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Mechanical Properties of Self-Healing Concrete with Artificial and Natural Fibres

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Abstract: ***This paper describes the comparative experimental data on the mechanical properties of polypropylene and basalt fibre reinforced self healing concrete. In that compression, split tensile and flexure parameters are studied. Polypropylene and basalt fibre, both with same concrete mix M25 grade. The total dosage of fibre are maintained at 0.3%, 0.4% and 0.5% by volume fraction. The experimental data demonstrated polypropylene and basalt fibres reinforced concrete to be stronger in compression, tensile and flexure in early stages. This paper also presents the increase in compressive strength of fibre reinforced concrete by microbial activity of bacteria, Bacillus subtilis. Bacteria were introduced in concrete by encapsulation method. In all the techniques calcium lactate were used as organic precursor. Specimens were made by bacteria mixed with fibre reinforced concrete to compare the changes in compressive strength of concrete. Results showed that fibre reinforced concrete incorporated with bacteria shows significant enhancement in compressive strength of concrete.***

Keywords: Mechanical properties, Polypropylene, Basalt, Bacillus Subtills, Hybrid Fibre Reinforced Concrete, Encapsulation method, Calcium Lactate.

I. INTRODUCTION

Concrete is the widely used construction material mainly due to its availability, low cost, sustainability and durability. It is also a fragile material, as it degrades over a period of time by development of substances like cracks which may arise due to chemical attack, humidity, variation in temperature, hydration etc., the appearance of small cracks (<0.3mm) in the concrete is mostly unavoidable as it affects the service life and sustainability.

The autogenous healing mechanism is applicable for these type of small cracks. Bacillus Subtilis, a bacteria which is used for the study of self healing property of the concrete. The biocementation of the bacteria is done by injection of bacteria through capsules. This study mainly deals about the considerable increase of compressive strength. In addition to self healing concrete, the study of hybrid fibre reinforced concrete is also made. A hybrid fibre reinforced concrete is one in which two or more different types of artificial and natural fibres are used. Fibres are added as different percentages as 0.3%, 0.4%, 0.5% respectively based on other studies. Tests are conducted to study the mechanical properties of concrete with various percentage of fibres. Test include compressive strength, flexural strength and slit tensile strength tests.

II. BACTERIA USED

Type of bacteria used from the bacillus family is BACILLUS SUBTILIS. When the cracks appear in the concrete, the water seeps in the cracks. The spores of bacteria germinate and starts feeding on the calcium lactate consuming oxygen. The soluble calcium lactate is converted to insoluble limestone. The soluble limestone starts to harden. Thus filling crack, automatically without any external aide.

III. MATERIALS

A. Fine Aggregate

In the present study locally available sand was used. Sieve analysis was done. The specific gravity of sand was 2.9. Sieve analysis of sand confirmed to zone 1 (from IS 383-2016).

B. Coarse Aggregate

Crushed stone aggregate 20mm size was used for concrete. Specific gravity of coarse aggregate was 2.6.

C. Cement

Portland pozzolana cement (PPC)- Super grade cement supplied by Ramco cements. The specific gravity of the cement tested according to IS 445:1980, was found to be 2.9

D. Water

The portable water available in the college campus has been used.

E. Fibre

1) *Basalt Fibre:* Basalt fibre is made from single material, crushed basalt, from a carefully chosen quarry source. Basalt of high acidity (over 46% silica content) and low iron content is considered desirable for fibre production. Unlike with other composites, such as glass fibre, essentially no materials are added during its production. The basalt is simply wasted and then melted. The manufacture of basalt reqires the melting of the crushed and washed basalt rock at about 1500˚C (2730˚F). The molten rock is then extruded through small nozzles to produce continous filaments of basalt fibre.

Table:1 Basalt fibre

Tensile strength	2.8-3.1 Gpa
Elastic modulous	85-87 Gpa
Elongation	3.15%
Density	2.67 g/cm^3
Aspect ratio	2.0

2) *Polypropylene Fibre:* Polypropylene is a thermoplastic polymer used in a wide variety of applications including packaging and labeling, textiles (e.g., ropes, thermal underwear and carpets), stationery plastic parts and reusable containers of various types, laboratory equipments are loudspeakers, automotive components, and polymer banknotes. Polypropylene fibre concrete is versatile and can be used in most applications. Polypropylene fibres added to the concrete for strengthening concrete and for protection of concrete against micro cracks. The function of polypropelene is not a replacement of steel but to avoid the creation of micro cracks in the concrete.

Table:2 Polypropylene fibre

Property	Polypropylene
Length	20mm
Diameter	100µm
Specific gravity	0.9
Tensile strength	450Mpa

Figure1: Basalt fibre

Figure2: Polypropylene fibre

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IV. PREPARATION OF BACTERIAL CONCRETE

By encapsulation method the bacterial concrete is prepared. The bacteria and its food (calcium lactate) are placed and treated as a pellets. About 6% of clay pellets are added for making bacterial concrete. When concrete structures are made with bacterial concrete, when the cracks occurs in the structure and clay pellets are broken and bacteria germinates and eat down the calcium lactate and produces limestone, which hardens and thus sealing the crack. Minor cracks about 0.5mm width can be treated by using bacterial concrete.

A. Chemical Process of self healing Concrete

When the water comes in contact with the unhydrated calcium in the concrete, calcium hydroxide is produced by the help of bacteria. Which acts as a catalyst. This calcium hydroxide reacts with atmospheric carbondioxide and forms limestone and water. This extra water molecule keeps the reaction going.

Figure3: Bacillus subtilis


Figure4: bacterial pellets

V. MIX PROPORTIONS

Water	Cement	FA	CA
191.6	426	558	1109
0.45	1	1.30	2.60

Mix ratio – 1:1.30:2.60

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VI. CONCRETE PREPARATION

The control specimens, fibre added specimens and the infilled tubes are casted with M25 grade concrete with 20mm coarse aggregate and fine aggregate of nominal requirements. The water / cement ratio to be used is 0.45, which was obtained from the mix design. The concrete is prepared by manual mixing. For the fibre reinforced concrete, basalt and glass fibre are partially mixed with sand by percentage of 0.3,0.4 and 0.5 .The concrete is prepared and placed in the mould. While placing the concrete in the mould they are blown with tamping voids in order to achieve compaction

Figure4: Casted specimens

VII. RESULTS

A. Tests on Fresh Concrete

As the water-cement ratio is 0.45 it is necessary to evaluate the workability of fresh concrete. The workability of the fresh concrete was tested by slump cone tests.

1) Slump cone Test: The slump test result is a measure of the behaviour of a compacted inverted cone of concrete under the action of gravity. It measures the consistency or the wetness of concrete.

Table:3 Results of slump test

Sl.No	W/C Ratio	Fibre %	Slump Value (cm)	Type of Slump
1	0.45	0	3.8	True slump
2	0.45	0.3	3.4	True slump
3	0.45	0.4	3.3	True slump
4	0.45	0.5	3.2	True slump

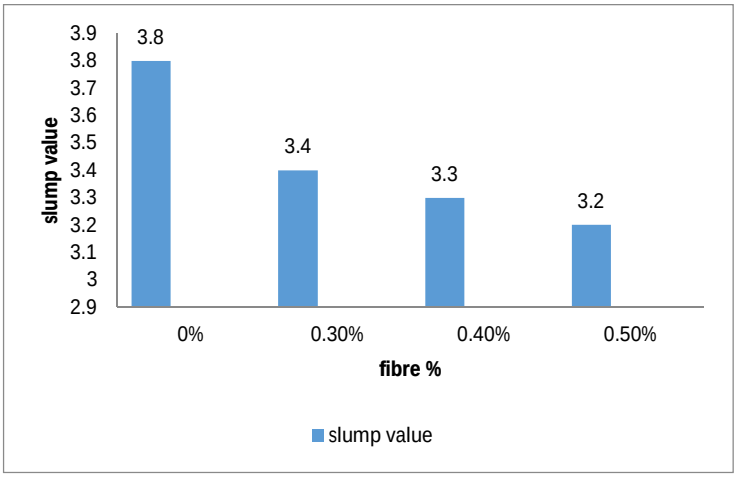


Figure5: Slump values

B. Tests on Hardened Concrete

The mechanical properties of the concrete such as compressive strength, split tensile strength, flexural strength were determined for each concrete mix by taking 3 trails for each test. The average value from the 3 trails was tabulated and compared.

1) Compressive Strength Test: To determine the compressive strength of the cubes. It consists of applying a compressive axial load to the moulded cubes. And it is cracking load range, the load is allowed until the crack occurs.

Table:4 Results of compressive strength tests

SL.NO	FIBRE %	STRESS (N/mm$^{2)}$
1	0%	28.89
2	0.3%	29.5
3	0.4%	32.3
4	0.5%	30.6

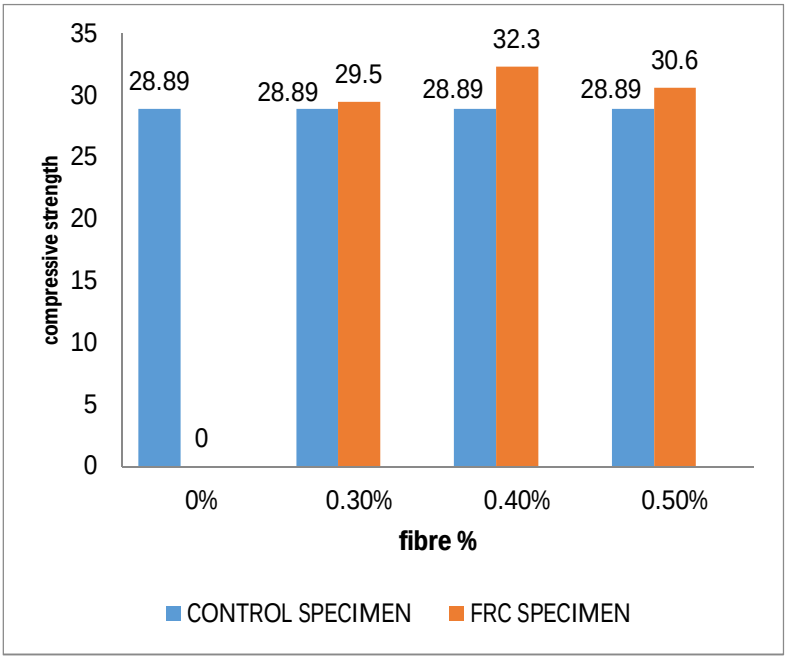


Figure6: Compressive strength values

C. Split Tensile Strength

The tensile strength is one of the basic and important properties of the concrete. The concrete is usually expected to resist the direct tension because of its low tensile strength and brittle nature.

Table:5 Results of split tensile strength tests

SL.NO	FIBRE %	STRESS (N/mm$^{2)}$
1	0%	2.6
2	0.3%	2.7
3	0.4%	2.9
4	0.5%	2.8

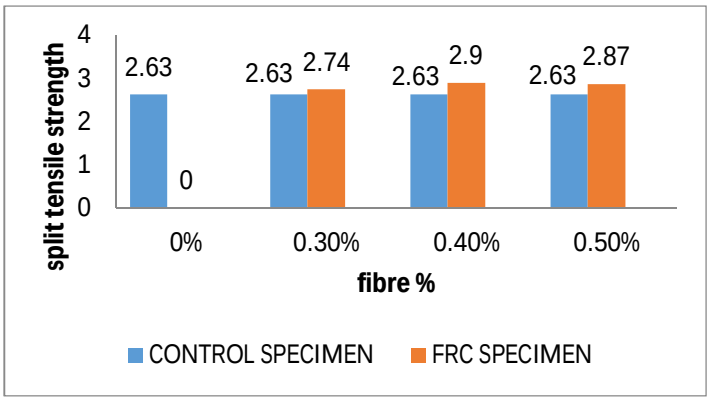


Figure7: Split tensile strength values

D. Flexural Strength Of Concrete

Flexural test evaluates the tensile strength of concrete indirectly. It tests the ability of unreinforced concrete beam and slab to withstand failure in bending. The results of flexural test on concrete expressed as a modulus of rupture which denotes as (MR) in Mpa or psi. Indian standard determined the size of the concrete specimens as 150mm width, 150mm depth, and span of 700mm. flexural strength were determined for each concrete mix by taking 3 trails for each test. The average value from the 3 trails was tabulated and compared.

Table:6 Results of flexural strength tests

SL.NO	FIBRE %	MODULOUS OF RUPTURE (kg/cm^3)
1	0%	2.91
2	0.3%	3.02
3	0.4%	3.21
4	0.5%	3.17

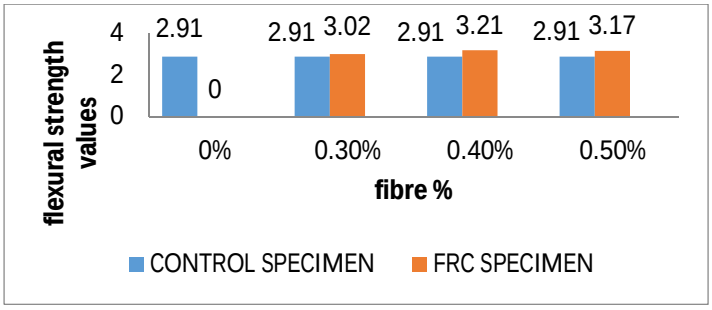


Figure:8 flexural strength values

E. Comparison Of Compressive Strength

Above results clearly shows that 0.4% of hybrid fibre reinforced concrete yields more strength compared to 0.3% and 0.5% of hybrid fibre reinforced concrete. Therefore 0.4% of hybrid fibres are mixed with bacterial concrete to check the comparison of compressive strength. Bacterial concrete are prepared by encapsulation method

Table:7 Results of compressive strength tests

SL.NO	MIX	STRESS (N/mm^2)
1	CM	28.89
2	0.4% HFRC	32.3
3	0.4% HFRBC	37.3

Comparison of compressive strength values are given below

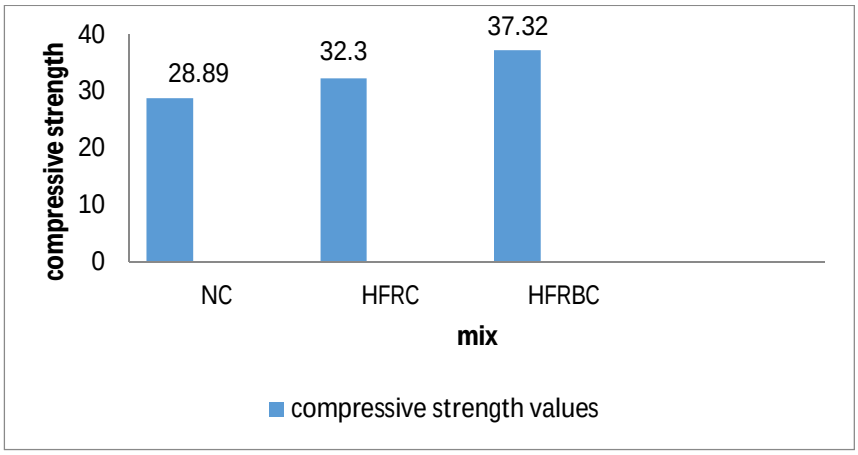


Figure:9 Comparison of compressive strength

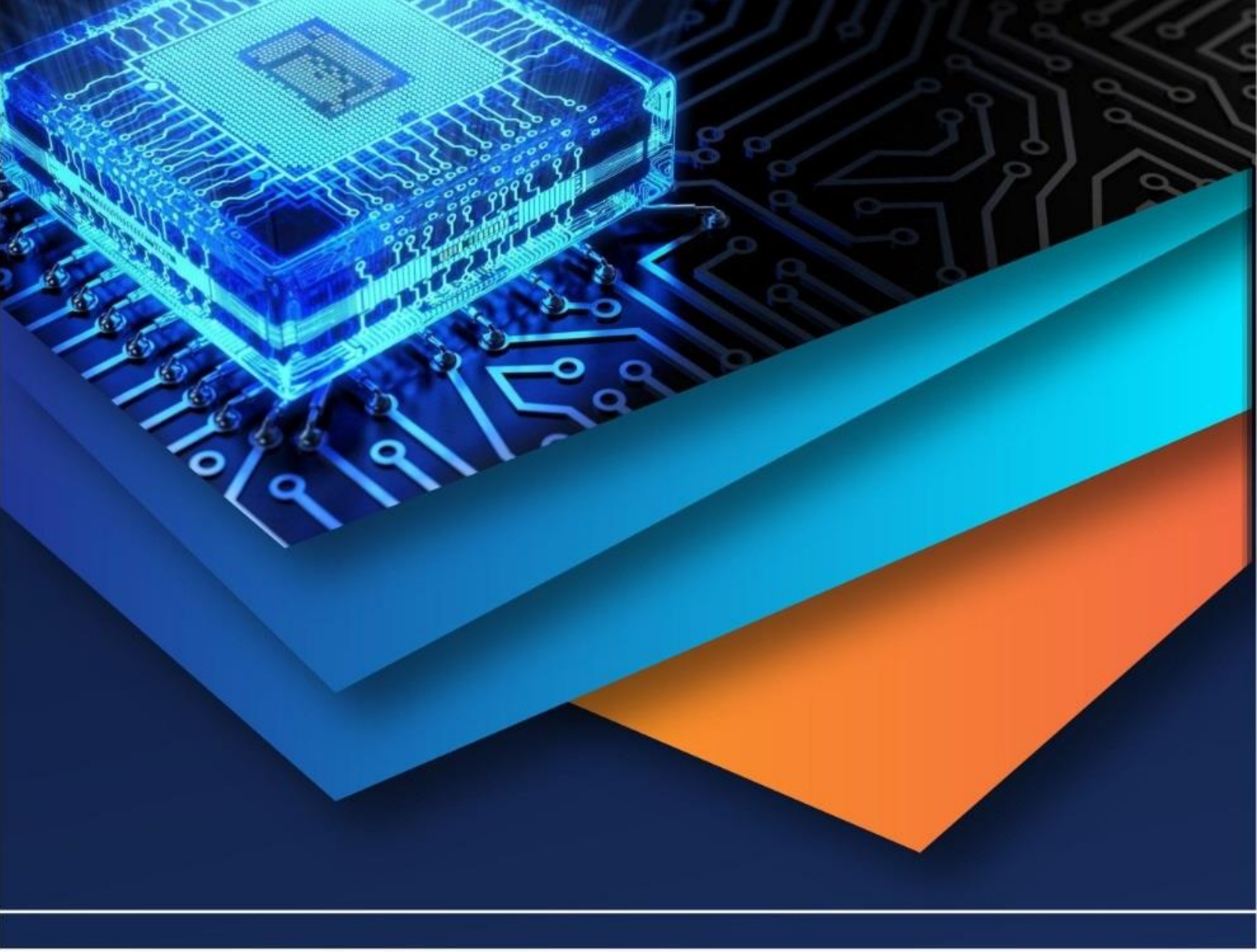
VIII. CONCLUSION

The conclusion drawn from these experimental investigation are as follows:

A. The compressive strength of hybrid reinforced concrete was increased 34.2% compared to control specimens
B. The split tensile strength of hybrid fibre reinforced concrete was increased 49.65% when compared to control specimens
C. The flexural strength of hybrid fibre reinforced concrete was increased when compared to control specimens
D. The compressive strength of hybrid fibre reinforced bacterial concrete was increased 36.2% compared to hybrid fibre reinforced concrete
E. Above datas clearly shows that hybrid fibre reinforced bacterial concrete yields more strength compared to hybrid fibre reinforced concrete

REFERENCES

[1] Aparna V, Vivek D, Kancharla neellima and Karthikeyan B, (2017) “Experimental investigation on steel-concrete composite columns for varying parameters”
[2] Gajalakshmi P, Janee Helena H and Srinivasa Raghavan (April 2011) “Experimental investigation on the behavior of concrete filled steel columns”
[3] Indira Devi, Elakkiya, Janani, Kirthiga (2016) “ Experimental investigation on concrete filled steel tubular columns using FRP composites”
[4] IS 383-1970 specification for coarse and fine aggregates from natural souce of concrete (1993)
[5] IS 10262-1982 Recommended guidelines for concrete mix design(1998)
[6] Kadhim Zuboon Nasser (2012) “Structural behavior of concrete filled aluminium tubular columns”
[7] Teng, Yua, Wonga (2016) “Concept and behavior of HFRC steel tubular columns”
[8] Vinayagar K, Senthil kumar A (2016) “Crasnworthiness analysis of double section bi-tubular thin walled structures”
[9] J.Y.Wang, H.Soens, W.Verstraete (2016) “Self-healing concrete by use of microencapsulated bacterial spores”
[10] Zaheer Hussain A, Ashna tom, Juliet joseph (2017) “Microbial concrete and influence of microbes on properties of concrete”
[11] Padmanaban iyer, Saro Y, Kenno 2015 “Mechanical properties of fibre reinforced concrete made with basalt filament fibre”
[12] Amit rai, Alani, Mortesa 2014 “Applications and properties of fibre reinforced concrete”
[13] Amir , Y.P.Joshi 2013 “Mechanical properties of fibre reinforced concrete-A comparative study”
[14] Sivakumar and Manu santhanam 2010 “ Mechanical properties of high strength concrete reinforced with metallic and non metallic fibres”
[15] Viktrant , Kavitha and Kene S. 2012 “Experimental investigation on hybrid fibre reinforced concrete”
[16] Song ,P.S and S. Hwang, 2012 “Mechanical properties of high-strength steel fibre reinforced concrete”
[17] P.K.Mheta, P.J.Montrio, 2006 “Microstructure properties and materials”
[18] P.Hewiett, 2003 “Chemistry of cement and concrete”
[19] S.K.Ramachandran, V.Ramakrisna,“Remedition of concrete using microorganisms”



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