EFFECTS OF WATER REDUCING ADMIXTURES IN LIGHTWEIGHT COCONUT SHELLS CONCRETE

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ABSTRACT

The study investigate the effect of water reducing admixtures in lightweight coconut shells concrete, the water used in production of concrete cubes were mixed with complast SP432MS admixture in the order of 0%, 2%, 4%, 6%, 8%, 10% replacement, the water –cement ratio and mix ratio adopted was 0.5 and 1:2:4 respectively. The specimen of 150×150×150mm^3 cube size were used and cured for hydration period of 7,14,21 and 28 days respectively. The result revealed that the compressive strength obtained at 28days curing of coconut shell concrete without admixture (control) was12.25N/mm^2, while for the concrete with admixture were in the range of 14.44N/mm^2,15.73N/mm^2,18.12N/mm^2,14.60N/mm^2,8.0N/mm^2. The study arrived at an optimum replacement level of 6%.

Keywords*: Admixture, Compressive strength,Coconut shell concrete and curing.*

INTRODUCTION

Attention has been seriously placed on provision of comfortable and affordable houses for human habitation right from the beginning of civilization, because shelter is one of the basic need of man. The problem of providing adequate housing has been a major concern, not only to individual but to government at all level as well. However, common building materials such as cement, sand, gravel and steel etc have invariably become expensive and unaffordable especially by the majority of the Nigerian population (Aguwa and Amadi, 2010). The necessity to research for alternative naturally occurring, local affordable construction materials is pertinent.

Concrete is the most versatile heterogeneous construction material and the impetus of infrastructural development of any nation. Civil engineering practice and construction works around the world depend to a very large extent on concrete. Concrete is a synthetic construction material made by mixing of cement, fine aggregate, coarse aggregate and water in the right proportion. Each of those component contribute to the strength their concrete possess (Gambir, 2004). Hence, the overall cost of concrete production depends largely on the availability and cost of its constituent.

Coconut trees are found in abundance in almost all part of Nigeria. Coconut shell has three distinct layers: the thin, smooth green outer layer or epicarp, the middle fibrous layer or mesocarp and finally the hard dark-brown inner shell or endocarp, which is being investigated in this work as lightweight aggregate. All the three layers of the coconut shell are usually discarded as waste products after breaking and removal of the edible nuts. This coconut shell is usually hard, durable and it remain un-decayed for a long period of time when thrown away as solid waste. About 4000kg of coconut shell is thrown away as waste per annum by sellers of coconuts at Minna central market in Niger state, Nigeria. This is an indication that significant quantities of this material are available all over the country more especially in the rural areas where they are produced (Aguwa and Amadi,2010). Water reducing admixtures; when water is added to a grout, mortar (plaster) or concrete mixture, the cement and other fines in the mix such as fly ash, rice husk and stone dost flocculate or clump together. The flocculated fines cause an increase onviscosityby entraPping a part of the water and thereby physically resisting the flow. To reduce the viscosity (a functional effect of workability) to the desired level, it may be necessary to add more water. Water is added up to a certain point beyond which the plastic and harden physical properties of the mixture are compromised. Alternatively, to achieve the desired workability and hardened physical properties it is often necessary to add a water reducer to disperse or deflocculates the systemand reduce the amount of water to be added during mixing. The idea on the exact quantity of this admixture to be incorporated for the production of coconut shell concrete that will offer the optimum compressive strength is the main target of this research work. The objectives of this paper include the following: to determine the physical properties of the aggregate, to determine the slump of the fresh coconut shell concrete and to determine the compressive strength of concrete made from partial replacement of complast SP432MS on the coconut shell concrete.

Water reducing admixture enable a given fresh concrete mix to have higher flowability (workability) without increasing the watercontent which results in faster rate of concrete placement, easy placement in relatively poorly accessible location without vibration, true shutter finish for highly reinforced concrete members and reduction in cement content. Benefit of water reduction in hardened state of concrete are increased strength, density, durability, volume stability, abrasion resistance, reduced permeability and cracking.

The increase in the popularity of using environmentally friendly low cost and light weight construction materials in building industry has brought about the need to investigate how this can be achieved and as well benefit the environment (Adebayo et al, 2013). The cost of construction materials is increasing day- by day because of high demand, scarcity of raw materials, and high price of energy. However, from stand point of energy saving and conservation of natural resources, the use of alternative constituent in construction materials is now a global concern. Today efforts are being made towards intensive research and development in producing sustainable and environmentally friendly construction materials. In this regard a number of research have been conducted on the possibility of utilizing agricultural wastes to partially replaced cement, fine and coarse aggregate for concrete construction. Obam and Tyagher (2005) found out that partial replacement of OPC with rice husk ash mixed with 45% slaked lime gave the maximum strength of concrete at water-cement ratio of 0.86.Tyagher et al (2011) indicated that partial replacement of OPC with saw dust ash mix with 45% slaked lime gave the maximum strength of concrete at water-cement ratio of 0.55.

Akeem et al (2013) consider the effect of admixture on the properties of corn cob Ash cement concrete, in their studies, the workability and compressive strength of CCA cement concrete incorporated with accelerator, plasticity and water reducing and retarding were carried out. The result revealed that, admixture generally improve the workability and compressive strength of corn cob cement concrete, greatest effect was caused by plasticizer which improves the flow properties of mix by dispersing the cement particles and breaking up cement agglomerate.

The effect of addition of calcium nitrate on selected properties of concrete containing volcanic Ash was also investigated by Ezekial and Ibrahim, (2011). They found out that concrete setting time showed a decrease in both the initial and final setting time of the mixture as the $Ca(NO_3)_2$ content was increased. The resulting strength at 28days hydration period shows a strength increase as the percentage of $Ca(NO_3)$ was increased to 10%.

JUSTIFICATION

The cost of concrete construction has been astronomically high that it has become extremely difficult for low income earners in Nigeria to own houses. In order to make houses affordable to this class of Nigerians, cost of conventional building materials, have to be minimized. One of the ways to minimize cost of concrete construction is to practically replace cement and aggregate with some suitable materials that do not requires extensive treatment (Tyagher et al, 2012).Aguwa and Amadi (2010) studied the performance of coconut shell as coarse aggregate for production of lightweight concrete, they uses coconut shell to fully replace crushed stone with the mix proportion of 1:2:4 and water cement ratio of 0.65. Test result showed that the average compressive strength at 28 days was 11.29N/mm^2. It is on this note that this research work is aimed (carriedout) to achieved the better understanding the effect of water reducing admixture (complast SP432MS) in lightweight coconut shell concrete, to arrive at the optimum replacement level of the admixture.

MATERIALS AND METHOD

Cement: The cement used was Dangote brand of Ordinary Portland Cement (OPC) bought from a cement deport at Minna Niger state, Nigeria and it conformed to BS 12 (1978) as confirmed by Aguwa and Amadi, (2010)

Sand: The sand collected from a river in Minna Niger state, Nigeria and used as a fine aggregate was clean,sharp,free from organic matter and well graded in accordance with BS 882 (1983).

Coconut shell: The coconut shell as waste products from coconuts was collected from dump site in MinnaNiger state, Nigeria. It was clean and not mixed up with any foreign materials. It was broken into smaller sizes in the laboratory manually to ensure maximum size not exceeding 20mm and to conform to BS 882, (1983) recommendation.

Water: The water used for mixing and curing was obtained from tap. The physical examination of the water revealed that it was clean, free from deleterious materials and fit for drinking as recommended by BS 3140.

Laboratory test

Laboratory test carried out on the sand and coconut shell for the purpose of characterization and classification include sieve analysis, specific gravity, moisture content and porosity in accordance with BS 1377, (1990). The determination of bulk density and water absorption of the sand and coconut shell was carried out in accordance with BS 812 part 2, (1975). Slump test were carried out on the fresh concrete in accordance with BS 1881 part 102, (1983) while compressive strength test was carried out on the hardened concrete in accordance with BS 1881 part 116, (1983).

Casting of cubes

Wooden mould of $(150 \times 150 \times 150)mm^3$ were used. The water-cement ratio used for the casting of the cubes was 0.5. The mould were lubricated with engine oil in order to reduce the friction and enhance removing of cubes from the mould, they were then filled with concrete in three layers and each layer was tamped 25 times. The hardened cubes were removed after 24 hours and taken to the curing tank (BS 1881: part 108:1983).

Slump test: Before mixing the concretefor casting the cubes, a trial mix was carried out to determine the slump. Slump test is very useful in detecting the variation in the uniformity of the mix of a given nominal proportion (BS 1881 part 102, 1983). It is a popular method used all over the world on the day-to-day, hour-to-hour variation in the materials being fed into the mixer or mixing platform if by hand (Neville, 2000).

Curing of cubes:

Curing is the process of keeping the concrete under a specific environmental condition. Good curing is typically considered to be in a most environment which promoteshydration. More specifically, the aim of curing is to keep concrete saturated until the originally water filled spaced in fresh cement paste has being filled to the desired extent by the product of hydration of cement.

Compressive strength: Compressive strength test on concrete cube was determined using an electrically operated Seidner compressive machine using standard procedure for concrete curing age of 7,14,21, and 28days respectively at Civil Engineering laboratory, Federal University of technology, Minna.The weight of each cube was always taken before the compressive strength test was conducted. During crushing care was taken to ensure that the cubes were properly positioned and aligned with the axis of the thrust of the compressive machine to ensure uniform loading on the cubes (Neville, 2000).

Results and Discussion

Table1. Physical properties of constituent materials

Parameters	Sand	coconut shell
Specific gravity	2.62	1.73
Compacted Bulk density	1602.54kg/m^3	632.83kg/m^3
Uncompacted bulk density	1468.46kg/m^3	566.70kg/m^3
Moisture content	1.7%	0.47%
Coefficient of uniformity(C_u)	1.67	8.67
Finess modulus	4.88	2.99
Coefficient of concavity (C_c)	1.45	0.46
Void ratio	0.44	0.67
Porosity 8%	10%	
Water absorption	2.0	26.16

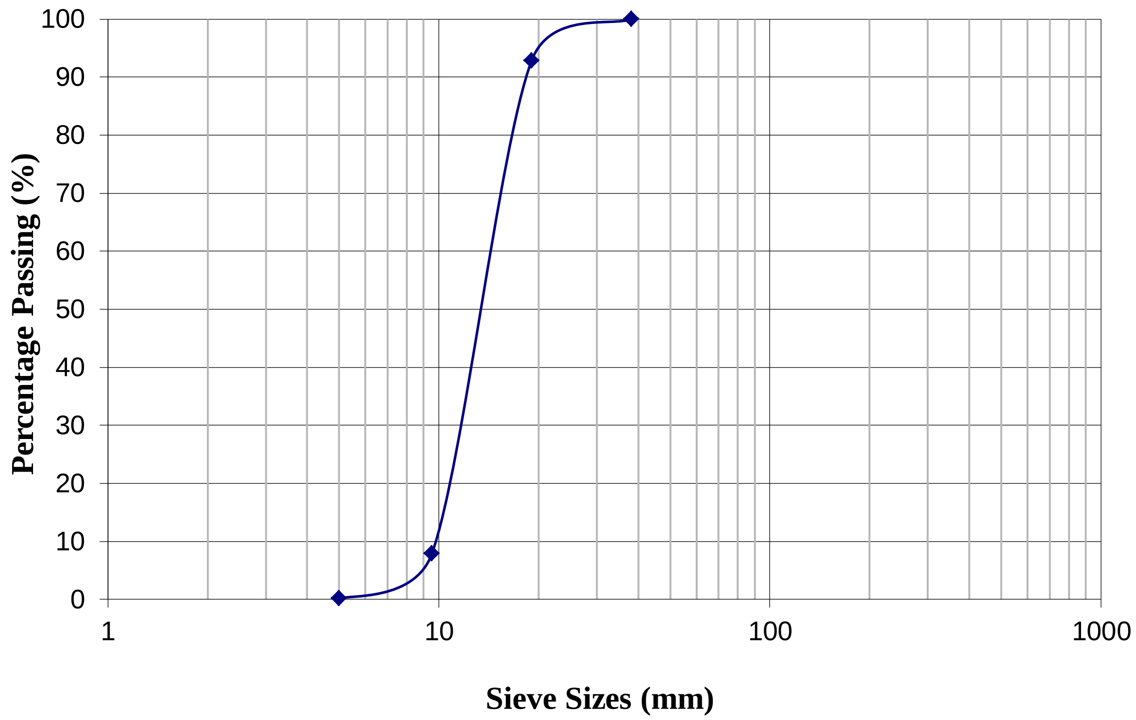

Figure 1: Particle Sizes Distribution of Coconut Shells

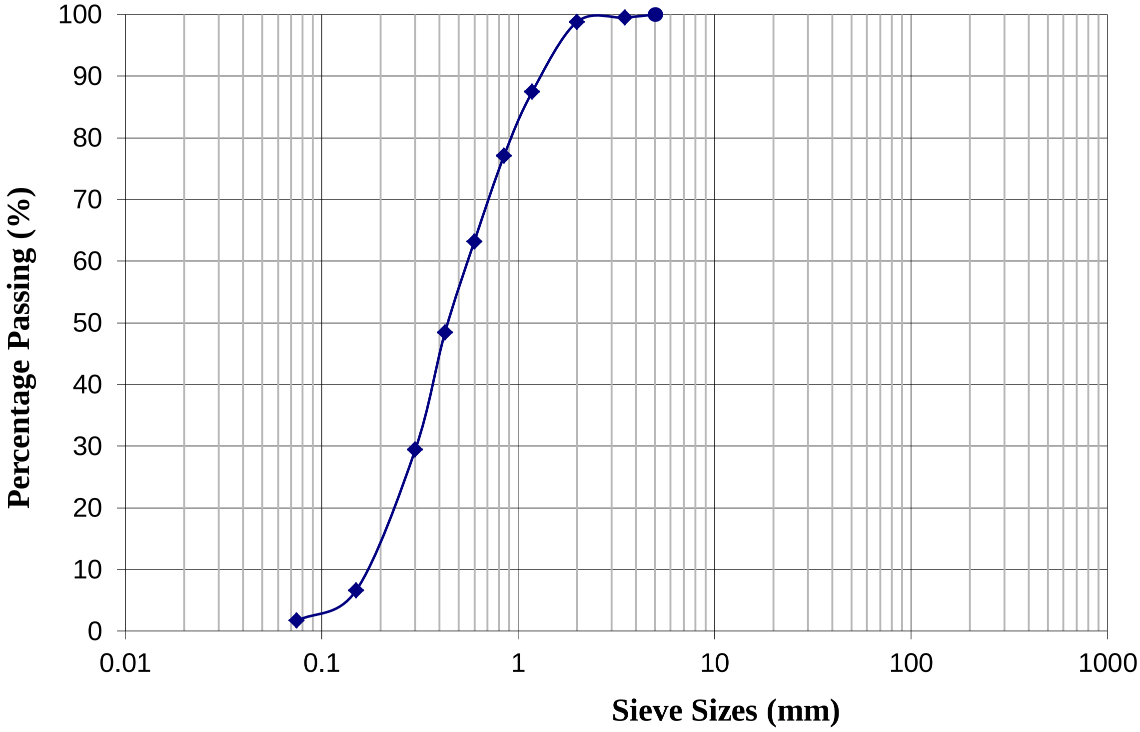

Figure 2: Particle Sizes Distribution of Sands

Characterization of sand and coconut shell

The properties of sand and coconut shell used for the study are summarized in table 1, while figure 1 & 2 shows their particle size distribution. The graph of the sieve analysis for the sand indicated that the fine aggregate is well graded and classified in zone III in accordance with BS 882, (1983) classification for aggregate. The fineness modulus of sand and coconut shell are 4.88 and 2.99 respectively, their specific gravity are 2.62 and 1.73 which are in agreement with the recommendation of BS 1377, (1990) for clean quartz and flint sands. The specific gravity of coconut shell is very low compared with that of natural aggregate this is an indication that the coconut shell is much lighter than most natural aggregate which generally have specific gravity between 2.5 and 3.0 (Neville, 2000). The uncompacted bulk density of coconut shell is 566kg/m^3, this is similar to that ofAgbede and Manassah (2009), who reported that periwinkle shell, has a bulk density of 515kg/m^3 and can be used as a light weight aggregate inconcrete works. Also the compacted and uncompacted bulk densities of sand are 1602.54kg/m^3 and 1468.46kg/m^3 which agree with the value of 1610kg/m^3 and 1512kg/m^3 reported by Aguwa and Amadi (2010).

From table 1, the porosity of coconut shell was found to be 10%,this value fall within the range for natural aggregate which is between 0%-50% as reported by Bala and Aminulai (2013). Generally, porosity of aggregate affect the strength and durability of concrete, the strength of concrete is low and the durability is reduced drastically when the porosity of aggregate is high. Moreover, coconut shell posses degree of absorption of 26.16% which is very high compare to that of most natural aggregates, which ranges between 0.2–4.53%, this may be as a result of large surface area and high porosity. Hence coconut shells concrete experience much dryness due to absorption of much water by the aggregate. The density of coconut shell concrete determined was 1772.94kg/m^{3}which is within the range of 320-1920kg/m^{3}Specified for the lightweight concrete(Dahunsi, 2003).

Table 2: Summary of compressive strength at 28days curing

% of Admixture	Testing Age
	28days
0	12.25
2	14.44
4	15.73
6	18.12
8	14.60
10	8.0

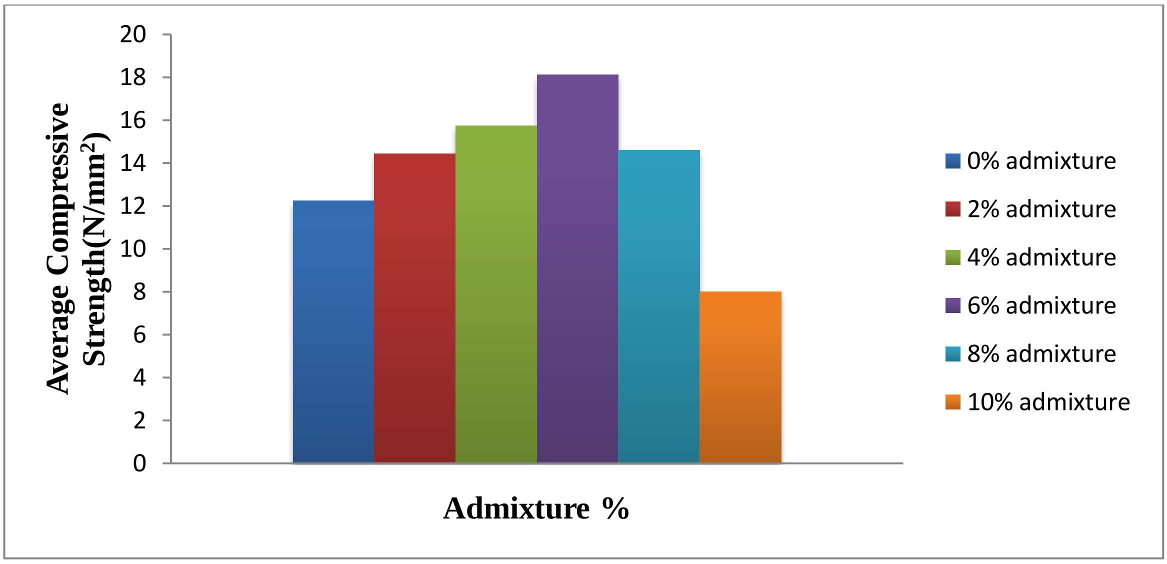

Figure 3: Relationship between compressive strength and varying percentage of admixture at 28days.

The 28days compressive strength from table 2 was plotted as shown in figure 4, the graph indicated that the compressive strength increase steadily as the quantity of admixture increases up to 6% replacement, where the highest compressive strength of 18.12N/mm^2 corresponding to 10% replacement was achieved.

The compressive strength of concrete coconut shell without admixture (control) is 12.25N/mm^2 which is almost the same with 11.29N/mm^2 obtained by Aguwa and Amadi (2010). They made mention that the value was a true one and was confirmed by statistical analysis carried out. It was also noted that the strength of CSC produced increased along with the increase in the curing age.

According to Neville, (2000) Lightweight concrete and masonry concrete usually have compressive strength in the range of 0.3 to 40N/mm^2. Therefore the concrete produced by coconut shell as coarse aggregate partially replaced by 6% complast admixture which offers the highest strength of 18.12N/mm^{2}satisfied the standard requirement.

Thus the complast admixture improves the strength of the concrete made from coconut shell concrete, this can safely be concluded that complast admixture lead to a significant improvement in microstructure which can be attributed to the fact that water reducing admixture enable a given fresh concrete mix to have higher flowability (workability) without increasing the water content which result in faster rate of concrete placement, easy placement in relatively poor accessible location without vibration, true shutter finish for highly reinforced concrete members and reduction in cement content. The result of a shear slump of coconut shell was presented in table 3, the slump increases as the admixture content increased. This satisfied the specific requirement of35-65mm for different lightweight concrete. Generally higher slump will produce more workable concrete and that will result in higher compacting factor.

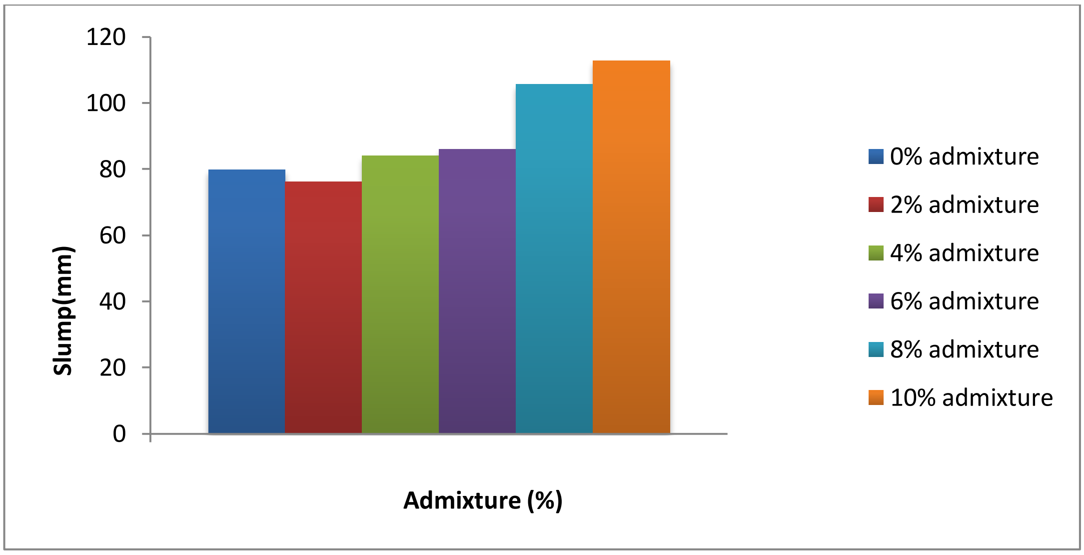

Figure 4: Relationship between the varying % of admixture and slump

Table 3: Results of Slump Test

% of Admixture	Mix Ratio	W/C Ratio	Slumps Trials			Slumps Average	Slump Type
			1	2	3		
0	1:2:4	0.5	62	55	62.5	59.83	Shear
2	1:2:4	0.5	50.5	62	56	56.17	Shear
4	1:2:4	0.5	69	65	58	64	Shear
6	1:2:4	0.5	66	70	62	66	Shear
8	1:2:4	0.5	95	77	85	85.67	Shear
10	1:2:4	0.5	88.5	98	92	92.83	Shear

CONCLUSION

The effect of water reducing admixtures in lightweight coconut shells concrete ware studied, and base on the analysis of the result obtained, it is concluded that;

1. The physical properties of coconut shell as proved that it has satisfactory properties as coarse aggregate and can be used for the production of lightweight concrete.
2. Lightweight concrete produced with coconut shell aggregate incorporated with complast admixture has an improved compressive strength for masonry concrete constructionand a reduced structural weight of the concrete compered to the normal aggregate,
3. By using the coconut shell as a coarse aggregate for production of lightweight concrete, it will boost the commercial activities of many dwellers in the areas where they are produced.
4. It will also improve the sanitary condition of the area were they are produced

ACKNOWLEDGEMENTS

Our sincere aPpreciation and gratitude goes to our Head of Department, Engr. Dr. M. Abdullai, for his encouragement and advice during the course of this research. Honourable mention and regards goes to our fathers in the department, Engr. Prof S. Sadiku, Engr. Prof. O. D. Jimoh and the entire staffs (Academic and Non-academic) of the Civil Engineering department. Also not forgetting the technical staffs in the laboratory for their advice and suPport. Special thanks to all the undergraduate students that were involved inpractical/laboratory works during the research.

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