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Study on compressive strength of concrete on Partial Replacement Of Cement With Quarry Dust and sewage sludge

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Abstract*— Quarry dust which is released directly into environment can cause environmental pollution. To reduce the impact of the quarry dust on environment and human, this waste can be used to produce new products or can be used as admixture in concrete so that the natural resources are used efficiently and hence environmental waste can be reduced. Here quarry dust is used for partial replacement of cement in concrete for studying the strength property of concrete. The aim of the experiment is to find the maximum content of quarry dust partial replacement of cement in concrete. The percentages of quarry dust and sewage sludge partial replacement of cement in concrete are 0, 5%, 10%, 15%, and M30, M40 grade concrete cubes of 150x150x150mm size were cast for conducting compressive strength test. From the experimental studies 10% of partial replacement of cement with quarry dust improved hardened concrete properties.

***Keywords*— concrete, quarry dust, sewage sludge, compressive strength, properties**

I. INTRODUCTION

Concrete is strength and tough material but it is porous material also which interacts with the surrounding environment is rapid increase in construction activities leads to active shortage of conventional construction materials such as cement, fine aggregate, coarse aggregate. Concrete has attained the status of a major building material in all the branches of modern construction. It is very difficult to point out another material of construction which is a variable as concrete and which is the best material choice is for strength and durability.

The cement manufacturing industries are releasing large amount of carbon dioxide (CO2) for their processes which is effected into atmosphere and this is one of cause for global warming. Since researches were searching for cheaper material that can be used as substitute for the materials. Even most of municipal and industrial waste has been disposed of in landfills and also increasing refusal of communities to have landfills are nearby as well as the increasing pressure from environmental agencies to require proper waste management is creating the need for alternative final disposal consistent with environmental needs at a rational cost. Use of these material not only helps in getting them utilized in cement, concrete and other construction material, it helps in reducing the cost of cement and concrete manufacturing processes but also has numerous indirect benefits such as reduction in landfill cost with saving in energy and protecting the senvironment from possible pollution effects. So then the cement replaced with Quarry dust and waste water sludge in concrete.

Paper making industries generally produces a large amount of solid waste. Over 300 million tons of industrial wastes are being produced per annum by chemical and agricultural process is available in India. These materials possess problems of disposal along with health hazards and aesthetic problem. The paper fibers will be recycled only a limited number of times before they become too short or weak to make high quality of paper. It means that the broken, low- quality paper fibers are separated out to become like waste sludge. But Paper sludge behaves like cement because of silica and magnesium properties which improve the setting of the concrete. And the quantity of sludge varies from mill to mill. However the amount of sludge generated through a recycled paper mill is greatly dependent on the type of furnish being used and end product being manufactured. About 300 kg of sludge is produced for each tone of recycled paper. Which is relatively large volume of sludge produced each day that makes making landfill uneconomical as Quarry dust is bulky.

Utilization of the widely spread industrial wastes in the civil construction practice may lead to a real possibility of significant decrease in the environment pollution by paper and lime production wastes and perceptibly economize the price of civil construction. The use of paper-mill residuals in concrete formulation.

II. REVIEW OF LITERATURE

Dhiraj Agrawal, Pawan Hinge1, U. P. Waghe[1] In the present age the waste generated from industries is the huge concern for the environment, health, and cause for land filling. Recycling of such wastes and using them in construction materials appears to be viable solution is not only to the pollution problem but also an economical option

in construction. In view of utilization of industrial waste is the construction material, the present paper reviews various waste materials at different levels in construction materials. Compressive test to find the strength of concrete and mortar incorporating different waste materials is reviewed and recommendations are suggested at the outcome of the study. The different waste materials tested are Quarry Dust, Rice Husk Ash, Crumb Rubber, Sewage Sludge Ash , Quarry dust Ash, Class F-Fly ash , Pumice Fine Aggregate.

A.M. Md Nazar , N.F. Abasa , M.A. Othuman Mydin [2] A revenue study of the conducted as a result of investigations into a use of Quarry dust as a recycled materials and additives of concrete mixes for the use in construction projects. The study had been provided the assurance that of concrete produced had the correct mechanical strength of concrete. Concrete mixes containing Quarry dust were prepared, and their basic strength characteristics such as the compressive strength, flexural strength, ultra pulse velocity and dynamic modulus elasticity were tested. Four concrete mixes, i.e. a control mix, and a 10%, 20%, and 30% mix of Quarry dust as a cement replacement for the concrete were prepared with a DOE mix design by calculating the weight of cement, sand and aggregate. As a result, when the percentage of Quarry dust in the concrete increased, the strength is decreased. Overall, a high correlation was the observed between density of concrete and strength of the concrete containing Quarry dust. The best percentage of mix volume for Quarry dust is 10 %, because it has a tendency to absorb water and its strength is long-time. A good relationship was observed between the density and strength of concrete mixes were containing Quarry dust.

Seyyedeh Fatemeh Seyyedalipour, Daryosh Yousefi Kebria; [3] Nowadays, increasing the amount of wastes is concerning reality and environmental aspects has become a major priority. The Following this worry, the purpose of that study was to investigate the use of paper industry wastes in the various concrete mixes containing various contents of the waste is to reduce the environmental effects of these waste disposal. The concrete mixes prepared with the adequate amount of these wastes, cement, aggregate and water compared in terms of some tests especially strength with the conventional concrete.

Abdullah shahbaz khan, Ram panth, Gagan Krishna R.R [4] The use of paper-mill pulp in concrete formulations were investigated as alternative to the landfill disposal. The cement has been replaced by waste paper sludge accordingly in the range of 10%, 20%, 30% by weight for M20 and M30 mix. By using adequate amount of the waste paper pulp and the water, concrete mixtures has been produced and compared in terms of slump and strength with the conventional concrete. Over 300 million of tones industrial wastes are the being produced per annum by chemical and agricultural process in India. These materials pose problems of disposal and health hazards. This Quarry dust consumes a large percentage of local land fill space for each and every year. Worse yet, some of the wastes are land spread on crop land as a disposal technique raising the concerns about a trace contaminants of building up in soil or running off into area lakes and streams.. Waste paper sludge obtained from a paper factory in Trondheim, Norway, It has bulk density 460kg/m3 specific gravity 2.6, ash content of 94% and a pH value of 11.4. The material is essentially composed of amorphous silicates and aluminates, mainly gelignite (2CaO.Al2O3SiO2) and melilite (8CaO3Al2O3MgO5SiO2); which are responsible for a pozzolanic reaction.

Mr..R.Balamurugan, Mr.R.karthickraja [5] Concrete is strength and tough material but it is a porous material also which interacts with in the surroundings environment. To make a good quality paper limited number of times recycled Paper fibers can be used which produces a large amount of solid waste. The innovative use of hypo sludge in concrete formulations as a supplementary cementations material was tested as an alternative to traditional concrete. These tests were carried out to evaluate the mechanical properties like compressive strength up to 28 days.

Concluded that the compressive increased up to the 10% addition of hypo sludge and further increased in hypo sludge reduces the strengths gradually. This research work is concerned with experimental investigation on strength of concrete and optimum percentage of the partial replacement by replacing cement via 5%, 10%, 15%, and 20% of Hypo Sludge. Keeping all this view, the aim of investigation is the behavior of concrete while adding of waste with different proportions of Hypo sludge in concrete by using tests like compression strength and split strength.

Bashar S. Mohammed, Ong Chuan Fang [6] The use of paper-mill residuals in concrete formulations was investigated as an alternative to landfill disposal. The mechanical and durability properties of concrete containing paper-mill residuals collected from a wastewater treatment-plant were evaluated. Class F fly ash was used as a replacement for Portland cement (PC) when incorporated into concrete mixtures containing paper-mill residuals and the resulting products were compared to normal concrete. Compressive, splitting tensile, flexural strength and drying shrinkage tests were carried out to evaluate the mechanical properties for up to 90 days. Rapid chloride-permeability tests and initial surface-absorption tests were carried out at 28 days to determine the durability properties. Concrete containing paper-mill residuals showed improvement in the durability test results when PC was replaced with class F fly ash.

Sumit A Balwaik , S P Raut [7] The use of paper-mill pulp in concrete formulations was investigated as an alternative to landfill disposal. The cement has been replaced by waste paper sludge accordingly in the range of 5% to 20% by weight for M-20 and M-30 mix. By using adequate amount of the waste paper pulp and water, concrete mixtures were produced and compared in terms of slump and strength with the conventional concrete. The slump increased up to 5% replacement of cement, above 5% it decreased. There is an increase in water absorption of concrete mixes as the content of paper pulp increased. The most suitable mix proportion from study is 5-10%.

III. SIGNIFICANCE OF THE PROJECT

Lot of research works are carried out on fines passing through 150 micron sieves used for replacing fine aggregates. Most of the construction specifications today limit the proportion of materials finer than 150 micron to 5% to 10% or less. The permissible limit of fines passing the 150 micron sieve is 20 % in the case of manufactured sand as per IS 383-1970. Detailed research works needs to be

done in using quarry dust of fines less than 150 mm micron to replace a portion of cement.

Objectives of project work could be summarized as to

- Compare the properties of conventional concrete mix M30 with the properties of concrete with quarry dust partially replacing cement. Find the optimum percentage of quarry dust that can be replaced for cement.
- Study the effect of strength properties with the optimum % cement replacement with another fine aggregate namely waster water sludge.

Scope of project work was to

- Make use of the locally available granite quarry dust as partial replacement of cement.
- The materials used in the manufacture of concrete are Cement, Fine aggregate, Coarse aggregate, Robosand and Water.

IV. SELECTION OF MATERIALS

In developing the concrete mix for construction, it is important to select proper, ingredients, evaluate their properties and understand the interaction among different materials for optimum usage. the ingredients used for this investigation were cement, fine aggregate, coarse aggregate, water, quarry dust and waste water sludge.

Cement is a fine, grey powder. It is mixed with water and materials such as sand, pozzolanas to make mortar and concrete. The cement and water forms a paste that binds the other materials together. In this work cement is used in the ordinary Portland cement of 53 grade conforming to IS: 12269-1987.The river sand and is being used in combination as fine aggregate conforming to zone-II according to IS: 383-1970 was used. The sand was sieved through a set of sieves 4.75 mm, 2.36 mm, 1.18 mm, 600µ, 300µ and 150µ. The river sand is wash and screen, to eliminate deleterious materials and over size particles. The coarse aggregates used in from a local crushing unit having 20 mm nominal size. The coarse aggregates confirming to IS: 383 are being used in 20 mm aggregate. The coarse aggregates produced from quarry was sieved through all the sieves (i.e ., 20 mm, 16mm, 12.5 mm, 10 mm and 4.75mm).The physical property evaluation and gradation of coarse aggregate were carried out and the test's confirming to IS: 2386 (part 1) – 1963. The water is used for mixing concrete should be portable drinking water having PH values lies between 6 to 8 and the water is free from organic matter and the solid contents should be within the permissible limits as per as per IS:456-2000 and conforming to 3025-1964.

Replacement Materials Quarry dust & Waste Water Sludge

The Quarry dust is collected from the paper mill in Bhimavaram. Quarry dust is a waste material then the cement replacement in some percentages. The sludge was collected from the sludge drying beds and land filling areas by random sampling method.

The waste water sludge is collected from the waste water treatment plant in Autonagar, Vijayawada. The sludge was collected from the sludge drying beds and land filling areas by random sampling method. The sewage sludge is the cement replaces in some percentages.

V. RESULTS AND DISCUSSIONS

The strength properties are calculating by replacing cement with Quarry dust and sewage sludge in different percentages are 5%, 10%, 15% in concrete. The detailed tabulations and graphs are presented as follows.

- **Workability Of Concrete**

The workability of concrete is observed by the Slump Cone method. The range of slump was selected as 25-50mm.

Table 5.1: Slump for M30 and M40 of Quarry dust and sewage sludge

Mix	Slump (mm)	
	M30	*M40*
Control Mix	35	38
PST 1	32	35
PST 2	28	30
PST 3	25	27
SST 1	30	32
SST 2	27	28
SST 3	25	26

- **Compressive strength results:**

The test results are presented here for the compressive strength of 7 days and 28 days of testing. The water cured specimens are eliminated from moisture content by surface drying before testing in Compression Testing Machine.

Table 5. 2: Compressive strength of concrete with Quarry dust

Mix	Compressive Strength (N/mm²)			
	M30 Grade		*M40 Grade*	
	7 Days	28 Days	7 Days	28 Days
Control Mix(C.M)	26.5	39.4	33.7	49.7
PST 1(5%)	**34.216**	**42.36**	**39.31**	**54.31**
PST 2(10%)	31.40	39.40	32.13	47.28
PST 3(15%)	26.81	32.14	30.12	43.13

Table5. 3: Compressive strength of concrete with Sewage sludge

Mix	Compressive Strength (N/mm2)			
	M30 Grade		*M40 Grade*	
	7 Days	28 Days	7 Days	28 Days
Control Mix(C.M)	26.5	39.4	33.7	49.7
SST 1(5%)	32.15	41.926	37.2	52.13
SST 2(10%)	27.07	39.55	30.35	45.28
SST 3(15%)	13.18	35.106	28.21	40.31

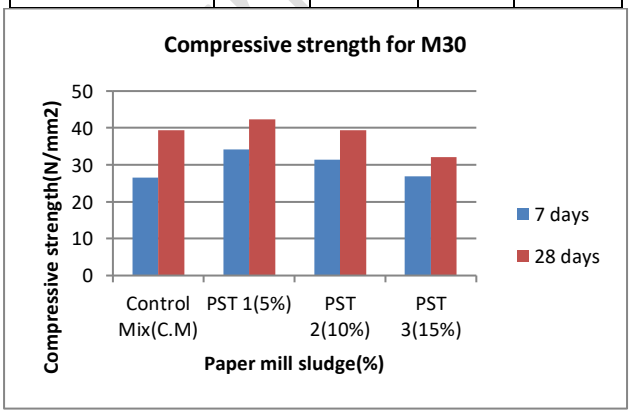

Fig 5.1 Variation of Compressive strength of concrete with Quarry dust of M30grade for 7&28 days

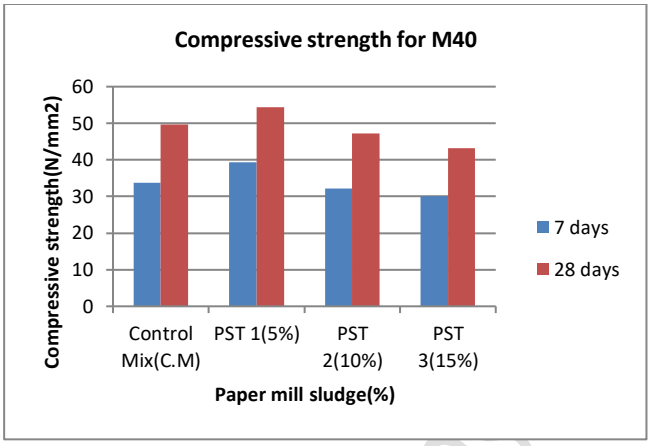

Fig 5. 2 Variation of Compressive strength of concrete with Quarry dust of M40grade for 7&28 days

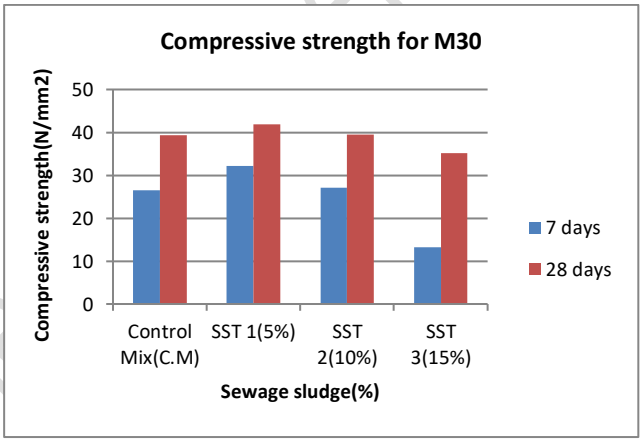

Fig 5.3 Variation of Compressive strength of concrete with Sewage sludge of M30grade for 7&28 days

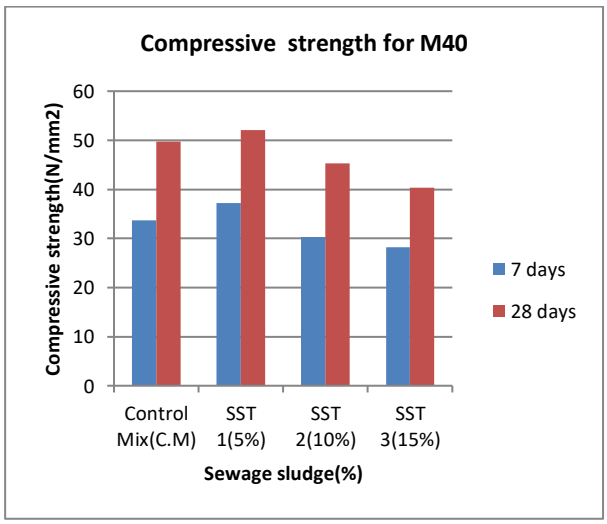

Fig 5. 4 Variation of compressive strength of concrete with Sewage sludge of M40grade for 7&28 days

VI. CONCLUSIONS

- Quarry dust and waste water sludge wastes are suitable for the use in small amount of concrete mixes as a replacement for the cement, but it is not appropriate for large quantities.
- The productive use of a waste material represents the a way of solving some problems of the solid waste management.
- The workability is decreased because of increase in Quarry dust and waste water sludge.
- The paper industry waste can be innovative supplementary cementitious construction material but judicious decisions are to be taken by engineers.
- Compressive strength is increased up to 5% replacement of cement with Quarry dust and waste water sludge for M30 and M40 mix..
- The maximum optimum level of the replacement of Quarry dust and waste water sludge with cement is 10%.
- Use of a waste paper sludge in the concrete can save the pulp and paper industry disposal costs and produce a 'greener' concrete for construction.

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