**Making Green Porous Concrete for Rain Water**

**Harvesting and Urban Pavements**

KUMARI SUSHMITA1, Prof. SHAIFALI SEHGAL2

1 M. Tech Scholar, Department of Civil Engineering, NIRT Bhopal, India

2 Prof. Department of Civil Engineering, NIRT Bhopal, India

**Abstract.** Pervious concrete is one of the most widely used materials by the concrete industry for providing storm water management, pollution control, noise control and sustainable design. The increased awareness in pervious concrete is mainly due to the benefit of storm water management which leads in sustainable development. In artistic point of view, pervious concrete pavement does not appear or perform like conventional concrete pavement.

The main aim of this project was to improve the compressive strength characteristics of pervious concrete. But it can be noted that with increase in compressive strength the void ratio decreases. Hence, the improvement of strength should not affect the porosity property because it is the property which serves its purpose.

KEYWORDS: Concrete mix, Silica Fume, Strength parameter, sustainable construction, workability

**Introduction**

Depletion of ground water and scarcity in consumption of fine aggregate in concrete construction is effectively controlled by implementing pervious concrete. Previous research on pervious concrete has focused primarily on optimizing the hydraulic properties of pervious concrete mixes. Permeability of pervious concrete is greatest concern for field application based on rainfall intensities which vary with distribution of aggregate sizes for providing adequate drainage properties.

Use of binder is vital and indispensable in any type of concrete. In pervious concrete, most of the studies are carried out using Ordinary Portland cement (OPC) as binder. However, in urbanized areas, source of the OPC binder is in short supply and may be costly. Also, necessary efforts and care should be taken to meet the expected human needs by giving importance to economy and pollution free environment to the construction industry. In order to fulfill this demand, alternate binder is preferable which should be user friendly, environment friendly and should ensure better performance. Therefore, different binders are needed in developing the applications of pervious concrete in all regions.

Consequently pozzolanic binder, fly ash based geopolymer binder are materialized to fulfill the above said needs. It can help in satisfying the demand for cement in concrete. As per the recent scenario, keen interest is shown to utilize industrial wastes in concrete among construction industry and researchers. Due to this, consumption of natural resources can be minimized and it makes environment healthy and clean and helps in minimization of waste disposal, reduction in cost of disposal and land fill

Material Used

The following materials are used during the research work-

 Cement

 Fine aggregates (Sand)

 Coarse Aggregates(10-20 mm)

 Super Plasticizer

 Water

Methodology

As stated earlier concrete mix design is required to be done if admixtures or additional cementing materials are added with partial replacement of cement in concrete is done. The behaviour and properties of green and hardened concrete totally depends on its ingredients ie. Cement, aggregates, cementing material and water to cement ratio. Properties of green concrete like workability and of hardened concrete like compressive strength, flexural strength, weight density etc. totally depends on the proportion of ingredients used in mix design, apart from this ratios of fine aggregate to coarse aggregate, water to cement, admixture to cement also plays and important role in different properties of concrete.. Concrete mix design is a trial and error process and its results totally depends on the lab results of its constituents thus a through and detailed lab test need to be done on ingredients before proceeding for mix design

Results

**Table 5.1 Compressive strength of sample containing GGBFS and Fly Ash**

|  |  |
| --- | --- |
|  | **Using GGBFS as Cement Replacement 50 %** |
| **S.No.** | **Sample ID** | **28 days** **Compressive Strength in MPa** | **Water : Cement** |
| 1 | A3GS1 | 15.87 | 0.33 |
| 2 | A4GS1 | 12.28 |
| 3 | A5GS1 | 8.56 |
| 4 | A6GS1 | 6.46 |
| 5 | A3GS2 | 13.73 |
| 6 | A4GS2 | 10.07 |
| 7 | A5GS2 | 6.89 |
| 8 | A6GS2 | 5.64 |
| 9 | A3GS3 | 12.44 |
| 10 | A4GS3 | 9.13 |
| 11 | A5GS3 | 6.79 |
| 12 | A6GS3 | 5.47 |
|  | **Using FLY ASH as Cement Replacement 50 %** |
| **S.No.** | **Sample ID** | **28 days Compressive Strength in MPa** | **Water : Cement** |
| 1 | A3FS1 | 11.34 | 0.33 |
| 2 | A4FS1 | 9.45 |
| 3 | A5FS1 | 9.12 |
| 4 | A6FS1 | 7.50 |
| 5 | A3FS2 | 10.36 |
| 6 | A4FS2 | 9.05 |
| 7 | A5FS2 | 7.35 |
| 8 | A6FS2 | 5.23 |
| 9 | A3FS3 | 10.12 |
| 10 | A4FS3 | 9.05 |
| 11 | A5FS3 | 6.23 |
| 12 | A6FS3 | 5.00 |

**Fig. 5.1 Variation of Compressive Strength Contain of GGBFS**

**Fig. 5.2 Variation of Compressive Strength Contain of Fly Ash**

The compressive strength of pervious concrete with addition of fly ash and GGBFS were measured at 28 days as shown in figures. For GGBFS mix it ranges from 15.85 MPa to 5.47 MPa with increasing aggregate to cement ratio from 3:1 to 6:1. And for FA mix it ranges from 11.34 MPa to 5 MPa with increasing aggregate to cement ratio from 3:1 to 6:1

The variation in compressive strength between small S1 and medium size S2 aggregate mix is up to 13.35 % and between S1 and bigger size S3 aggregate mix is up to 21%. Increase in compressive strength of different mix was observed by decreasing aggregate to cement ratio from 3:1 to 6:1.

## FLEXURAL STRENGTH TEST

**Table 5.2 Flexural strength of sample containing GGBFS and Fly Ash**

|  |  |
| --- | --- |
|  | **Using GGBFS as Cement Replacement 50 %** |
| **S.No.** | **Sample ID** | **28 days****Flexural Strength in MPa** | **Water : Cement** |
| 1 | A3GS1 | 3.21 | 0.33 |
| 2 | A4GS1 | 2.86 |
| 3 | A5GS1 | 2.62 |
| 4 | A6GS1 | 2.22 |
| 5 | A3GS2 | 2.96 |
| 6 | A4GS2 | 2.82 |
| 7 | A5GS2 | 2.37 |
| 8 | A6GS2 | 2.02 |
| 9 | A3GS3 | 2.86 |
| 10 | A4GS3 | 2.47 |
| 11 | A5GS3 | 2.07 |
| 12 | A6GS3 | 1.83 |
|  |  |
|  | **Using FLY ASH as Cement Replacement 50 %** |
| **S.No.** | **Sample ID** | **28 days Flexural Strength in MPa** | **Water : Cement** |
| 1 | A3FS1 | 3.11 | 0.33 |
| 2 | A4FS1 | 3.06 |
| 3 | A5FS1 | 2.86 |
| 4 | A6FS1 | 2.62 |
| 5 | A3FS2 | 2.81 |
| 6 | A4FS2 | 2.56 |
| 7 | A5FS2 | 2.30 |
| 8 | A6FS2 | 1.95 |
| 9 | A3FS3 | 2.55 |
| 10 | A4FS3 | 2.20 |
| 11 | A5FS3 | 1.95 |
| 12 | A6FS3 | 1.35 |

**Fig. 5.3 Variation of Flexural Strength Contain of GGBFS**

**Fig. 5.4 Variation of flexural Strength Contain of Fly Ash**

#### The flexural strength of pervious concrete with addition of fly ash and GGBFS were measured at 28 days as shown in figures. For GGBFS mix it ranges from 3.21 MPa to 1.83 MPa with increasing aggregate to cement ratio from 3:1 to 6:1. And for FA mix it ranges from 3.11 MPa to 1.35 MPa with increasing aggregate to cement ratio from 3:1 to 6:1 The variation in flexural strength between small S1 and medium size S2 aggregate mix is up to 7.75 % and between S1 and bigger size S3 aggregate mix is up to 10.91%. Increase in flexural strength of different mix was observed by decreasing aggregate to cement ratio from 3:1 to 6:1.

Conclusion

* For GGBFS mix it ranges from 15.85 MPa to 5.47 MPa with increasing aggregate to cement ratio from 3:1 to 6:1. And for FA mix it ranges from 11.34 MPa to 5 MPa with increasing aggregate to cement ratio from 3:1 to 6:1. Increase in compressive strength of different mix was observed by decreasing aggregate to cement ratio from 3:1 to 6:1. The decrease in compressive strength between small S1 and medium size S2 aggregate mix is up to 13.35 % and between S1 and bigger size S3 aggregate mix is up to 21%.
* Pervious concrete mix made with 12.5 mm larger size aggregate exhibited higher coefficient of permeability and porosity than smaller size aggregate. It is worth noting that larger size aggregate creates more number of interconnected voids between the aggregate particles and those voids cannot be entirely occupied by the binder paste. This fact allows more amount of water to penetrate.

.

References

1. Feng L, Zhang Y, Wang X, Mery S, Akin M, Li M, Xie N, Li Z and Shi X (2023), Impact of deicing salts on pervious concrete pavement. Front. Mater. 10:1189114. doi: 10.3389/fmats.2023.1189114
2. Xiao Q, Xia Y, Zhang G, Lin X and Zhao J (2023), Numerical simulation study on pore clogging of pervious concrete pavement based on different aggregate gradation. Front. Phys. 11:1162899. doi: 10.3389/fphy.2023.1162899
3. B.M Spoorthy, Anush K. Chandrappa and Umesh C. Sahoo. Mechanical and Functional Property Investigation of 2-Layered Pervious Concrete. The Open Civil Engineering Journal. 2023, Volume 17.
4. Ann Mary Kuruvila. Mechanical And Infiltration Characteristics of Pervious Concrete Pavement Incorporating Reclaimed Asphalt Pavement Aggregates: A Review. The International Conference on Emerging Trends in Engineering Yukthi-2023.
5. Gao, S.; Huang, K.; Chu, W.; Wang, W. Feasibility Study of Pervious Concrete with Ceramsite as Aggregate Considering Mechanical Properties, Permeability, and Durability. Materials 2023, 16, 5127.
6. Arega Mulu, Preeti Jacob and G. S. Dwarakish. Hydraulic Performance of Pervious Concrete Based on Small Size Aggregates. Advances in Materials Science and Engineering Volume 2022, Article ID 2973255, 12 pages.
7. Yanchen Oinam, Suhawn Ju, Seongwoo Gwon , Myoungsu Shin and Sukhoon Pyo. Characteristics of GGBFS-Based Pervious Concrete Considering Rheological Properties of the Binder. International Journal of Concrete Structures and Materials. (2022) 16:62.
8. T Ahmed and S Hoque. Study on pervious concrete pavement mix designs. 2nd International Conference on Civil & Environmental Engineering IOP Conf. Series: Earth and Environmental Science 476 (2020) 012062
9. Leo Gu L and Bo-Feng Xiao. Experimental Study on Porosity, Permeability and Strength of Pervious Concrete. Research Square. Version 1 posted 06 May, 2021
10. Tri Mulyono and Anisah. Properties of pervious concrete with various types and sizes of aggregate. MATEC Web of Conferences 276 (2019).