5)

20mm aggregate – 186Kg for 50mm slump

For superplasticizer reduce 20% (186-20% of 186) =148.8Kg

e) Calculation of cement content

W/C ratio = Water Content / Cement Content

Cement Content= Water Content/ (W/C ratio)

Cement Content=148.8/0.4=372Kg/m^3> 320Kg/m^2.Hence Ok

f.Aggregate proportion b/w Coarse Aggregate & Fine Aggregate

IS-10262,Table-5, P.no-6, Cl5.5.1

Zone II 0.62(w/c-0.5)

Every 0.05 decrease,increase 0.01, (w/c-0.45)(0.45-0.4=0.05)

0.62+0.01=0.63

Vol. Coarse Aggregates =0.63

Vol. Fine Aggregates =1-0.63=0.37

g. Mix calculation

1 .Vol. concrete=$1m^3$

2. Vol. cement= (Mass/Sp.gr) * x (1/1000)

= (372/3) x (1/1000)

= $0.124m^3$

3. Vol. water = (Mass/Sp.gr) x (1/1000)

= (148.8)/ (1*1000) = 0.149 m^3

4. Vol. Admixture = (Mass/Sp.gr) x (1/1000)

= (3.72/1.22) x (1/1000)

=0.00304 m^2

5. Vol. all aggregate

= [(1-0.01)-(0.124+0.149+0.00304)]

=0.71496m^3

6. Mass of coarse aggregates

=Vol. all in aggregate x Vol. Coarse Aggregate x Sp.gr of Coarse Aggregate x 1000

=0.714 x 0.63 x 2.63 x 1000

=1183Kg

7. Mass of fine aggregate

=Vol. all in aggregate x Vol. Coarse Aggregate x Sp.gr of Coarse Aggregate x 1000

=0.714 x 0.37 x 2.62 x 1000

=692.26Kg

Therefore, the mix proportions for M30 grade concrete are:

- Cement: 372 kg/m^3
- Fine aggregate: 692.26 kg/m^3
- Coarse aggregate: 1183 kg/m^3
- Water: 148.8 kg/m^3
- Admixture: 3.72 kg/m^3
- W/C ratio: 0.4

Mix Design Ratio

Cement	Fine Aggregates	Coarse Aggregates	Water	Admixture
1	1.86	3.2	0.4	0.01

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Test Conducted On Conventional Tests:

Sl.no	Days	Compressive Strength	Unit
1	7	26.6	N/mm^2
2	14	29.79	N/mm^2
3	28	33.18	N/mm^2

Sl.no	Days	Flexural Strength	Unit
1	7	3.22	N/mm^2
2	14	3.93	N/mm^2
3	28	4.81	N/mm^2

Compressive Strength Results

Compressive strength at 5% Fine Granite Powder& 5% Hypo sludge in cement

Sl.no	Days	Compressive Strength	Unit
1	7	27	N/mm^2
2	14	29.6	N/mm^2

Compressive strength at 2.5% Fine Granite Powder& 2.5% Hypo sludge in cement

Sl.no	Days	Compressive Strength	Unit
1	7	26.4	N/mm^2
2	14	29.3	N/mm^2

Compressive strength at 1.25% Fine Granite Powder& 3.75% Hypo sludge in cement

Sl.no	Days	Compressive Strength	Unit
1	7	26.2	N/mm^2
2	14	28.9	N/mm^2

Compressive strength at 3.75% Fine Granite Powder& 1.25% Hypo sludge in cement

Sl.no	Days	Compressive Strength	Unit
1	7	27.3	N/mm^2
2	14	30.6	N/mm^2

Flexural Strength Results

Flexural strength at 5% Fine Granite Powder& 5% Hyposludge in cement

Sl.no	Days	Flexural Strength	Unit
1	7	3.36	N/mm^2
2	14	3.97	N/mm^2

Flexural strength at 2.5% Fine Granite Powder& 2.5% Hyposludge in cement

Sl.no	Days	Flexural Strength	Unit
1	7	3.12	N/mm^2
2	14	3.81	N/mm^2

Flexural strength at 1.25% Fine Granite Powder& 3.75% Hyposludge in cement

Sl.no	Days	Flexural Strength	Unit
1	7	2.9	N/mm^2
2	14	3.76	N/mm^2

Flexural strength 3.75% Fine Granite Powder& 1.25% Hyposludge in cement

Sl.no	Days	Flexural Strength	Unit
1	7	3.41	N/mm^2
2	14	3.99	N/mm^2

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III. CONCLUSION

Based on the strength analysis of concrete using partial replacement of hyposludge and granite dust, the conclusions are:

- When hyposludge and granite powderare partially replaced in cement and fine aggregates in concrete can effectively improve the compressive strength of concrete.
- When hyposludge and granite powderare partially replaced in cement and fine aggregates in concrete can effectively improve the flexural strength of concrete.
- The optimum percentage of replacement of cement with hyposludge andfine aggregates with granite dust was found to be 1.25% and 3.75%, respectively, for achieving the desired strength properties of concrete.
- Compressive Strength has increased by 2% at 14days.
- Flexural Strength has increased by 1.1% at 14days.
- The use of hyposludge and granite powder as partial replacement of cementand fine aggregates in concrete can also reduce the cost of production and promote the sustainable use of waste materials.

Therefore, it can be concluded that the use of hyposludge and granite powder as partial replacement of cementand fine aggregates in concrete can be a viable solution for improving the strength properties of concrete and promoting sustainability in the construction industry. The further studies are required to be done to evaluate the Strength, durability and properties of concrete using hyposludge as replaced partially with cement and granite dust as replaced partially with fine Aggregates.

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