Structural Light Weight Concrete: A Review

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***Abstract*: Waste materials have been used to produce sustainable light weight concrete. Due to rapid industrialization, disposal of large amount of waste material such as fly ash, silica fume, recycled plastic and EPS cause environmental issues due to pollution. Other materials like coconut shells, Expended PolyStyrene beads(EPS),pumice stone, recycled plastic, periwinkle shells, waste glass particle, sawdust ,thermocol ,egg shell powder,fly ash, silica fume,clay etc have also been used to make Structural Light Weight Concrete. Considering the factors such as being eco-friendly, sustainable and considerably reducing the cost and weight of concrete various waste materials are used in concrete. Coarse aggregate,fine aggregate or cement has been partially replaced by these waste materials to produce structural light weight and low cost concrete. Coarse aggregate has been partially replaced by waste materials such as coconut shells, Expended PolyStyrene beads(EPS),pumice stone,recycled plastic, periwinkle shells etc. Fine aggregate has been partially replaced by waste materials such as waste glass particle, sawdust ,thermocol ,egg shell powder etc. Cement has been partially replaced by fly ash, silica fume,clay,egg shell powder respectively. All the materials mentioned above can be used in concrete as an alternate material to reduce both weight and cost of concrete. From experiments it has been observed that when the materials mentioned above are used in concrete as partial replacement of basic ingredients compressive strength and split tensile strength decreases with increasing percentage of these materials but optimum percentage of these materials gives better strength as same as conventional concrete. Use of above materials in concrete increase strength or reduce cost or both . Thus the problems related to environmental issues caused by above materials can be reduced and there by produce structural light weight concrete in a constructive manner by replacing them in concrete.**

***Keywords*: Coarse aggregate, Coconut Shell, Compressive Strength, Structural Concrete,split tensile strength,waste recycled plastic,Fly ash,silica Fume,Waste glass powder,Expended polystyrene beads.**

I. Introduction

Concrete is one of the oldest and the mostly used construction material in all over the world .The consumption of concrete in India is increasing rapidly per year .In year 2009 the concrete consumption was 193 million metric tons and now in year 2017 is 398 millions metric tons. The amount of waste materials may account to millions of tons annually. Weight of the structure is one of the limitations for construction of tall buildings specially in earthquake prone areas. If structures could be made lighter, cost of the foundation can also be lowered down.When structural light weight concrete used in the construction of structural elements ,the benefits are reduced overall cost ,better heat and sound insulation properties and better resistance to fire,although it has lower compressive ,split tensile and flexural strength of concrete but by using optimum percentage of these materials in concrete ,the mechanical properties of concrete can be raised to equivalent or considerably more than target mean strength.

Coconut is grown in more than 96 countries. India is the third largest, having cultivation on an area of about 1.67 million hectares for coconut production. Annual production is about 7798 million nuts with an average of 4342 nuts per hectare. However, it is also the main contributor to the nation's pollution problem as a solid waste in the form of shells, which involves an annual production of approximately 4.6 million tonnes. It also presents serious disposal problems for local environment, is an abundantly available agricultural waste from local coconut industries.India produces about 20% of the coconut produced in the world. Within India, Kerala produces 45% of it. Disposal of coconut shells poses environmental issues as it is not easily degradable.so, Aggregates made by crushing coconut shells can be effectively used in concrete by partially replacing coarse aggregate up to a certain amount.

Sangeetha et al.[2016]

Fig 1: Coconut shell and crushed Coconut shell (Source:http://goo.gl/images/pGSKCo,http://goo.gl/images/sBiEmA)

Expended polystyrene is a rigid cellular plastic that is made from expendable polystyrene that contains an expansion agent.It is most commonly used for packaging,food stuffs,medical supplies,electrical consume good and insulation panels for buildings.In 1839 ,a German apothecary Eduard Simon discovered polystyrene.

Expended polystyrene or EPS is strong and light weight material ,making it an excellence construction material and insulator in paneling system and also containing 98% of its volume with still air and offers excellent insulation properties.In past some EPS contains CFCs which were considered harmful to environment and human being.But now by using some eco-friendly methods EPS can be recycled and no longer contains CFCs anf used as partial replacement of coarse aggregate in concrete for making concrete light weight as compared to normal concrete.S.Ramesh Reddy et al .[2017]

Fig 2 :Expended PolyStyrene Foam and :Expended PolyStyrene Beads

(Source:http://goo.gl/images/brFuii,http://goo.gl/images/K5rnCq)

The use of fly ash (FA) in foamed concrete either as a cement or as a fine aggregate replacement can lead to enhancement in properties by reducing heat of hydration and giving the material good thermal insulation. Meanwhile, adding silica fume (SF) individually improves the early-age strength significantly and increases the bonding of the concrete mixtures . Therefore, both FA (to replace part of the fine aggregate) and SF (to replace part of the cement) were used in study.

Fig 3:Fly ash and Silica Fume (Source:http://goo.gl/images/veSzZe,http://goo.gl/images/RKYpnx)

Eggshell is usually thrown away as a waste. Eggshells are agricultural throw away objects produced from chick hatcheries, bakeries, fast food restaurants among others which can damage the surroundings and as a result it creates huge problem for the environment because it creates some allergies when kept for a longer time in garbage.The egg shells is a waste material but used as a useful material in concrete.About 1.61 million tones of egg shells are being waste annually so,the waste of egg is used in an engineering application and reduce the environmental issues.egg shell is a Calcium rich poultry waste with chemical composition nearly same as that of limestone.Bandhavya et al.[2017],Dhanalakshmi et, al.[2015]

Fig 4:Egg shell and Crushed Egg shell

(Source:http://goo.gl/images/7K2a8M,http://goo.gl/images/7K2a8M)

Saw dust or wood dust is a by- product or waste product of woodworking operations such as sawing,milling,planing,routing,drilling and sanding.Mill residues from pulp and paper manufacturing,lumber mills and other

industrial wood increasing urban wood residuals as waste material.This saw dust is used in concrete as partial replacement of fine aggregate in concrete.

Fig 5 : Saw Dust(Source:http://goo.gl/images/G58bsJ)

Periwinkle shells are obtained from periwinkle.Periwinkles are marine molluscs with thick spiral shells.Periwinkle shells can be used as partial replacement of coarse aggregate in concrete.Periwinkle shells have been used by the people of the coastal states.

Fig 6:Periwinkle shells(Source:http://goo.gl/images/G58bsJ)

Clay is fine - grained natural rock or soil material that combines one or more clay minerals with traces of metal oxides and organic matter.Clay are plastic due to their water content and become hard ,brittle and non-plastic upon drying or firing.Silts which are fine grained soils that do not include clay minerals,tends to have larger particle sizes than clay.Due to its fineness it can be used as partial replacement cement in concrete.

Fig 7:Clay(Source:http://goo.gl/images/VJoZok)

More than 15000 tonnes of plastic waste are generated in India everyday.Only 9000 tonnes is treated and remaining 6000 tonnes is not treated and dumped at sites,As we all know plastic is non- degradable even after a long period of time.So,this waste plastic is collected from plastic manufacturing industry and plastic bags used for domestic purpose ,waste plastic bottles etc and used as partial replacement of coarse and fine aggregate in concrete.This is the best way for the decomposition of waste plastic.

Fig 8:Waste Plastic and Crushed Plastic

(Source:http://goo.gl/images/xq4JSU,http://goo.gl/images/xq4JSU'a)

Million tons of waste glass is being generated annually all over the world.The waste glass obtained from grinding of crushed containers and after demolition of building produce waste glass and being non-biodegradable in nature.So,it can be used as partial replacement of cement in concrete and solve problems created for decomposition of waste glass.

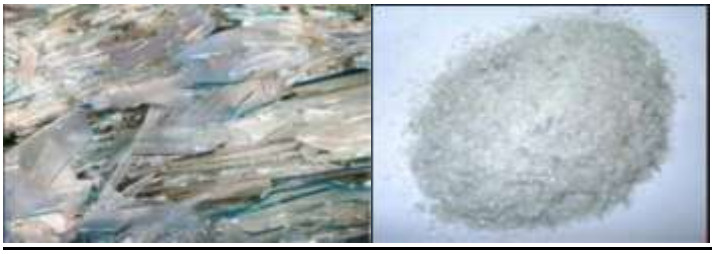

Fig 9:Waste Glass and Waste Glass Powder (source:http://goo.gl/images/8Hz4P8,http://goo.gl/images/M6TfMS)

II. Structural light weight concrete by partial replacement of coarse aggregate

Ashik Asokan et al. [2016] investigated polystyrene beads as partial replacement of coarse aggregate for M25 concrete mix in different percentages such as 5%, 10%, 15%and 20% respectively.From code the mix proportion for M25 grade of concrete was obtained as 1: 1.75: 1.92 with water cement ratio of 0.45.From conducted experiments it was observed that the workability increases with increase in polystyrene beads content but simultaneously strength decreases with increasing polystyrene beads.

Brajesh and Ravi [2015]studied the use of recycled plastics as partial replacement of natural coarse aggregate in cement concrete mix. Complete replacement of natural coarse aggregate by recycle plastic aggregate was not suitable, so it was replaced in different percentages as 0%, 10%, 20%,30% and 40% for prepared M20 grade of concrete with water cement ratio as 0.50.After 10% ,20%,30% and 40% replacement of recycle plastic aggregate the compressive strength was achieved up to 79.54% , 85.69%, 76.49% 63.22% and dry density was 30.75% ,32.04%, 32.47% and 33.12% when compared with conventional concrete.The recycled plastic aggregate has low thermal conductivity so,it can be used for thermal insulation work of buildings.

Daniel [2013] studied the mix ratio of 1:2:4 with a water cement ratio of 0.6 used as control specimen and coconut shells were used in different percentage such as 20%, 30% 40%, and 50% and 100% as partial replacement of coarse aggregate.The compressive strength of concrete at 28 days after 20%, 30%, 40% and 50% and 100% replacement was 19.7 N/mm^2, 18.68 N/mm^2, 17.57 N/mm^2, 16.65 N/mm^2 and 9.29 N/mm^2 corresponding to 94%, 89%,, 85%,79.6% and 44.4% of the compressive strength of the control concrete.The optimum replacement percentage was 18.5% which gave compressive strength of 20 N/mm^2 ie. equivalent to M 20 grade concrete and can be used in reinforced concrete construction. At 0% replacement the maximum density 2418 kg/m^3 was attained and minimum density 1871 kg/m^3 was attained at 100% replacement.

Dewanshu and Kalurkar revealed that M 20 grade of concrete was produced by 0%, 2.5%, 5%, 7.5%, 10%replacing the natural coarse aggregate by coconut shells. At 0% replacement the maximum compressive strength of 20.27 N/mm^2 was achieved and at 10% replacement concrete attained 18.91 N/mm^2 strength and at 100% replacement the minimum strength of 18.91 N/mm^2 was attained .From experimental results it was observed that by increase percentage replacement of coconut shell considerably reduced compressive strength of concrete and simultaneously increased workability of concrete.

Olanipekun et al. [2006]investigated the comparative cost analysis and strength characteristics of concrete produced by using crushed,granular Coconut Shell(CS) or Palm Kernel Shells(PKS) as partial replacement of coarse aggregate in different percentage as 0%,25%,50%,75% and 100%. Two nominal mix ratio (1:1:2 and 1:2:4) were prepared with water cement ratio of 0.75 and 0.50 and slump obtained was 62 mm for mix proportion of 1:1:2 and 37 mm for mix proportion of 1:2:4 respectively.At 0% replacement of CS or PKS in concrete , the density of concrete at 28 days was in between 2450 - 2440 kg/m^3 and at 75% and 100% replacement levels the density of concrete decreases from 1900 - 1760 kg/m^3.

HabiburRahman et al.[2014**]** investigate strength characteristics such as compressive strength,,modulus of rupture,modulus of elasticity,splitting tensile strength,density and also done cost analysis of concrete produce using the gradation of Oil Palm Shells(OPS) 0–50% on conventional coarse aggregate with the mix proportions 1:1.65:2.45, 1:2.5:3.3,and 1:3.3:4.2 by the weight of ordinary Portland cement , river sand , crushed stone , and OPS as a substitution for coarse aggregate. For the defined mix proportions the corresponding w/c ratios were used: 0.45, 0.6, and 0.75, respectively. Concrete compressive strengths , Splitting tensile strength , modulus of elasticity and Flexural strength with the 15% OPS substitution at the age of 28 days was on average2.4 N/mm2. The cost reduction after substitution of 15% OPS as coarse aggregates in concrete for the mix ratios 1:1.65:2.45, 1:2.5:3.3, and 1:3.3:4.2 was 15%, 12%, and 10% respectively.

Jyoti and J.P. Singh[2015] studied the characteristics strength of M25 grade of concrete by replacing the 20% of fly ash with cement and simultaneously by replacing 10%,20% and 30% of coconut shell as coarse aggregate in concrete.The mix prepared was in the proportion of 1:1.48:2.99 with water cement ratio of 0.44. After 10% and 20 % replacement of coconut shell by coarse aggregate the permeable voids were 30 percent and 88 percent higher than control concrete.From various experiments it was

observed that by increase in percentage Replacement of coconut shell reduces compressive, tensile and Flexural Strength of concrete, decreases densities of concrete but increases workability of concrete.The strength of concrete decreases with cement replaced by 20% fly ash along with 10%,20%,30% replacement of coconut shell but more as compared to concrete with only 0%,20%,30% replacement of coconut shell means without using fly ash.

Lakshmi Kumar Minapu et al. [2014]produced light weight M30 grade of concrete by using the light weight aggregate pumice stone as a partial replacement to coarse aggregate and mineral admixture materials like Fly Ash and Silica Fume.The concrete was prepared with 5% flyash + 5% silica fume and 10%,20%,30%,40% and 50% replacement of coarse aggregate by pumice stone .It was noticed that the optimum percentage of replacement of coarse aggregate by pumice stone was 20%. The density and compressive strength of concrete was found to decrease with the increase in percentage replacement of natural aggregate by pumice aggregate. The compressive, split-tensile and flexural strengths of concrete were increased by using additional mineral admixtures.

Anjali S. Kattire et al. investigated M 20 grade of concrete was produced by replacing by coconut shell as coarse aggregate in varying percentage such as 0%, 10%, 15%, 20%.The maximum compressive strength at 0% replacement was 31.75 N/mm^2 while the minimum strength after 20% replacement was 9.75 N/mm^2 which was less than 20 N/mm^2. The percentage replacement of coconut shell increases considerably reduces the compressive strength and split tensile strength of concrete. The use of coconut shell as partial replacement of coarse aggregate provides cost effective and eco-friendly concrete for construction.

Neeraj Deshmukh et al.concluded that the nominal mix M20 grade of concrete was prepared with different combination of natural material and coconut shell was replaced by coarse aggregate in proportion of 0%, 20%, 40%, 50% with water cement ratio constant at 0.5. From experiment it was observed that due to coconut shell the water absorption is more as compare to conventional aggregate was around 9.6% respectively.The coconut shell concrete has low workability as compare to conventional concrete. The compressive strength of concrete at 28 days was found to be 29.93N/mm^2 , 28.04N/mm^2 ,26.63N/mm^2 and 24.26N/mm^2 after 0%, 20%, 40% and 50% replacement of coconut shell.The optimum percentage of replacement as 20%.The cost reduces as compared to conventional concrete at 50% replacement was 11.09%, 40% replacement was 8.87% and at 20% replacement was 4.43%.

Olugbenga Joseph Oyedepo [2016]observed the Standard mix of 1:2:4 with varying percentages of 0%, 10%, 20%, 30%, 40%, 50% and 100% partial replacement of coarse aggregate by Periwinkle Shells (PWS) using water/cement (W/C) ratio of 0.55. With the addition 20% and 30% partial replacement of coarse aggregate with periwinkle shell in 28 days ,the optimum compressive strength value of 16.79 N/mm^2 and 16.71 N/mm^2 obtainedrespectively.After conducting various experiments the slump value ranges between 35 mm to 55 mm which represents true slump and the ACV and AIV of 31.59% and 22.61% obtained are satisfactory.

Kambli and Sandhya R. Mathapati [2014]Studied the three grade of concrete as M20, M35 & M50 grade with different combination of natural material coconut shell content in the proportion 0%, 10%, 20%, 30% and 40% as partial replacement of coarse aggregate in concrete.From experimental results it was noticed that compressive strength after 28 days for M20 ,M35 and M50 grade of concrete with 0% CS Replace was 31.4 Mpa, 57.77 Mpa,59.4 Mpa and with 20% CS Replace it was 30.36 Mpa, 50.51 Mpa, 55.88 Mpa and with 30% CS Replace was 22.96Mpa, 41.47 Mpa, 50.21 Mpa and with 40% CS Replace was 8.73 Mpa , 15 Mpa, 22.07 Mpa.By increasing coconut content in concrete reduced its strength and used for low cost housing because coconut shells reduced cost.

Sangeetha et al.[2016]explained the new material developed in which coarse aggregate was replaced by coconut shell and cement by clay. M 20 (1:1.5:3) grade of concrete was produced by 0%, 10%, 20%, 30% replacement of coarse aggregate by coconut shell and clay with constant water to cement ratio of 0.5.From experimental study after 10% replacement in 28 days were slightly attains strength of the cubes was 26N/mm^2.By increasing the percentage of coconut shells in concrete reduce the strength and density of concrete.From research work it also found that the addition of coconut shell decreases workability and addition of clay either as cement replacement or aggregate replacement increases workability of coconut shell in concrete. Compressive strength and split tensile strength of concrete reduced by increase in percentage replacement by coconut shell and clay.

Kakade and Dhawale [2015] studied the physical and mechanical properties of M20 grade of concretes was produced by adding coconut shells in different percentage (i.e. 25% and 50%) replacement for coarse aggregate.The slump obtained for trial mix was 55mm, which has showed that coconut shell concrete has a medium degree of workability.After 28 days the fresh concrete density and hardened concrete density using coconut shell was found to be in the range of 1975-2110kg/m^3 and 1880-1930kg/m^3.The compressive strength of coconut shell concrete after 28 days was found to be 21.31 Mpa and 14.88Mp for 25% and 50%replacement by coconut shell aggregate.After replacement of coconut shell by coarse aggregate with 25% and 50% the reduction in weight found to be 15% and 25%.

Satish Shinde et al. [2016] revealed that to produce M 20 grade of concrete by 0%, 10%, 15%, 20% replacement of coarse aggregate by coconut shell. The maximum compressive strength of 31.75 N/mm^2 was attained at 28 days 0% replacement, while the minimum strength of 9.75 N/mm^2 at 20% replacement which were less than the target mean strength 20 N/mm^2. The 10% replacement of coconut shell was same 0% replacement then the 10% replacement was suitable for sulphate attack.With increasing the percentage of coconut shell in concrete reduces its strength but 10% replacement was optimum percentage.

Tajamul Magrey et al.[2016]studied the coconut shells used in concrete as partial replacement of coarse aggregates& fine aggregates were replaced by waste glass respectively.Concrete sample of M20 grade mix with 1 : 1.5 : 3 ratio of cement, fine aggregate and coarse aggregate with the W/C 0.45 for all mixes. The slump values for concrete having coconut used as coarse aggregate in between 16 - 40 mm from 10% replacement to 30% replacement and slump value decreased with increase in coconut shell percentage.. Slump value for waste glass concrete was between 55-75 mm .The compressive strength of concrete after 10% and 30 % replacement of coarse aggregate by coconut shells at 28 days was 28.88 MPa and 24.53 MPa respectively.The compressive strength of concrete when fine aggregate was replaced by waste glass after 10%,20%and 30% at 28 days was 38 MPa ,37.33 MPa and 36.8 MPa respectively.

Thomas Tamut et al.investigated the properties of concrete such as compressive strength and tensile strengths which contain Expanded Polystyrene (EPS) beads in different percentages as 5%, 10%, 15%, 20%, 25% and 30%.It was found from experiment that the compressive strength of concrete at 28 days was after replacement of 5%, 10%, 15%, 20%, 25% and 30% EPS based concretes compared to control concrete were 91%, 77 %, 71%, 63%, 56%, and 45%, respectively.The compressive strength of control specimen having 0% EPS at 7 and 28 days was 31.77 MPa and 31.77 MPa.With increasing the amount of polystyrene beads in concrete mixture decreases the tensile strength. Mix with 15% EPS has a relative strength of 80% and that with 30% EPS has a relative strength of 70% of control specimen.

T.Subramani and V.K.Pugal [2015] revealed that the waste plastic was used as partial replacement of natural coarse aggregate for producing M30 grade of structural concrete with w/c ratio of 0.46.The plastic coarse aggregate replaced in 5%,10% and 15% by the weight of the natural coarse aggregate.From conducted experiments it was noticed that more than 20% replacement reduced the compressive and split tensile strength but less than 20% replacement gave retained more or less compressive and split tensile strength when compared to control concrete specimen.

Pramod S. Patil et al.[2014]studied that waste plastic used in concrete as partial replacement of coarse aggregate in concrete at level of 10 %, 20 %, 30 %, 40 % & 50 % by volume of aggregates.From experimental result it was noticed that at 20 % replacement the concrete gave strength with in permissible limit and also considerably reduce the density of concrete.At 10 % replacement of coarse aggregate by waste plastic coarse aggregate, the concrete could be satisfy as per IS codes.

III. Structural light weight concrete by partial replacement of fine aggregate

Elangovan [2015] studied that fly ash can be used as an partially alternative material for fine aggregate in the concrete and made the concrete more economical and eco-friendly concrete as well.A concrete mix was prepared using mix ratio of 1: 1.52: 3.05 with water cement ratio of : 0.5 in concrete.Four type of specimen were prepared given below 1: 1.52: 3.05: 0.5 +20% fly ash + 0.1% thermocol,1: 1.52: 3.05: 0.5 + 40% fly ash + 0.2% thermocol,1: 1.52: 3.05: 0.5 +60% fly ash aggregate + 0.3% thermocol,1: 1.52: 3.05: 0.5 + 80% fly ash + 0.4% thermocol.The compressive strength of control concrete cube specimen at 28 days was 20.88 N/mm^2 and the compressive strength of concrete mix after 28days curing having 60% fly ash and 0.3% thermocol has the highest compressive strength of 25.62 N/mm^2.The cost of concrete cube specimen took Rs.5145.27 per m3. While adding thermocol in cocntrol concrete specimen its cost increased as Rs.5445.27perm3.From experimental results it was concluded that concrete mix having 60% fly ash and 0.3 % thermocol gave better mix and has the highest compressive strength for both 7 days and 28 days test result.

K.Ambiga and P.Meenakshi deals with the production of concrete by partial replacement of sand with a varying proportion such as 10%, 20%, 30% by sawdust.The compressive strength of cube after 28 days with made with 0% ,10% ,20%and 30% sawdust replacement was 20.8N/mm^2, 16.30N/mm^2, 4.82N/mm^2 and 0.57N/mm^2.It was noticed that by increasing the percentage of saw dust it starts decreasing the compressive strength but the optimum percentage of replacing saw dust was 10% because it does not effect the compressive strength of concrete.After 10% sawdust replacement, there is about 10% reduction in weight and 3% reduction in production cost of concrete.

M.S.Kuttimarks and R.Shruthi [2014] studied that crushed or finely ground glass particles replaces fine aggregate and fly ash as replacement of cement.The glass can be replaced in different percentages such as 0%, 15% and 20% respectively.M40 grade of concrete was Prepared using different percentages of glass with Water-Cement ratio of 0.45.It was observed from experiment that the compressive strength increase with 15% of glass aggregate.The compressive strength of concrete with 15% of replacement to river sand by glass and 10% cement by fly ash was 43.33% in 14 days.

Nagaswaram Roopa et al. [2017] investigated the characteristics of M25 grade of concrete in which cement was partially replaced by fly ash in percentage of 35%, 40% and fine aggregate was partially replaced by thermocol 0.2%,0.3% respectively.The compressive strength of normal concrete at 28 days was 33.25 N/mm^2 and it increases 35.5 N/mm^2 due to 35% of fly ash and 0.2% of thermocol replacement and after 40% of fly ash and 0.3% of thermocol replacement gave the compressive strenght of 36.8 N/mm^2.So,it was observed that the compressive strength of concrete increased Compared to the normal mix and partial replacement of 35% fly ash and0.2% Thermocol was optimum.

Olugbenga Joseph Oyedepo et al. [2014]studied the effect of saw dust as partial replacement of fine aggregate in different proportions like 0%, 25%, 50%, 75% and 100% in the mix ratio of 1:2:4. was prepared using water/cement of 0.65. However the values of workability obtained at 0%, 25% and 50% addition of sawdust as partial replacement for sand were 40mm, 9mm and 5mm respectively.From experimental results the compressive strength of concrete at 28 days with 25%, 75% and 100% sawdust

as partial replacement was 14.15 N/mm^2, 12.96 N/mm^2 and 11.93 N/mm^2 respectively .At 25 % by weight the use of sawdust as partial replacement of sand gave the same strength requirement when sawdust was not used.

Sneha N. Kole and Shyam R. Suryawanshi [2017]studied the use of polystyrene with partial replacement of fine aggregate with 0%, 5%, 10%, 15%, 20% and 25% of polystyrene(by volume). Concrete mix design with characteristic compressive strength or 20Mpa was designed without any admixtures with water cement ratio 0.50. From experimental results the partial replacement of fine aggregate with polystyrene reduces the compressive strength and tensile strength of concrete and also noticed that this polystyrene based concrete is best suitable for non-structural elements which do not require high compressive and tensile strength.

Tajamul Magrey et al.[2016]studied the coconut shells used in concrete as partial replacement of coarse aggregates& fine aggregates were replaced by waste glass respectively.Concrete sample of M20 grade mix with 1 : 1.5 : 3 ratio of cement, fine aggregate and coarse aggregate with the W/C 0.45 for all mixes. The slump values for concrete having coconut used as coarse aggregate in between 16 - 40 mm from 10% replacement to 30% replacement and slump value decreased with increase in coconut shell percentage.. Slump value for waste glass concrete was between 55-75 mm .The compressive strength of concrete after 10% and 30 % replacement of coarse aggregate by coconut shells at 28 days was 28.88 MPa and 24.53 MPa respectively.The compressive strength of concrete when fine aggregate was replaced by waste glass after 10%,20%and 30% at 28 days was 38 MPa ,37.33 MPa and 36.8 MPa respectively.

J.Karthick et al.[2014] revealed that M25 grade of concrete was produced by using egg shells powder in different percentages as 10%,20%,30%,40% and 50% as replacement of fine aggregate.From experimental result it was noticed that the compressive strength reduced from 24 Mpa to 9.67 Mpa at 0% and 50% replacement of egg shell powder at 28 days.The split tensile strength reduced at 0% and 50% replacement was 2.36 Mpa to 0.21Mpa.The flexural strength reduced at 0% and 50% replacement was 2.86 Mpa to 0.99 Mpa.20% replacement of egg shell powder was optimum and gave same required strength and also reduced the weight upto 2kg to 2.8kg.

Zainab Z. Ismail and Enas A.Al - Hashmi[2008]studied the properties of concrete when sand was replaced by waste plastic in different percentages such as 0%,10%,15% and 20 % in concrete.From experimental results it was noticed that compressive strength and flexural strength of concrete decreases but workability increases with increasing percentage of waste plastic in concrete.The load deflection - curve of concrete that contain plastic waste showed the arrested of the propagation of the micro cracks by introducing waste plastic that had fabriform shapes.

IV. Structural light weight concrete by partial replacement of cement

Jyoti and J.P. Singh[2015] studied the characteristics strength of M25 grade of concrete by replacing the 20% of fly ash with cement and simultaneously by replacing 10%,20% and 30% of coconut shell as coarse aggregate in concrete.The mix prepared was in the proportion of 1:1.48:2.99 with water cement ratio of 0.44. After 10% and 20 % replacement of coconut shell by coarse aggregate the permeable voids were 30 percent and 88 percent higher than control concrete.From various experiments it was observed that by increase in percentage Replacement of coconut shell reduces compressive, tensile and Flexural Strength of concrete, decreases densities of concrete but increases workability of concrete.The strength of concrete decreases with cement replaced by 20% fly ash along with 10%,20%,30% replacement of coconut shell but more as compared to concrete with only 0%,20%,30% replacement of coconut shell means without using fly ash.

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Sangeetha et al.[2016]explained the new material developed in which coarse aggregate was replaced by coconut shell and cement by clay. M 20 (1:1.5:3) grade of concrete was produced by 0%, 10%, 20%, 30% replacement of coarse aggregate by coconut shell and clay with constant water to cement ratio of 0.5.From experimental study after 10% replacement in 28 days were slightly attains strength of the cubes was 26N/mm^2.By increasing the percentage of coconut shells in concrete reduce the strength and density of concrete.From research work it also found that the addition of coconut shell decreases workability and addition of clay either as cement replacement or aggregate replacement increases workability of coconut shell in concrete. Compressive strength and split tensile strength of concrete reduced by increase in percentage replacement by coconut shell and clay.

Bandhavya et al.[2017] studied the effect of egg shell powder as partial replacement of cement in different percentages as 0%,5%,10% and 15% by weight in M25 grade of concrete.From experimental result it was noticed that for 5% and 10% replacement,the compressive strength was higher than normal but split tensile strength decreases as egg shell powder increases.The compressive strength at 28 days with 0% and 15 % egg shell powder was 33.18 Mpa and 30.96 Mpa respectively.The split tensile strength at 28 days with 0% and 15 % egg shell powder was 3.06 Mpa and 2.45 Mpa.

Dhanalakshmi et al.[2015]studied the effect of fly ash and egg shell powder as partial replacement of cement.The M 40 grade of concrete were produced by varying percentage such as 0%, 2.5%, 5%, 7.5%, 10% and 12.5% of egg shell powder and fly ash in different percentages as 0% to 30%.From experimental result it was found out that at 7.5% of egg shell powder gave more split tensile and flexural strength as compared to normal concrete.At 7 days Compressive strength of egg shell concrete was almost similar to control concrete mix(M40)and greater than at 28 days.

Keramat khan and K U Muthu [2017] investigated the optimum percentage of egg shell powder in different percentage as 0%,2.5%, 5%, 7.5%, 10%, 12.5% as partial replacement of cement in first phase and after that effect of rice husk ash and Metakaolin (0%to 20%)with egg shell powder as replacement of cement in second phase.The optimal strength was achieved at 5% ESP,10% meta kaolin and 10% rice husk ash .At 5% ESP,10% meta kaolin and 10% rice husk ash the compressive ,split tensile and flexure strength was 31.3Mpa,4.1Mpa and 9.2Mpa at 28 days of curing.

N. Parthasarathi et al.[2017] studied the effect of Egg shell powder in different percentage as 5%, 10% and 15% in addition with the silica fume by 2.5%, 5%, and 7.5% as partial replacement of cement.From experimental result it was observed that compressive strength increases at 15% replacement of egg shell powder and also 7.5% of silica fume in concrete.At 15% replacement of egg shell powder with cement increase the flexure strength as compared to conventional concrete.

V. Conclusion

Although strength decreases by using material such as coconut shells,egg shells,fly ash and silica fume and EPS these materials can be used in mass low cost construction.Near coastal areas where coconut shells are available locally and abundantly they can be used in partial replacement of coarse aggregate for low cost housing construction.By using EPS the weight of concrete is less as compared to normal concrete.Therefore,it can be used in mass concrete for low cost housing projects in earthquake prone areas.Thus by using above discussed waste materials,the waste can be reduced which otherwise could have created a huge environmental problem. Increase in percentage replacement by coconut shell reduces compressive strength of concrete but increases workability of concrete. Coconut shell can be used as partial replacement of coarse aggregate in R.C.C concrete. Due to surface texture of coconut shell, the bond strength is high . Due to its light weight, it helps in reduction of dead load, increase the progress of building construction and has lowest haulage and handling cost.The density and compressive strength of concrete is found to decrease with the increase in pumice content. By producing light weight concrete with use of recycled plastic coarse aggregate there will be reduction in cost of raw materials and minimization of disposal of polymer waste.It can be used in thermal insulation work of buildings due to decrease in thermal conductivity of this type of concrete.Increase in the EPS beads content in concrete mixes reduces the compressive and tensile strength of concrete but show good workability without any special bonding agent and could easily be compacted and finished.The split tensile strength of concrete decreases when egg shell powder increases in concrete.

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