### Review on Strength Properties of Concrete by Partial Replacement of Cement with Metakaolin and Egg Shell Powder and Replacement of Coarse Aggregate with Recycled Aggregate

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## *Abstract-* The main parameter investigated in this study is Mechanical properties( like Strength, Ductility, Wear resistance, etc.) of concrete using M20 grade by partial supplant of cement with Metakaolin is 5% and egg shell powder 0 to 6% by Recycled aggregate. Numerous tests such as compression, split tensile property, Flexural property and Acid (H2SO4 and HCL) curing tests are conducted on specimens also, these qualities are contrasted and the traditional cement without metakaolin and egg shell powder. Standard cuboids shape of 150X150X150mm will be mould and tried for compressive quality. Standard cylinder of 150mm diameter and 300mm height will be mould and tried for tension. Standard light emission beam of 500X100X100mm will be thrown and tried for flexural quality. These cubes, cylinders and beams are casted and tested for 7 and 28 days after this Acid curing Tests will be done for 7 and 28 days. Then analyze all the results mathematically and graphically. Compression, Flexural and Split tensile features of basic concrete and metakaolin (MKC) concretes are compared and observed and concluded that the solidity of conventional concrete is higher than the MK.

***Keywords-* Egg shell powder, Metakaolin, aggregate**

Earlier, a study of compression, split tensile, and flexural properties and Acid curing by using H2SO4 & HCL tests was undertaken to use Rice husk Ash, Metakaolin, as admixtures of partial supplant for cement has done. Following are the related studies.

1. *Amarnath Yerramala (2014)*

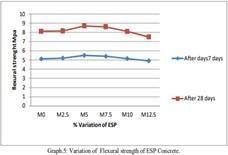
Studied behavior of concrete with egg outer shell dust as cement substitution. Research work depicts investigation into exploitation of poultry unproductive in concrete by means of an improvement of cement fusing egg shell powder (ESP). Numerous ESP cements were generated by swapping 5-15% of ESP for concrete. Outcomes demonstrated that ESP can constructively be utilized as partial substitution of cement in concrete. The details introduced spread strengthen enhancement and transmission features. As for based on outcomes, at 5% egg outer shell dust substitution the strengths were prominent than basic concrete and shows that 5% egg outer shell dust is an absolute substance for the greatest strength. The exhibition of egg outer shell dust cements was practically identical up to 10% egg outer shell dust substitution as far as transition behavior with base concrete. Outcomes further show that escalation of fly ash alongside ESP is valuable for enhanced execution of concretes.

### Table 2.1.1 Strength Details of Concrete

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1. *Dinakar, P.Pradosh, K.Sahoo, G.Sairam (2019***)**

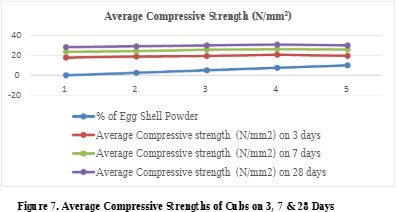
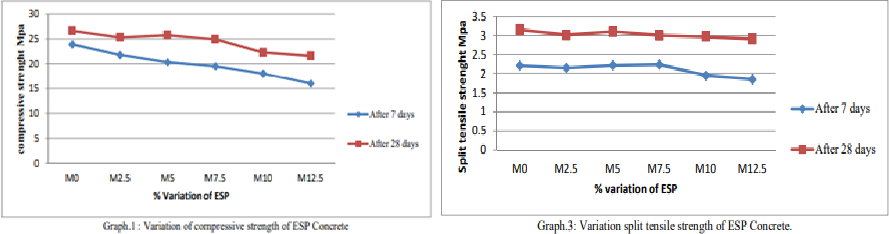
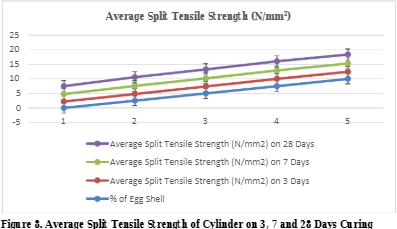
It is an experimental investigation conducted to understand the effect of metakaolin level on the properties of stable concrete. Metakaolin mixtures with binder supplant of 5% 10% and 15% were designed for the target strength of 90MPa. The water binder ratio is 0.3. The compressive strength was observed 106MPa at 10% substitution of MK. Even tensile strength, durability and resistance were as well followed the same trend. The metakaolin is useful in preparation of high strength concrete.

1. *Mohit (2019)*

He experimented the replacement of cement by many materials like fly ash, slag, silica fume, metakaolin, egg shell powder, rice husk ash etc. is done and researched. Various experiments were performed to check physical properties of cement, aggregate and admixtures. The physical tests like dry density, moisture absorption and void content and mechanical related tests like compression and split tensile examines are conducted for concrete. From the test, they noticed that there is a better performance in setting time, workability and durability. This concrete is good in tensile strength but not in compression.

1. *Sunny A.Jagtap, Mohan N.Shirsath Sambhaji, L. Karpe (2017)*

They conducted a study to understand the impact of metakaolin on the properties of concrete. They partially replaced cement by metakaolin with 5%, 10%, 15% and 20% by weight of cement. M35 grade concrete design is adopted with a mix proportion of 1:1.69:2.28 for 0.42 water binder ratio. The compression and flexural strength were tested for 7 and 28 days. The results obtained concluded that the strength properties increase up to 15% replacement of MK.

1. *Ayobami Busari, Joseph Akinmusuru, (2019)*The investigation on strength and durable features of sample using metakaolin as a sustainable material gave the result that an increase in the percentage of metakaolin reduces the workability and hence the enhancing the admixtures. The mechanical properties of concrete improved when added at about 10 to 25% of metakaolin. The heat of hydration increases with increase in the amount of metakaolin.
2. *Keramat khan, Dr K U Muthu (2017)*Investigated on the effect of metakaolin, Rice husk ash and egg crust dust by partial replacement of cement and keeping same W/C ratio to ordinary concrete and metakaolin, RHA & ESP. The concrete mixes has 0%,5%,10%,15% and 20% of metakaolin, RHA with 5% ESP, replacing cement partially and compressive, spit tensile and flexural tests are conducted. From this research the results are much better as compare to conventional concrete.
3. *Nisar Ahmed Gabol, Fareed Ahmed Memon, Mian Jawaduddin, Zaheer H Zardari (2019)*

In this research, they did supplant of binder with egg outer shell dust. The main objective is to determine the workability and mechanical properties using various percentages like 0%, 2.5%, 5%, 7.5%, and 10% of ESP by the weight of cement. They did totally of 120 concrete samples in that 60 cumecs, 30 cylinders and 30 prisms with target strength of 28 N/mm2.The compressive strength, cylindrical specimens, bending strength are tested at 3,7 and 28 days. The dimensions of cube used is 100x100x100, for cylinders 200x100 and for prisms 100x100x500.During the test the results are i.e., with Egg shell powder at 7.5% tensile strength increased by 9.6% and maximum strength of 8% at a 28 days of curing. As portion of egg outer shell dust increases the working capability of fresh concrete decreases.

1. *Vandana P. Pandya, Iliyas U. Rasool Bhai (2015)*

They adopted M25 grade mix proportion 1:1:2 is for casting and testing of cubes for compressive strengths at 7 and 28 days. The metakaolin contents substituted in cement are 0%, 3% and 5% by quantity of cement. The water binder ratio of 0.45 is constant. Minimum 10% of MK is to be used to completely achieve the requirements. On enhancement in portion of MK the compression resistance improves drastically.

1. *CH Jyothi Nikhila & J D Charan Kumar (2015)*

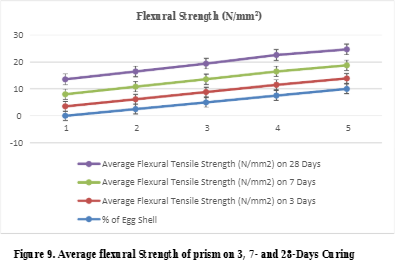
They studied that the metakaolin (MK) is a supplementary cement nous material or not. The exploratory work has been done as partial supplanting of binder with MK in M70 grade at 0-30% in intervals of 5% substitutions. The mix configuration was utilized “Erntroy empirical shacklock’s method”. Cuboids are tested for durability concentrates with H2SO4 and HCL of 0.5% and 1% focuses respectively. Cubes, Cylinders, Prisms are tried for Temperature at 15% replacement. The examples were warmed to various temperatures of 1000c, 2000c, 3000c, 4000c and 5000c of three distinct terms. The outcomes reason that the utilization of Metakaolin concrete (MKC) has improved the performance of concrete under different conditions.

1. *Dr. T. Felixkala, M. Narmatha (2016)*

The specimen was casted for M60 grade of concrete with 5- 20% supplant of cement by metakaolin with even water binder ratio of 0.32. OPC of 53 grade cement, crushed stones of maximum size 20mm coarse aggregate and river sand passing IS sieve 4.75mm fine aggregate are used in the investigation. As a result of this investigation, the maximum strengths are occurred at 15% replacement by MK. At MK 15%, the increase in compressive and flexural strengths at 28 days are 17.45% and 14.28% respectively.

1. *Bindu Biju, Imran H (2016)*

This study is deliberated to conceive a high performance concrete (HPC) blend for M70 class and to perceive the best partial substitution of cement with corresponding metakaolin from chosen particular dosages. The compaction strength at 28day so curing is 78.65N/mm2. The strength was found to increased by 6% when 10% by weight of cement was replaced with metakaolin. They concluded that the strength increase is due to the presence of silicon and aluminates that increases the cementing capacity. The workability was reduced while adding Metakaolin which was rectified with use of super plasticizers.



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| **Trial Mix** | **Compressive Strength (N/mm2)** | | |
|  | **7th Day** | **14th Day** | **28th Day** |
| MHPC 2.5 | 62 | 70.66 | 72 |
| MHPC 5 | 66 | 76 | 78.66 |
| MHPC 7.5 | 67 | 76.22 | 79 |
| MHPC 10 | 70 | 79.11 | 84 |
| MHPC 12.5 | 60 | 73.33 | 77.7 |

### Table 2.1.2: Data of Compressive Strength for 7, 14, &28 days

1. *R. Padmapriya, V.K.Bupesh Raja, V.Ganesh Kumar and J.Baalamurugan(2019)*

The experimental tests were directed to examine the effects on behavior of concrete in partial supplant of sand and cement by steel based slag and metakaolin respectively. The hexagonal shaped specimens of side 120mm and 80mm height were casted. Compression, bending, tension related resistances, moisture absorption, acid and alkali attack examines were operated. Outcome shows optimal portion supplant of metakaolin and steel based slag is 10% and 20% respectively.

1. *Memduh Nas, Sirin Kurbetci (2018)*

In this work, the concrete containing metakaolin 5% 10% and 20% by weight of cement are tested for compressive bending resistance, freeze-thaw and high temperature protections, slender coefficients and quick chloride penetrability properties. Water to binder ratio is maintained as 0.6 and all properties shown the maximum results at 20% MK

1. *Dr.Vani ,Mohammad Ansari, Dinesh Kumar.M and Milan Charles.J (2016)*

This paper describes the consequences and exploratory findings of supplant of egg shell dust in cement. The compression was carried out for replaced with 10%, 15% and 20% of Egg outer dust in Pozzolana Portland cement. From findings, it is proved that supplant of Egg shell dust if about 10% to 15% is effect and they increase further the portion ESP decreases the compressive strength.

|  |  |  |
| --- | --- | --- |
| **PERCENTAGE OF ESP ADDED** | **TRIAL NUMBER** | **COMPRESSIVE STRENGTH**  **on 7th DAY (N/mm2)** |
| 0% | 1  2  3 | 18.49  17.32  18.65 |
| 10% | 1  2  3 | 22.08  20.81  21.44 |
| 15% | 1  2  3 | 24.00  22.50  23.60 |
| 20% | 1  2  3 | 21.03  18.60  19.11 |

### Table 2.1.3: Compressive Strength Values by Replacing of cement with EggShellPowder

1. *Shaik Akhil Mastan, V.R.Prasath**Kumar(2015)*

This test study means to explore the appropriateness of fly ash and egg outer shell dust as partial supplant for finer aggregates in creation of minimal cost and insubstantial weight concrete. Here, test study is an endeavor to locate the ideal use of supplants in typical cement by supplanting the waterway sand (7%, 14%, 21%, 28% and 35%) by weight at different extents. Tests are directed on concrete cube shapes, cylinders and flexural shafts to contemplate compression, split tensile and flexural qualities. Tests are led for finding the quality of the concrete in 7 days and 28 days. At long last the outcomes are contrasted and the typical ordinary cement. The weight decrease is additionally determined. The reasonableness of fly ash and egg outer shell dust concrete is assessed.

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| --- | --- | --- | --- | --- | --- | --- |
| **Mix**  **%** | **Compressive Strength at 7 days (N/mm2)** | **Split Tensile Strength at 7 days (N/mm2)** | **Flexural Strength at 7 days (N/mm2)** | **Compressive Strength at 28 days (N/mm2)** | **Split Tensile Strength at**  **28 days (N/mm2)** | **Flexural Strength at 28 days (N/mm2)** |
| 0 | 26.85 | 2.80 | 3.13 | 38.69 | 3.60 | 4.30 |
| 7 | 31.47 | 3.04 | 3.46 | 45.86 | 3.82 | 4.61 |
| 14 | 29.19 | 2.l91 | 3.30 | 42.23 | 3.70 | 4.29 |
| 21 | 28.28 | 2.86 | 2.64 | 41.51 | 3.58 | 3.46 |
| 28 | 26.85 | 2.75 | 2.31 | 40.63 | 3.50 | 3.30 |
| 35 | 21.94 | 2.57 | 1.64 | 31.15 | 3.24 | 2.97 |

Table 2.1.4: Average Test Results for M30 Grade Concrete

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Mix**  **%** | **Compressive Strength at 7 days (N/mm2)** | **Split Tensile Strength at 7 days (N/mm2)** | **Flexural Strength at 7 days (N/mm2)** | **Compressive Strength at 28 days (N/mm2)** | **Split Tensile Strength at 28 days (N/mm2)** | **Flexural Strength at 28 days (N/mm2)** |
| 0 | 31.60 | 2.94 | 3.79 | 46.26 | 3.78 | 5.11 |
| 7 | 32.04 | 3.08 | 4.12 | 46.85 | 3.95 | 5.44 |
| 14 | 31.54 | 3.01 | 3.96 | 46.45 | 3.86 | 5.28 |
| 21 | 29.74 | 2.83 | 3,30 | 45.86 | 3.65 | 4.61 |
| 28 | 26.63 | 2.73 | 2.63 | 40.96 | 3.53 | 3.46 |
| 35 | 23.77 | 2.62 | 1.81 | 37.33 | 3.38 | 2.80 |

Table 2.1.5: Average Test Results for M40 Grade Concrete

REFERENCES

1. Amarnath Yerramala : Experimented on Properties of concrete with Egg Shell Powder as Cement Replacement. Published by *The Indian Concrete Journal*, [www.researchgate.net](http://www.researchgate.net/), Page No. 95 -102, October 2014.
2. Dinakar P, Pradosh K. Sahoo, G. Sairam : Experimented on Effect of Metakaolin content on the properties of High Strength Concrete, Published by *International journal of Concrete Structures and Materials*, vol. 7,Issue No. 3,;Page No 215-223,ISSN 1975-0485/#ISSN 2234- 1315,September 2013. This Article is published with open at Springer.com.
3. Mohit : Researched on Application of Sustainable Cement Alternatives in Concrete, Published by *International Journal of Engineering and Advanced Technology (IJEAT),* [www.ijeat.com](http://www.ijeat.com/) ,vol. 9, Issue 01, ISSN 2249-8958,October 2017.
4. Sunny A. Jagtap, Mohan N. Shirsath, Sambhaji L. Karpe : Study on Effect of Metakaolin on the Properties of Concrete, Published by *International Research Journal of Civil Engineering and Technology(IRJET),* [*www.irjet.com*](http://www.irjet.com/) ,vol. 01, Issue 07, ISSN(online) 2395- 0956,ISSN(print) 2395-0972, July 2017.
5. Ayobami Busari, Joseph Akinmusuru, and Bamidele Dahunsi : Experimented on Strength and Durability Properties of Concrete using Metakaolin As a Sustainable Material: Review of Literature, Published by *International Journal of Civil Engineering and Technology (IJCIET),* [www.iaeme.com](http://www.iaeme.com/) ,vol. 10,Issue 01,Page No. 1893-1902, ISSN (online) 0976- 6316,ISSN (print) 0976-6308, January 2019.
6. Keramat khan, Dr K U Muthu : An overview on Experimental Investigation on concrete using Egg Shell Powder, Metakaolin and Rice Husk Ash, Published by *International journal for Research in Applied Science & Engineering Technology (IJRASET),* [www.ijraset.com ,](http://www.ijraset.com/)vol. 05,Issue 08,Page No: 1713 to 1725,ISSN :2321-9653,August 2017.
7. Nisar Ahmed Gabol, Fareed Ahmed Memon, Mian Jawaduddin, Zaheer H Zardari : Analysis of Egg Shell Powder as a partial Replacing Material in Concrete

Published by *International Journal of Modern Research in engineering technology*

1. Nisar Ahmed Gabol, Fareed Ahmed Memon, Mian Jawaduddin, Zaheer H Zardari : Analysis of Egg Shell Powder as a partial Replacing Material in Concrete

Published by *International Journal of Modern Research in engineering technology*

1. C H Jyothi Nikhila and J D Chaitanya Kumar: Partial Replacement of cement with metakaolin in High Strength concrete Published by *International Journal of Engineering Research and Science & Technology(IJERST),* [www.ijerst.com,](http://www.ijerst.com/)Vol.4,No. 4,November 2015.
2. Dr. T. Felixkala, M. Narmatha : Study on Metakaolin- Best Material for Replacement of Cement in Concrete. Published by *IOSR Journal of Mechanical and Civil Engineering(IOSR JMCE),* [www.iosrjournals.org,](http://www.iosrjournals.org/) vol. 13,Issue 4 ,ISSN (online)2278- 1684 ,ISSN(print) 2320- 334X,Page No. 66-71,Jul-Aug 2016.
3. Bindu Biju, Imran H : Researched on Partial Replacement of Cement with Metakaolin in High Perfomance Concrete Published by *International journal of Innovative Research in Science,Engineering and Technology (IJIRST),* [www.ijirset.com](http://www.ijirset.com/)

,vol No.5,Page No. 133-139, special Issue 14,ISSN(online):2319- 8753,ISSN(print):2347-6710,December 2016.

1. Bindu Biju, Imran H : Researched on Partial Replacement of Cement with Metakaolin in High Perfomance Concrete Published by *International journal of Innovative Research in Science,Engineering and Technology (IJIRST),* [www.ijirset.com](http://www.ijirset.com/)

,vol No.5,Page No. 133-139, special Issue 14,ISSN(online):2319- 8753,ISSN(print):2347-6710,December 2016.

1. Memduh Nas, Sirin Kurbetci : Study on Durability Properties of Concrete containing Metakaolin. Published by *Advances in Concrete Construction*, vol. 6,Issue No. 2,Page No. 159- 175, ISSN 2287-5301,[www.techno-press.org,](http://www.techno-press.org/) March 2018.

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