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GAINFULL UTILIZATION OF HYPO SLUDGE IN CONSTRUCTION INDUSTRY- A REVIEW

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Abstract: ***Paper industry is one of the growing fields in industrial sector all over the world. Waste generation from paper mills is an unavoidable issue. Solid waste known as hypo-sludge produced during the process of coating paper is an issue to be focused on. It is a material generally white in color, found as effluent of Hypo plant. It needs to be disposed without causing health and environmental hazards. But hypo-sludge issue is not pronounced so prominently along with waste-water crisis of paper industry. Hypo-sludge needs large land space to be disposed, create problems for cultivable lands and also fills up the bed of the rivers if discharged into rivers directly. Hence, hypo sludge, solid waste of paper industry, needs to be well managed. In this paper, ill-effects of hypo sludge as waste material and the possible ways of gain full utilization of hypo sludge in construction industry has been discussed.***

Keywords: **hypo sludge, cement concrete, mortar, utilization construction industry**

INTRODUCTION

The present day world is witnessing the construction of very challenging and aesthetic structures. Hypo Sludge is economical. The cost of Hypo Sludge is generally less than Ordinary Portland Cement depending on transportation. Significant quantities may be substituted for Ordinary Portland Cement in concrete mixtures and yet increase the long term strength and durability. Thus, the use of Hypo Sludge may impart considerable benefits to the concrete mixture over a plain concrete for less cost. There are the main reasons to use Hypo Sludge in concrete: Reducing the cost of concrete production, Improve the quality of fresh and hardened concrete, Extend the concrete lifetime. Hypo sludge consumes a large percentage of local landfill space for each and every year. Worse yet, some of the wastes are land spread on cropland as a disposal technique, raising concerns about trace contaminants building up in soil or running off into area lakes and streams. Some companies burn their sludge in incinerators, contributing to our serious air pollution problems. To reduce disposal and pollution problems emanating from these industrial wastes, it is most essential to develop profitable building materials from them.

REVIEW OF LITERATURE

This literature review deals with the experimental work carried out by researchers in developing the gain full utilization of hypo sludge in construction industry.

Pera J et.al (1998) found that despite a smaller kaolinite content, the burnt paper sludge exhibits more pozzolanic activity than commercially available metakaolin, especially at early ages. **(14)**

Ishimoto H. et.al (2000) reported that efforts to actively recycle paper have caused the amount of papermaking sludge to increase steadily each year, with current estimates of over 3,000,000 tons discharged annually throughout Japan. The Nippon Telegraph and Telephone Corporation has achieved success in converting ash derived from incinerated papermaking sludge into a new porous material with high caution exchange capacity by reacting this ash in an alkali solution. The application of the new material could be to environmental conservation, such as improvement of water quality and admixture in concrete. **(9)**

Albinas Gailius et.al (2003) investigated workability and strength of concrete made with different proportions of waste paper sludge ash (WSA) and ground granulated blast furnace slag (GGBS) as binder, at two w/b rations: 0.5 and 0.4. The rate of development of strength of concrete made with WSA-GGBS binder achieved 1-day strength of about 2-6 % of its 28-day strength, while the 7-day strength was in the range 53-64 % of the 28-day strength. **(1)**

J. Bai et.al (2003) Compressive strength and hydration characteristics of wastepaper sludge ash–ground granulated blast furnace slag (WSA–GGBS) blended pastes were investigated at water to binder (w/b) ratio of 0.5. The optimum blend composition to give maximum strength was 50% WSA–50% GGBS, and after 90 days, pastes manufactured from this blend exhibit compressive strengths close to 50% of those from an equivalent Portland cement paste. **(4)**

T.R. Naik et.al (2003) Researchers propose to incorporate the fibrous residuals from mills into ready-mixed concrete to improve the strength, durability, and life span of concrete structures exposed to weather. The life span of high-performance concrete coined by researchers as "cellucrete" has the potential to rise from the normal 25 to 35 years to up to 100 years. **(12, 13)**

Ritzawaty binti Mohamad Shukeri et.al (2008) reported on the results of an investigation of utilization of wastepaper as additional materials in concrete mixes containing of the waste, which are control mix, 5%, 10%, 15% as an additional materials to concrete were prepared with ratios of 1:2:3 by weight of cement, sand, and aggregate respectively. With the addition of 25% wastepaper in proportion to the amount of cement, the mechanical strength decreased significantly. Overall, a high correlation was observed between density and strength of concrete containing paper. In general, each group of concrete mixes containing wastepaper, compressive strength, tensile strength, and flexural strength of concrete decreased with the increase of the amount of wastepaper. Concrete mix with 5% wastepaper showed higher tensile strength and flexural strength than control mix. Good relationship was observed in density and compressive, tensile, and flexural strength of concrete mixes containing wastepaper. **(17)**

Sumit A Balwaik et.al (2010) The use of paper-mill pulp in concrete formulations was investigated as an alternative to landfill disposal. Use of waste paper pulp in concrete can save the pulp and paper industry disposal costs and produce a 'greener' concrete for construction. The cement was replaced by waste paper sludge in the range of 5% to 20% by weight for M-20 and M-30 mix. The slump increased up to 5% replacement of cement. The compressive, splitting tensile and flexural strength increased up to 10% addition of waste paper pulp. There was an increase in water absorption of the concrete mixes as the content of the paper pulp increased. This phenomenon is expected since more amount of paper pulp will

involve in the hydration process. Therefore, additional amount of water was required for cement hydration which is the common solution to this kind of problem. However, higher water content decreases the strength of concrete. **(5)**

R. Srinivasan et.al (2010) carried out experimental investigation on strength of concrete by replacing cement via 10%, 20%, 30%, 40%, 50%, 60% and 70% of Hypo Sludge. Compressive strength of the concrete increased when the percentage of replacement was increased up to 40%. Further replacement of cement reduced the compressive strength. Replacement of cement with hypo sludge material gave maximum compressive strength at 30% replacement. **(18)**

Ahmad Ruslan Mohd Ridzuan et.al (2011) studied the strength development of Controlled low strength material (CLSM) using waste paper sludge ash (WPSA) in CLSM mixtures without adding Portland cement. Series of four compounds which were the CLSM containing 5%, 10%, 20% and 30% of waste paper sludge ash (WPSA) as a substitute for Portland cement. The WPSA that could act as a cement replacement for Portland cement for the production of CLSM and maintain the natural aggregates by using waste materials and industrial recycling. **(3)**

Gabriele Fava et.al (2011) On the basis of the data collected, it was concluded that paper mill sludge ash (PA), if used to replace up to 10% of the portland cement, shows a positive effect on the mechanical performance of mortars. On the other hand, because of its high fineness and consequently high water absorption, it required a higher amount of water. It was concluded that the use of PA should not be higher than 10% by weight of the cement replaced, unless mortar mixtures are judiciously proportioned. **(8)**

Bashar S. Mohammed et.al (2011) concluded that higher residual content and fly ash content in the concrete mixtures would increase the water demand of concrete for a given slump, thus, decreasing the workability of fresh concrete. The workability of concrete containing paper-mill residuals and fly ash content could be adjusted and improved by using proper amount of superplasticizer. The Class F fly ash decreased the workability of concrete due to its high percentage of fly ash replacement in mixture proportion and high carbon content which increases the water demand. **(6)**

According to **Jan-Erik Nylunda et.al (2012)** "Sustainability" is used as a catchword, with different meanings depending on the actor. They examined how the term "sustainability" is used by the Brazilian pulp maker Veracel Cellulose, and other major cellulose pulp producers in South America, and the cleavage between the companies and the local communities in their understanding of the term sustainability. To ensure long-term sustainability of company operations, sustainable business development of the pulp and paper industry should include local livelihood perspectives to a greater extent than at present. **(10)**

Mikael Ottossona et.al (2013) Based on a study of policy-induced changes in the Swedish pulp and paper industry, this paper followed a process of socio-technical regime destabilisation. Results from the study showed that in industries where established firms have significant power, processes of endogenous renewal were more likely to destabilise established regimes than processes based on niche solutions. Further, the study showed how policy measures aimed to destabilise the current regime may result in different responses, owing to the different capabilities of individual firms. The analysis suggested that heterogeneous capabilities within established industries provide possibilities for policy makers to initiate change. **(11)**

Dharani N et.al (2013) Hypo sludge was used as a replacement to cement. Replacement percentages used during the study were 10%, 20%, 30%, 40%, 50%. For each replacement percentage of cement with hypo sludge, 0.2%, 0.3%, 0.4% of Recron 3s fibres were added and specimens were cast to determine the mechanical properties. The optimal replacement percentage of cement with hypo sludge was found to be 30% when Recron 3s fibers are not added. On addition of Recron 3s fiber with cement matrix, the compressive strength and split tensile strength decreased with increase in fiber content, however the flexural strength increases with increase in fiber content. When hypo sludge and Recron 3s fiber added, the optimum dosage of Hypo sludge was 20% and optimum Fiber content was 0.4%. **(7)**

Sajad Ahmad et.al (2013) replaced as 5%, 10%, 15% and 20% of cement in concrete for M-25 mix by Waste Paper Sludge Ash and tested. Use of waste paper sludge ash in concrete will preserve natural resources that are used for cement manufacture and thus make concrete construction industry sustainable and waste paper sludge can be used as fuel before using its ash in concrete for partial cement replacement and also the disposal problem for paper industries for this waste material is fully solved. **(2)**

Shah Rushabh A et.al (2013) analysed the performance of cement mortar by replacing the cement with hypo sludge. The evaluation of Hypo Sludge for use as a supplementary cementitious material (SCM), i.e., as a pozzalona, begins with the mortar testing. Mortar is similar to concrete in that it contains cement, water and aggregate, except that in mortar graded fine aggregate is the only aggregate present. With the control mortar, i.e.10 %, 30% and 50% of the ordinary Portland cement (OPC) confirming IS 269IV is replaced with Hypo Sludge, The data from the Hypo Sludge mortar is compared with data from a "control" mortar without Hypo Sludge. They concluded that adequate strength developments were not found in mortars made of the mixed cement and Hypo Sludge as cement replacement for 1:3 mortars at 28 days. So it can be used in non-structural elements in the low range compressive strength where strength is not required. **(19)**

Solanki Jayraj et.al (2013) investigated the strength of concrete and optimum percentage of the partial replacement by preparing a mix M20 grade was designed as per Indian Standard method and the same was used to prepare the test samples. The design mix proportion used were Conventional Concrete, 10%, 20%, 30%, 40% replacement of cement by industrial waste hypo sludge. In the test performed, the optimum compressive stress obtained by utilizing paper waste was at 30% replacement. **(20)**

Pitroda J R et.al (2013) checked the durability of concrete by replacing cement with hypo sludge. The water absorption and sorptivity of Paper Industry Waste (Hypo Sludge) concrete shows lower water absorption and sorptivity at 10% replacement with Paper Industry Waste (Hypo Sludge) for M25 and M40 grade concrete. **(15)**

Solanki Jayraj et.al (2013) studied the effect of hypo sludge on flexural strength of concrete. The results of study undertaken to investigate the feasibility of using hypo sludge as cement in concrete. The effects of replacing cement by hypo sludge on the flexural strength of beams (500 mm*100 mm*100 mm) are evaluated. Two test groups were constituted with the replacement percentages of 0%, 10%, 20%and 30%.The results showed the effect of hypo sludge on concrete beams has a considerable amount of increase of the flexural strength characteristics. To investigate the utilization of Hypo Sludge as Supplementary Cementitious Materials (SCM) and influence of hypo sludge on the Strength on concretes made with different Cement replacement levels. Flexural strength of the concrete increases when the

10% replacement of cement by hypo sludge is increased up to 8.91%. Environmental effects from wastes and residual amount of cement manufacturing can be reduced. **(21)**

Pitroda J R et.al (2013) evaluated the Modulus of Elasticity of Concrete with Partial Replacement of Cement by Paper Industry Waste (Hypo Sludge). The cement has been replaced by hypo sludge in the range of 0%, 10%, 20%, 30% and 40% by volume for M-25 and M-40 mix. For M40 grade 10% replacement with hypo sludge gave modulus of elasticity same as M40 grade traditional concrete. This research concludes that hypo sludge can be used as construction material where less strength is required. **(16)**

Balamurugan R et.al (2014) replaced the cement content with 0%, 5%, 10%, 15% and 20% hypo sludge and found the compressive strength after 28 days. Up to 10% of hypo sludge concrete, the compression strength has been increased, so up to 10% cement has been replaced by hypo sludge. By replacement of hypo sludge the cost of construction should be minimized. By effective utilization of waste product into concrete also reduce the environmental effects. If silica is added the strength will be considerably increased because hypo sludge has less quantity of silica as compared to cement. This type of concrete will be used for road works effectively with less consumption of cement. **(3)**

CONCLUSIONS

The following conclusions were made from the experimental work carried out by researchers in developing the gain full utilization of hypo sludge in construction industry.

1. Use of hypo sludge in concrete can save the disposal costs and produces a green concrete for construction.
2. Modulus of elasticity decreases with % replacement of hypo sludge.
3. Compressive strength of the concrete measured after 28 days increases when the 20 % hypo sludge is replaced with cement.
4. Hypo sludge can be used in non-structural elements in the low range compressive strength where strength is not required.
5. Hypo Sludge can be used to prepared low cost temporary structure.
6. Adequate strength developments were not found in mortars made of the mixed cement and
   Hypo Sludge as cement replacement for 1:3 mortars at 28 days.
7. Hypo sludge can be used as Construction Material where less strength is required.
8. Environmental effects from wastes and residual amount of cement manufacturing can be reduced through this low cost concrete.
9. The Paper Industry Waste (Hypo Sludge) can be innovative supplementary cementitious Construction Material but judicious decisions are to be taken by engineers.

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