Experimental Study On The Properties Of Concrete Made With Alternate Waste Materials

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Abstract - *Availability of raw material is very less due to higher use of concrete. This Scarcity of good quality natural river sand and the gravel is also due to depletion of resources and restriction due to environmental consideration. This makes concrete manufacturing to look for suitable alternative fine and coarse aggregate. And as the manufacture of one tonne of cement generates about 1 tonne of carbon dioxide, to conserve the environment we need to look in for a suitable alternative for cement as well. A modern lifestyle, alongside the advancement of technology has led to an increase in the amount and type of waste being generated, leading to a waste disposal crisis, so it has been considered to reuse some of these waste materials to substitute a percentage of the primary materials used in the concrete. Such recycling not only helps conserve natural resources, but also helps solve a growing waste disposal crisis. The present investigation has been undertaken to study the effect of waste materials in concrete , by replacing egg shell powder[ESP] of 0%,10%,15% and 20% with the cement, saw dust of 0%, 10%, 20%,30% and with the fine aggregate and e-waste of 0%,10%, 15% and 20% with the coarse aggregate, in M30 grade concrete. The optimum replacement percentage of these materials were identified. And a concrete mix with all the above replaceable materials was casted and its behaviour were also analysed.*

Key words: Egg Shell Powder[ESP], Saw Dust, E-Waste

1.INTRODUCTION

In India, the Construction industry is the second largest industry. Use of concrete is very large as a result, availability of natural material is reduced and Scarcity of good quality natural raw materials arises. The depletion of resources and restriction due to environmental consideration, makes the concrete manufacturing to look for suitable alternative materials for construction. There is no material which plays the role of the ideal material in concrete but to full fill the requirement of industries we have to replace partially all the materials. In India, a number of waste materials are produced by different manufacturing companies, electronic wastes, municipal solid wastes and other wastes. With disposal of waste in to the land causes serious impact on environment and it spoils the land. Thus experimental study aims to use wastes such as egg shell, saw dust and electronic waste to develop an acceptable concrete mixture

Most of the eggshell waste is commonly disposed in landfills Without any pre-treatment because it is traditionally useless. Eggshells can be applicable to reduced cost of construction material and producing a new raw material for development in the construction industry. This project aims to use eggshell powder as a cement replacement.

Research concerning the use of Electronic waste to augment the properties of concrete has been going on for recent years. The use of this materials in concrete come from the environmental constraints in the safe disposal of these products. It has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects. This project aims to use e-waste as a coarse aggregate replacement.

Sawdust is an industrial waste in the timber industry constitute a nuisance to both the health and environment when not properly managed. Wood sawdust wastes are accumulated from the countries all over the world and cause certain serious environmental problems

and health hazards. It is one of the major underutilized by products from sawmilling operations. Generation of wood wastes in sawmill is an unavoidable hence a great efforts are made in the utilization of such waste. Thus, this research investigates the potential use of wood sawdust wastes as fine aggregate replacement to produce a low-cost and lightweight composite for construction and engineering purpose.

2. LITERATURE REVIEW

In order to gain an insight about cement , fine aggregate and coarse aggregate replacement with Egg shell powder, Saw dust, E-waste respectively , the literatures related to it were collected. Major highlights from this literatures are discussed below.

2.1 Literature Review On Egg Shell Powder

M.Sivakumar, Dr.N.Mahendran (2014)studied about the strength and permeability properties of concrete using fly ash , rise husk ash and egg shell powder (ESP).They have evaluated the physical and chemical attributes of fly ash, rice husk ash and egg shell powder. Assessment results accomplished underscore the point that strength and permeability properties of concrete significantly jumping up to 30% of cement substitution by combined Fly ash (15%), Rice Hush Ash (15%) with additive ESP (5%), and subsequently tends to drop down with every supplementary accumulation of substitution outside this level

D.Gowsika,S.Sarankokila,K.Sargunan(2014) conducted an Experimental Investigation of Egg Shell Powder as Partial Replacement with Cement in Concrete. The cement mortar of mix proportion 1:3 in which cement was partially replaced with egg shell powder as 5%, 10%, 15%, 20%, 25%, 30% by weight of cement. There was a sharp decrease in compressive strength beyond 5% egg shell powder substitution. The admixtures used are Saw Dust ash, Fly Ash and Micro silica to enhance the strength of the concrete mix with 5% egg shell powder as partial replacement for cement. And replacement of 5% Egg shell powder + 10% micro silica replacement in cement yields similar flexural strength as in conventional concrete. And replacement of 5% Egg shell powder + 10% Micro silica replacement in cement yields higher Split Tensile strength as compared to other compositions.

Dhanalakshmi M , Dr Chandrashekar A, Dr Sowmya N J(2015) carried out a Comparative Study on Egg Shell Concrete with Partial Replacement of Cement by Fly Ash. Based on the experimental investigation the following conclusion were drawn . Addition of ESP to cement concrete leads to reduction in workability. Density decreased with addition of ESP to cement concrete. Increase in workability was found with addition of fly ash to optimum egg shell powder concrete. Increase in density was observed to addition of fly ash to optimum egg shell concrete. Compressive strength of egg shell concrete was lower than control concrete mix M40).The combination of ESP + FA showed the reduction in compressive strength compared control concrete and egg shell powder concrete.

2.2 Literature Review On Sawdust

Dilip Kumar et al. (2014) researched on low cost construction material for concrete as saw dust and investigated on the effects of introducing the cost between sawdust used concrete block and sand used concrete block .There made concrete specimens by replacing the sand with 10% 15% and 20% saw dust and there conclude that at the initial ages, with the increase in the percentage replacement of sawdust, the strength as well as compressive strength increases .While using sawdust in concrete, the weight of concrete will decrease and it can be used as Light weight Concrete in civil engineering applications

Olugbenga Joseph Oyedepo ,Seun Daniel Oluwajana , Sunmbo Peter Akande (2014) Investigated the Properties of Concrete Using Sawdust as Partial Replacement for Sand. The concrete mix ratio of 1:2:4. was prepared using water/cement of 0.65 with 0%, 25%, 50%, 75% and 100%.Concrete produced using sawdust as partial replacement of sand has influence on the properties of the concrete.

The result of the analysis carried out showed that the use of sawdust as partial replacement of sand between 0 to 25% will contributes to reduction in sawdust waste generated in the society without adversely affecting concrete strength.

Tomas.U.Ganiron Jr(2014) has studied on Effect of replacement of fine aggregate with sawdust in concrete mixture for building construction. The sawdust-gravel-cement concrete showed 10% reduction in weight than traditional concrete which got about 40% weight. Due to mixing the concrete with waste material, the workability and consistency parameters are varied from traditional concrete and the sawdust waste material is cheaper than the fine aggregate.

2.3 Literature Review On E-Waste

Pravin A. Manatkar, Ganesh P.Deshmukh (2015) has investigated the use of non-metallic e-waste as a coarse aggregate in a concrete. Their paper shows analysis of compressive strength of M20 and M25 grade of concrete by replacing coarse aggregate by adding non metallic e-waste in 0% to20% and it is observed that some percent non metallic e-waste can be use as a coarse aggregate in concrete. It was identified that e-waste can dispose in concrete as a coarse aggregate. Volume E-waste on earth reduces, when it use in concrete. Up to 5-6% replacement of e-waste was suitable to use up to (G+2)

building construction, road construction. Up to 10% replacement of e-waste was used in construction where low strength required such as garden wall construction etc. More than 10% was not considerably useful for construction field because of strength decreases. It was observe that e-waste increase 5% strength decrease .E-waste concrete block having flexibility it directly not fail during test firstly it compress up to 1cm then break. It was very important at the time of earthquake it provides some time for clearance in structure. Solid waste management of e-waste done, when it use in concrete.

Suchithra S, Manoj Kumar, Indu V.S(2015) carried out a study on replacement of coarse aggregate by e- waste in concrete. The work was conducted on M20 grade mix. The replacement of coarse aggregate with E-waste in the range of 0%, 5%, 10%, 15%, and 20%.The test results showed that the addition of E-waste shows increase in compressive strength up to 15% replacement. Increase in split tensile strength was almost insignificant whereas gain in flexural tensile strength have occurred even up to 15 % replacements.

Rajiv Gupta, Harish Puppala, Nakka Rajesh(2015) investigated the application of recycled coarse aggregates and e-waste for pavements with low traffic. There study was an integrated experiment in which different combinations of e-wastes and recycled coarse aggregate together were used as a substitute of conventional aggregate. The compressive strength of M20 mix designed was assessed by casting cubes and the flexural strength by prisms. Experimental study was carried out to find if the e-waste strips can be used as the reinforcement instead of steel. Results were checked against the standards of IRC to use for the sub-grade of the pavement. It was found that For the designed load of 51 kN ,load carrying capacity of the beams drops by 73% when the e-waste is replaced with 1.5 times the area of steel. When the combination of e-waste is used along with the recycled aggregate it is advisable to use the admixtures as the recycled coarse aggregates will have a coating of cement which is in dry state absorbs water. Instead of using the e-waste pieces and joining those with binding wire if they were made into some small sheet which was continuous the results may be effective. As while working with the small pieces which were joined the probability of change in orientation may take place.

2.4 Literature Review Summary

From all the above literature reviews, it was evident that Egg Shell powder can be used as a cement replacement, Saw Dust can be used as a fine aggregate replacement and E-waste can be used as a coarse aggregate replacement, individually in a concrete mix. The optimum percentage of replacement was also identified for all waste materials individually. But there was no literatures available on the utilisation of all the three above mentioned replacement in the same concrete mix. Hence it is planned to use Egg shell as cement replacement , Saw Dust and E- waste as fine and coarse aggregate respectively together as an ingredient of the concrete.

3.MATERIALS AND ITS PROPERTIES

Materials needed for control concrete are Cement, Fine Aggregate (sand), Coarse Aggregate (broken stone), egg shell powder , saw dust, e-waste and water. The materials used for the project is collected and made sun dried before usage.

3.1 Cement

Ordinary Portland cement of 53 grade having specific gravity of 3.12 and fineness modulus of 5.3% was used. The Cement used has been tested for various proportions as per IS 4031-1988 and found to be confirming to various specifications of 12269-1987.

3.2 FINE AGGREGATE

Fine aggregates are termed as “filler” which fills the voids in concrete. The fractions of aggregates less then 4.75mm are known as fine aggregates. The river sand is used as fine aggregate conforming to requirements of IS:383-1970 comes under zone II. The physical properties are shown in Table 4.2

3.3 COARSE AGGREGATE

Aggregates fractions larger than 4.75mm are termed as coarse aggregates. The fraction of aggregates used in the experimental work passed in 20mm sieve and retained on 10mm IS sieve comes under Zone II aggregates conforming to IS: 383-1970. The physical properties of the coarse aggregates are shown in Table.4.3

3.4 EGG SHELL POWDER

Egg shells contain almost 100% calcium carbonate, which, in the form of limestone, is commonly used a mineral filler in the manufacture of cement. Eggshell waste was collected from an eatery. The grinded egg shells were sieved through the 90 micron sieve size and then packed to use it in the cement replacement.

FIGURE-1: Processing of Eggshell

3.5 SAWDUST

Saw dust is also known as wooden dust. It is the by-product of cutting, drilling wood with a saw or any other tool it is composed of fine particles of wood, the carpenter are responsible for producing the wooden dust. It is produced as a small discontinuous chips or small fragments of wood during sawing of logs of timber into different sizes. It bonds well to ordinary concrete and is a good insulator.

FIGURE-2: Saw Dust

3.6 E-WASTE

Generally the electrical components whose life is over are considered as the E-waste. E-waste describes loosely discarded, surplus, obsolete, broken,electrical or electronic devices.The e-waste collected is of irregular shape and irregular size, they are passed through the 20 mm sieve and the e-waste retained on the 10mm sieve is collected and to be used for the preparation of concrete mix.

FIGURE-3:E-waste

3.7 WATER

Water conforming to the requirements of IS: 456-2000 is found to be satisfactory for making concrete. It is generally stated that water fit for drinking is suitable for making concrete.

Table -3.1: Physical properties of cement

SL. NO.	PROPERTY	CEMENT
1	Specific Gravity	3.12
2	Initial Setting Time	38 min
3	Final Setting Time	480 min
4	Fineness Modulus	5.3 %
5	Standard consistency	31%

Table -3.2: Chemical Properties of Cement &ESP

COMPOSTION	CEMENT (%)	ESP(%)
SiO_2	20.25	0.11
Al_2O_3	5.04	Nil
Fe_2O_3	3.16	Traces
CaO	63.61	47.49
MgO	4.56	Nil
Na_2O	1.18	Nil
K_2O	0.14	0.14

Table -3.3: Physical Properties of Fine Aggregate and Saw Dust

Materials	Specific Gravity	Finess Modulus (%)	Bulk Density (Kg/m3)	Water Absorption (%)
Fine Aggregate	2.55	3.9	1736.67	1.69
Saw dust	2.05	5.5	1336.67	1.80

Table -3.4: Physical Properties of Coarse Aggregate and E-Waste

Materials	Specific Gravity	Finess Modulus (%)	Bulk Density (Kg/m^3)	Water Absorption (%)
Coarse Aggregate	2.71	3.18	1612.67	0.33
E-waste	1.41	2.88	650	Nil

4. EXPERIMENTAL CONDITIONS

4.1 Concrete Mixes

Mix proportion for M30 grade concrete used in this study was 1: 1.67 : 3.13 conforming to IS 10262-2009 with water-cement ratio of 0.45.

Cement is replaced by egg shell at 0%,10%,15% and 20%, the Fine Aggregate is replaced by the saw dust at 0%, 10%, 20%,30% and the Coarse Aggregate is replaced by e-waste at 0%,10%, 15% and 20%.

4.2 Preparation Of Test Specimen

Weight batching and hand mixing were adopted in this study for concrete production. After thorough mixing, the concrete was placed into the moulds which were properly oiled. After placing of concrete in moulds, proper compaction by hand was given. Cubes of size 150*150*150mm, cylinders of size 150mm diameter and 300mm length were casted. Demoulding was done after 24 hours of casting and specimens were cured in water tank.

5. TESTS AND RESULTS

5.1 Compressive Strength Test

Compressive strength test was conducted to calculate compressive strength developed in concrete specimens containing egg shell powder, saw dust and e-waste individually at the age of 7, 14, 28 days respectively. Cube mould casted was used for this test. It was done on compressive testing machine (CTM) having loading capacity 2000kN.

FIGURE-4:curing of specimen

Table -5.1: Compressive Strength(N/mm^2) for ESP

MIX PROPORTION OF ESP	0%	10%	15%	20%
7 DAYS	23.56	14.67	13.7	10.22
14 DAYS	27.56	18.22	17.33	14.22
28 DAYS	36.89	25.78	24.89	20.89

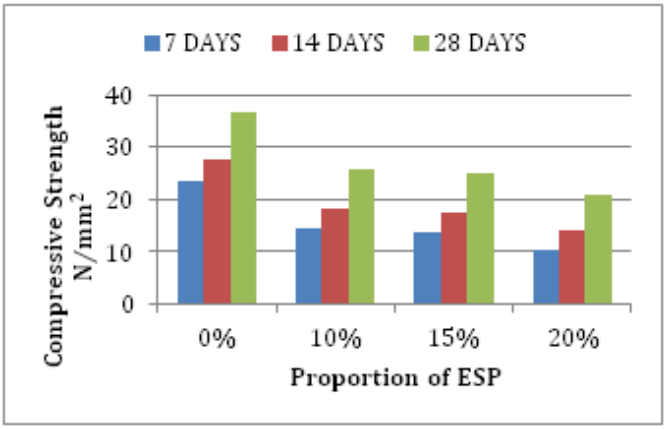

Chart -1: Compressive Strength results for ESP

Table -5.2: Compressive Strength(N/mm²) for saw dust

MIX PROPORTION OF Saw Dust	0%	10%	20%	30%
7 DAYS	23.56	7.11	3.11	1.77
14 DAYS	27.56	10.22	4.44	2.22
28 DAYS	36.89	11.56	5.33	2.67

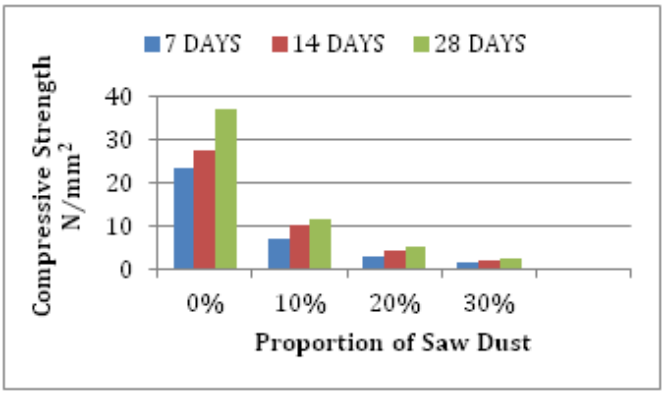

Chart -2: Compressive Strength results for saw dust

Table-5.3: compressive strength (N/mm²) for E-waste

MIX PROPORTION OF E-waste	0%	10%	15%	20%
7 DAYS	23.56	17.33	16.4	11.56
14 DAYS	27.56	24.44	23.11	20.89
28 DAYS	36.89	28.89	27.11	23.11

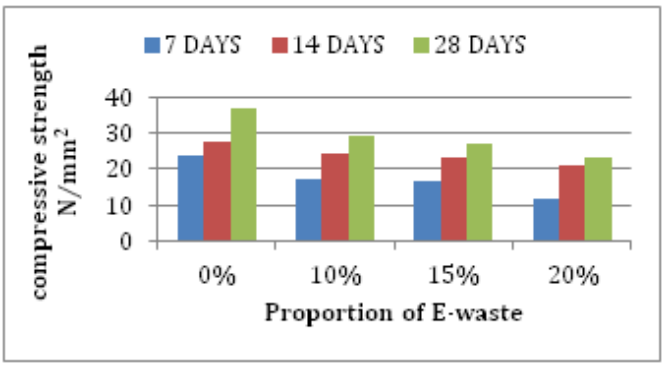

Chart -3: Compressive Strength results for E-waste

5.2 Split Tensile Strength The split tensile strength of concrete is one of the basic and important properties. This test on concrete cylinder is a method to determine the tensile strength of concrete.

Table-5.4: split Tensile strength(N/mm²) for ESP

MIX PROPORTION OF ESP	0%	10%	15%	20%
7 DAYS	1.56	1.69	1.56	1.13
14 DAYS	1.84	2.55	2.12	1.56
28 DAYS	1.98	2.97	2.26	1.69

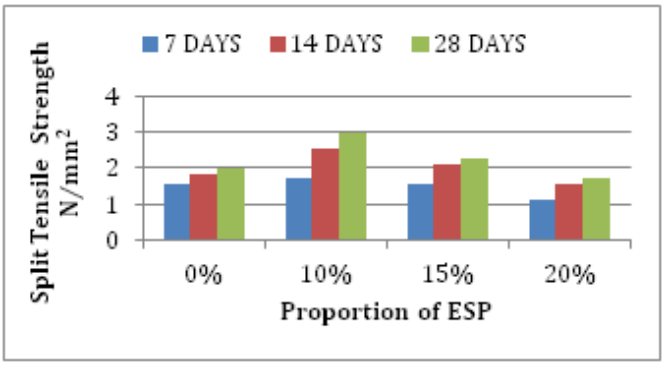

Chart -4: split tensile Strength results for ESP

Table-5.5: Split Tensile strength(N/mm²) for saw dust

MIX PROPORTION OF Saw Dust	0%	10%	20%	30%
7 DAYS	1.56	0.99	0.57	0.14
14 DAYS	1.84	1.41	0.85	0.28
28 DAYS	1.98	1.69	0.99	0.42

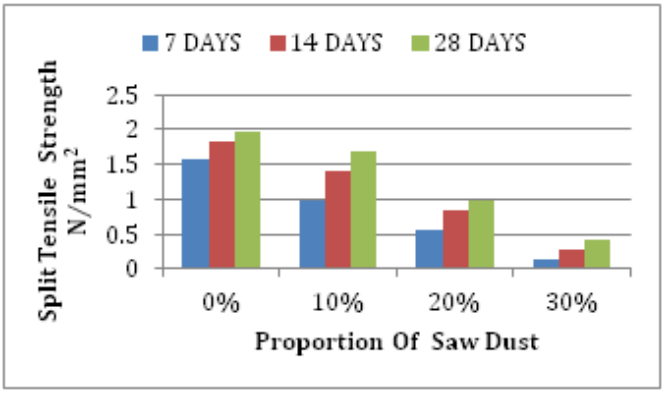

Chart -5: split tensile Strength results for saw dust

Table-5.6: split Tensile strength(N/mm²) for E-waste

MIX PROPORTION OF E-waste	0%	10%	15%	20%
7 DAYS	1.56	1.41	0.99	0.57
14 DAYS	1.84	1.69	1.27	0.71
28 DAYS	1.98	1.84	1.56	0.85

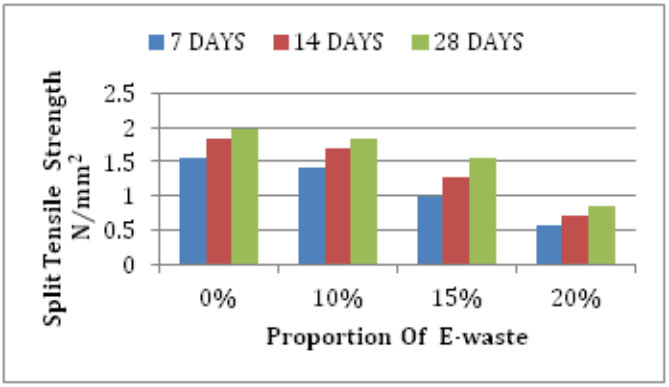

Chart -6: split tensile Strength results for E-waste

The optimum percentage of egg shell powder, saw dust and e-waste replacement in concrete were found out. A modified concrete mix with the optimum eggshell powder(15% of cement), saw dust(10% of fine aggregate) and E-waste(15%of coarse aggregate) along with the corresponding ingredients of concrete were again casted and tested at the age of 7 days.

Table-5.7: strength Results(7 Days) for Optimum Mix

Strength Results	Compressive Strength (N/mm²)	Split Tensile Strength (N/mm²)
7 DAYS	16	0.99
14 DAYS	20.89	1.27
28 DAYS	25.33	1.41

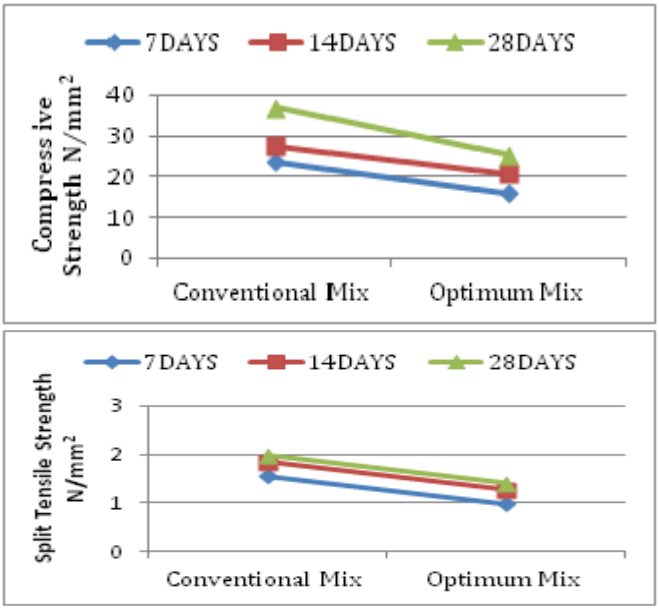

Chart -7: Strength Comparison of Conventional Mix and Optimum Mix

6. CONCLUSION

This study intended to find the effective ways to utilize the waste particles as the ingredients of concrete. It is also observed that the compressive strength and split tensile strength of concrete is found to be optimum when cement is replaced by 15% with ESP. The optimum replacement level in fine aggregate with Saw Dust is 10%.The addition of E-waste shows increase in the strength up to 15% replacement. Beyond it the strength is decreasing. In the

optimum mix split tensile strength is higher than the compressive strength when compared to the conventional mix.

The following conclusions are also obtained.

- Egg shell powder seems to have a more pronounced effect on the split tensile strength than the compressive strength.
- Attempt made at using 10% replacement of sand with sawdust was not successful as there the bonding was very poor.
- The sawdust replacement did not appear to have a significant effect on the compressive strength and the split tensile strength.
- E-Waste in the concrete by replacing coarse aggregate solves a potential disposal problem and it saves natural aggregate.

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