iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 2017 **Issue:** **Month of publication:** March 31, 2017

DOI:

www.ijraset.com

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Experimental Investigation Of Influence Of Eco Sand In Conventional Concrete

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Abstract: ***The Concrete is a composite construction material plays a vital role in the construction of the nation's infrastructure. One of the important ingredients of conventional concrete is natural sand or river sand. The issue of environmental degradation and expensive nature of the river sand make us to switch on to the alternative sources. Lots of researches has been done to replace the sand, in this study we replace the river sand with 5%, 10%, 15%, 20%, 22%, 25%, 27%, 30%, and 35% by weight of eco sand. Since the sand is fine powdered crystalline silica which can replace up to a varying percentage of conventional sand usage in concrete. Its micro-filling effect reduces pores in concretes and provides better moisture resistivity and thus durability. The experimental work mainly concentrates with compressive strength and flexural strength. M30 grade of concrete was used and the specimens were tested at 7, 14 and 28 days. It was concluded that replacing about 25 percent of ecosand for fine aggregate will not have any adverse effect on the strength of the concrete. Effective use for waste material and thus cost effective and performs as well as naturally occurring sand.***

Keywords— Concrete; Environmental degradation; River sand; Replacement of Eco-sand; Compressive strength and Flexural strength test.

I. INTRODUCTION

Concrete is a composite material composed of fine aggregate, coarse aggregate, cement bonded together with a fluid cement that hardens over time. Most concretes used are lime-based concretes such as Portland cement concrete or concretes made with other hydraulic cements, such as cement found. However, asphalt concrete, which is frequently used for road surfaces, is also a type of concrete, where the cement material is bitumen, and polymer concretes are sometimes used where the cementing material is a polymer.

When aggregate is mixed together with dry Portland cement and water, the mixture forms a fluid mass that is easily molded into shape. The cement reacts chemically with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone-like material that has many uses. Often, additives (such as pozzolans or superplasticizers) are included in the mixture to improve the physical properties of the wet mix or the finished material. Most concrete is poured with reinforcing materials (such as rebar) embedded to provide tensile strength, yielding reinforced concrete.

Mineral admixtures are becoming more popular in recent decades. The use of recycled materials as concrete ingredients has been gaining popularity because of increasingly stringent environmental legislation, and the discovery that such materials often have complementary and valuable properties. The most conspicuous of these are fly ash, a by-product of coal-fired power plants, ground granulated blast furnace slag, a by-product of steelmaking, and silica fume, a by-product of industrial electric arc furnaces. The use of these materials in concrete reduces the amount of resources required, as the mineral admixtures act as a partial cement replacement. This displaces some cement production, an energetically expensive and environmentally problematic process, while reducing the amount of industrial waste that must be disposed of. Mineral admixtures can be pre-blended with the cement during its production for sale and use as a blended cement, or mixed directly with other components when the concrete is produced. The mix design depends on the type of structure being built, how the concrete is mixed and delivered, and how it is placed to form the structure.

II. LITERATURE REVIEW

A. Prabu, Logeswaran, and George (2015) the construction materials are making the idea of sustainable construction more believable every day. As more and more "Green" buildings are constructed, builders and designers are beginning to develop more effective techniques for producing savings in both energy and materials usage. In this paper, GGBS & ECO SAND has been chemically and physically characterized and used as partial replacement in the ratio of 0%, 10%, 20%, 30% and 40% by weight of cement and sand in concrete. Test results are compared between conventional concrete and Ultimate Concrete for GGBS & Eco sand with different percentages used as partial replacement.

B. Belhadj et al (2014) the paper mainly aims to study the effect of the incorporation of barley straws and wood shavings on the physico-mechanical properties of sand concrete intended for the construction in arid zonesWith combined addition, the problem of shrinkage was relatively solved: decreases of about 11.76% and 39.02% were recorded in comparison with the cases where barley straws and wood shavings are taken separately. In addition, the thermal diffusivity has been reduced of about 35.47% with respect to the basic composition. Due to its higher deformability, the barley straw improves the toughness and ductility of sand concrete and reduces its dimensional variations.

C. Magudeaswaran, Eswaramoorthi, and Kumar (2015) this paper aims at making and studying the different properties of green high performance concrete using this silica fume, fly ash and the other ingredients, which is locally available eco sand and coarse aggregates. An experimental investigation was carried out to evaluate the physical and mechanical properties of green high performance concretes containing cementetious materials by the replacement of cement with silica fume (7.5-15%) and fly ash (15-30%) and replacement of sand with eco-sand, a by-product of cement as filler material. Super plasticizer is added to 1% to improve the workability of concrete.

D. Vijaysankar et al. (2013) the purpose of the present study is to investigate the behaviour of Fly ash based Geo polymer Concrete Solid Blocks and its Durability, the size of the block were adopted was 200mm x 200mm x 400mm. The brick were cast with fly ash to river sand, M-sand and eco-sand (silica sand) with the ratio of 1:2.5 by weight. Sodium hydroxide and Sodium silicate solution were used as the alkaline activators. The binder solution consists of a combination of NaOH and Na2SiO3 solution in the ratio of 1:2.5. The optimum water/ binder ratio of 0.416 was selected as per available literature. The water/binder ratio is the ratio of solution (NaOH, Na2SiO3 and water) to fly ash.

E. Maintaining the Integrity of the Specifications

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III. ECO SAND

Many researchers have been carried out investigated on Eco sand in the past years to assess the properties and its behaviour. Some of the works carried out are discussed below.

S.L. Beckwith, J.M. Justice, L.H. Kennison, B.J. Mohr (2014) investigates the performance of two metakaolins as Supplementary Cementatious Materials (SCMs) was evaluated at 8% by weight cement replacement. The metakaolins varied by their surface area (11.1 vs. 25.4 ECO25%/g). Performance of metakaolin mixtures was compared to control mixtures at water-to-cement ratios of 0.40, 0.50, and 0.60 where no SCM had been used and to mixtures where silica fume had been used as partial replacement for cement. In both mixtures containing metakaolins, compressive, splitting tensile and flexural strengths increased, as well as elastic modulus, as compared to control mixtures. Setting time was reduced in the pastes with both metakaolins. Additionally, considering durability, both metakaolins reduced rapid chloride ion permeability and expansion due to alkali-silica reaction when compared to control and silica fume mixtures. In general, the finer of the two metakaolins proved more effective in improving concrete properties, although both performed superior to silica fume.

Fig 1: Image of Eco sand from ACC cement factory, madukkarai, comibatore

Vishnumanohar (2014) investigates by carried out Eco sand (finely graded silica) is a locally available, low cost, and inert industrial solid waste whose disposal is a matter of concern likes construction waste. On an overall, the Eco sand can be comparable to the natural river sand. The Eco sand satisfies the zone III gradation for not only to partially replace the sand, but for making good concrete. From the obtained results we observed that the maximum strength is achieved by 15% of fine aggregate replacement with eco sand in concrete. While increasing the percentage of eco sand the compressive strength value is getting decreased. From the SEM analysis, at a 15% replacement the mix remains homogeneous as the micro pores are filled and the transition zone is densified. Higher the percentage of fine aggregate replacement higher was the strength activity index. The strength activity index nearly varies linearly with percentage replacement of fine aggregate with eco sand. The maximum strength activity index was 1.49 at 15% replacement level. From the experimental investigation it was found that 15% replacement level is the optimum level**.**

IV. EXPERIMENTAL STUDY

A. Cement

The Cement is a substance, which acts as a binding agent for materials. The raw material used for manufacture of cement consists of lime, silica, alumina and iron oxide. This oxide, when subjected to high clinkering temperature combine with each other to form a complex compounds called Begue's compounds (C_3A, C_3S and C_2S). Lot of factors impact on the strength of concrete, but strength of cement is the most important and direct factor. In this study Ordinary Portland cement of grade 53 conforming to IS 12269 – 1987 was used. The propertis of the cement are listed in table 1.

TABLE I. PHYSICAL PROPERTIES OF CEMENT

PROPERTIES	RESULT	VALUES AS PER IS 12269-1987
SPECIFIC GRAVITY	3.112	3.15
FINENESS TEST	6%	<10%
CONSISTANCY TEST	32%	-
INITIAL SETTING TIME	32 min	>30 min
FINAL SETTING TIME	365 min	<600 min

B. Fine aggregate

TABLE II. PHYSICAL PROPERTIES OF FINE AGGREGATE

PROPERTIES	RESULT
Size	Passing through 4.75 mm sieve
Fineness Modulus	3.923
Specific Gravity	2.66
Bulk density	1600 kg/m^3
Co-efficient of uniformity	4.099
Zone	II

The Cement Naturally occurring river sand was used as fine aggregate. River sand is normally preferred over crushed sand. Fine aggregate with a rounded particle shape and smooth texture was largely used, as it requires lesser amount of water during mixing of concrete. River sand passing through 4.75mm sieve was used in this project. Tests on fine aggregate were conducted under the guidelines given in IS 2720:1991. The Properties of the fine aggregate are shown in table 2.

C. Coarse aggregate

The Coarse Aggregate is the strongest and least porous component of concrete. The coarse aggregate used for the experimental study was obtained from the local source. The tests for coarse aggregate are carried out as per is IS 2386(Part 4&5):1936.The Properties of coarse aggregate are shown in table 3.

TABLE III. PHYSICAL PROPERTIES OF COARSE AGGREGATE

Parameters	Values
Size	20 mm
Grade	'C'
Specific Gravity	2.41
Bulk density	1652 kg/m^3
Water Absorption	1%
Impact value	12.17%
Abrasion value	31.20%
Attrition value	6.12%

D. Eco sand

Eco sand are very fine particles, a bi-product from cement manufacture, which can be used to increases efficiency in concrete. Its micro-filling effect reduces pores in concretes and provides better moisture resistivity and thus durability. It has more consistent grading than many extracted aggregates. For this study eco sand obtained from ACC cement factory, Madukkarai, Coimbatore. Physical properties of eco sand are given in table 4 and the chemical composition of Eco sand are listed in table 5.

TABLE IV. PHYSICAL PROPERTIES OF ECO SAND

PROPERTIES	RESULT
Specific Gravity	2.42
Fineness Modulus	0.028

TABLE V. CHEMICAL COMPOSITION OF ECO SAND

SI.NO	Chemicals	Amount %
1	Silica (SiO_2)	68.1
2	Alumina (Al_2O_3)	10.7
3	Potassium (K_2O)	4.3
4	Calcium (CaO)	2.2
5	Iron (Fe_2O_3)	1.7
6	Sodium (Na_2O)	0.6
7	Magnesium (MgO)	0.5
8	Loss on Ignition (H_2O)	11.5

E. Water

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials.

F. Mix Proportion

The mix design has been adopted as per IS 10262-2009. The concrete used in this study was proportioned to attain Characteristic strength of 30 MPa.

V. RESULTS AND DISCUSSION

Based upon the comparative study conducted the ratio E0, E1, E2, E3, E4 & E5,E6 ,E7, E8, E9 and E10 were adopted for further testing processes as they are volume increase is substantial, mouldable, consistent, stable after curing. There were eleven samples of E0, E1, E2, E3, E4, E5, E6, E7, E8, E9 and E10 each for testing and the results would be taken as the three specimens of each mix. From the comparison of all the activity E5 was found to be the richest mix design.

A. Compressive Test of Concrete Cube

Concrete cubes of standard size of 150mm×150mm×150mm were cast and cured for 7 , 14 and 28 days tested for its compressive strength . The average compressive strength of the cubes at various days for each addition of eco sand are tested as per as per BIS 516 – 1959 and presented in Table 6.

It is clearly evidenced from the table 6 shows that, decrease in natural sand content by increasing the replacement of eco sand shows more influence in the compressive strength of concrete. The compressive strength increases with increase in eco sand up to certain limit. It reaches the maximum of value 44.6N/mm^2 at 28 day by 25% replacement of eco sand. The graph showing the abrupt variation of compressive strength is given below.

TABLE VI. COMPRESSIVE STRENGTH OF ECO SAND

%Replacement of Ecosand	Compressive Strength N/mm²		
	7 days	14 days	28 days
C.S	30.2	33.2	34.4
5%	28	32.6	38.31
10%	29.62	36.9	40.82
15%	30.25	38.07	42.2
20%	32.6	39.78	42.3
22%	32.73	40.7	43.7
25%	33.2	44.2	44.6
27%	32.1	36.4	38.13
30%	31.3	34.6	39.31
35%	21.95	29.06	31.7

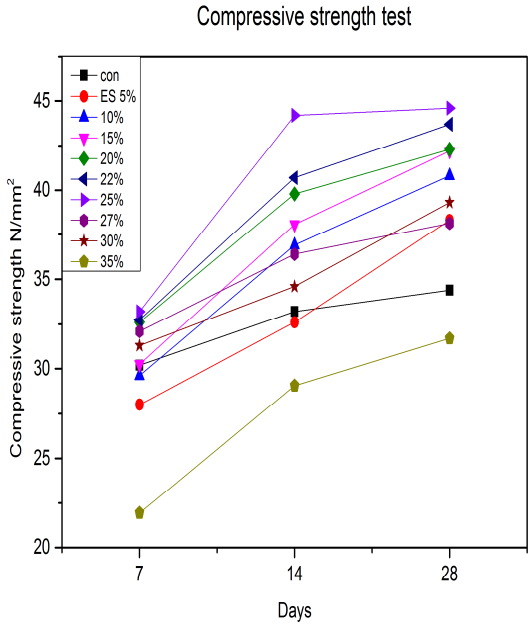

Fig 2: Image of Compressive strength results for different percentages of Eco sand

B. Split Tensile Test of Cylinder

Concrete cylinder of standard size (d=150mm, h=300mm) were cast and at the end of the curing period of 7, 14 and 28 days tested for its split tensile strength as per per BIS 516 – 1959. The average split tensile strength of the cylinder for various % replacement of eco sand are shown in Table 8.

Split tensile strength was conducted by placing the cylinder specimen horizontally in the compression testing machine (CTM), and applying a uniformly distributed load which increased gradually at a constant speed.

Table 7 presented below helps us to understand that the increase in percentage replacement of eco sand increases the split tensile strength of the concrete cylinder. With the 25% of replacement of eco sand will provide a maximum split tensile strength of 3.58 N/mm^2 beyond which shows an inverse effect. Which means 25% replacement is the richest mix design increasing the content of eco sand above 25% will steadily reduce the strength of the concrete.

TABLE VII. SPLIT TENSILE STRENGTH OF ECO SAND

%Replacement of Ecosand	Split Tensile Strength N/mm^2		
	7 days	14 days	28 days
C.S	2.3	2.33	2.38
5%	2.31	2.4	3.03
10%	2.4	2.7	3.2
15%	2.8	2.9	3.31
20%	2.8	2.9	3.4
22%	2.9	3.04	3.46
25%	3.2	3.3	3.58
27%	2.7	3.1	3.5
30%	2.6	3.08	3.42
35%	2.53	2.74	3.2

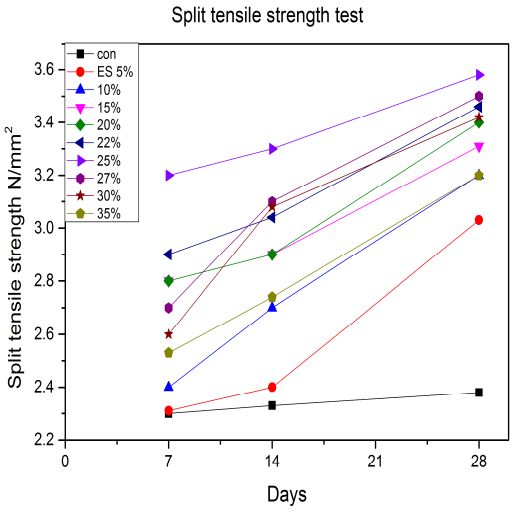

Fig 3: Image of Split Tensile strength results for different percentages of Eco sand

VI. CONCLUSION

A. Use of Ecosand reduces the amount of fine aggregate content as well as heat of hydration in a mortar mix. Thus, the construction work with Ecosand concrete becomes environmentally safe and also economical.

B. Ecosand can be used as substitute for fine aggregate which will reduce the cost of fine aggregate in concrete and also reduce the consumption of sand. Therefore it is safe to replace the fine aggregate with 25% Ecosand considering strength. It also enhances the workability of fresh concrete.

C. Eco sand replacement with fine aggregate with 25% gives optimum result but after that, the strength got slowly decreases. The degree of workability of concrete improved with addition of Eco sand in concrete up to 25% replacement level for M30 grade concrete.

D. Eco sand can be used as substitute for sand (fine aggregate) which will reduce the cost of sand in concrete and also reduce the consumption of sand. Therefore it is safe to replace the sand with 25% eco sand considering strength

E. It is observed that the compressive strength and the split tensile strength of concrete can be improved by replacement with Asbestos & Eco sand for cement and fine aggregate

F. Modification of mix design due to reduction in water content results in reduction of cement and fine aggregate conte

G. Quantity of fine aggregate used in control sample is 840 kg/m3. While adding eco sand by 25% it reduced to 630 kg/m3 which reduces fine aggregate usage and ends up in saving.

H. 28 days compressive strength, split tensile strength, modulus of elasticity, strength of ultimate concrete is more than the conventional concrete. From the result it is observed that the concrete with asbestos and eco sand is showing improvement of all types of strength characteristics

I. Hence it is concluded that concrete with Eco sand can be used for all normal construction activities to that of the conventional one.

Since by using the Asbestos and Eco sand at the optimum level in concrete works, it is seen that all the strength characters are increasing than in the conventional concrete. Particularly, this meets the sustainability conditions and saves the natural resources.

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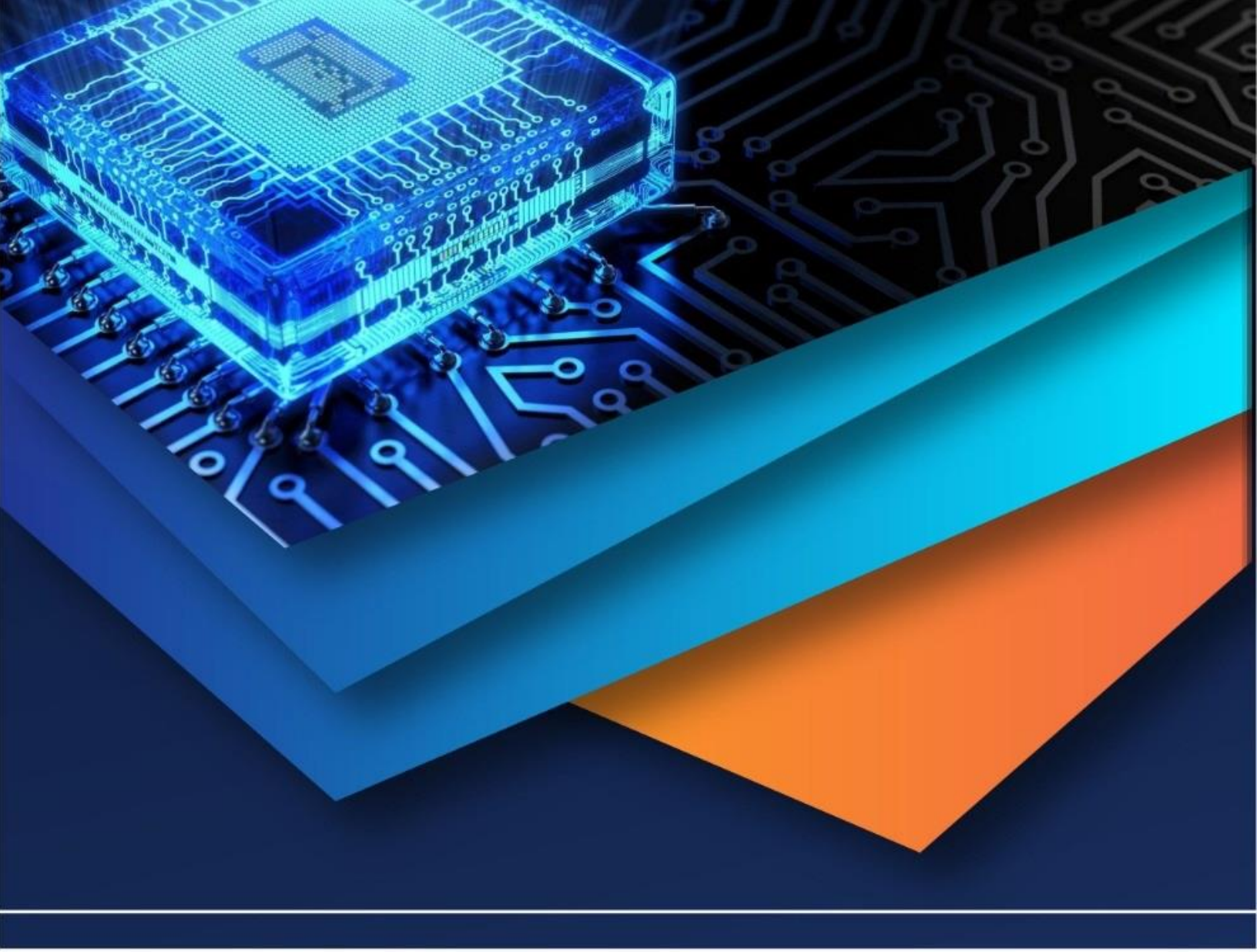

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