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EXPERIMENTAL ST UDY ON STRENGTH PROPERTIES OF STEEL FIBER AND GLASS FIBER BASED ON FLYASH BASED CONCRETE

PS.Sai Bhavana*, E.V.Chandra Sekhar
* PS.Sai Bhavana, Krishna Chaitanya institute of Technology & Sciences, Markapur, A.P., India
E.V.Chandra Sekhar Department of Civil engineering, Krishna Chaitanya institute of Technology & Sciences, Markapur, A.P., India

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ABSTRACT

Cement is the most popular material used in construction the demand and cost of cement is increasing day to day, so experts are looking for supplementary materials with the main objective of reducing solid waste disposal problem. Fly ash which is a solid waste generated from thermal power station is used in partial replacement of cement in various proportions which is environmental friendly and also different fibers are also used to increase tensile strength and reduce cracks in the concrete. Concrete is the most vital material in the modern construction. Which has been in practice from olden days but concrete suffers from low tensile strength, limited ductility and little resistance to cracking. To overcome these weaknesses a new variety of concrete is desired. Therefore here is an experimental study proposing changes to the conventional concrete to increase fire resistance, increase crack resistance, increase ductility and flexural strength by partial replacement of fly ash to the cement and introducing fibers in the preparation of the concrete.

INTRODUCTION

General:

Cement is likely the most broadly utilized development material as a part of the world. The principle constituent in the traditional cement is Portland concrete. The measures of bond production discharge roughly break even with measure of carbon dioxide into the air. Bond creation is expending critical measure of normal assets. strength is due to the propagation of such micro cracks. In plain concrete structural cracks develop even before loading, due to drying shrinkage or other causes of volume change. The width of these initial cracks is few microns, but their other dimensions may be of higher magnitude. When loaded, the micro cracks propagate and open up, and additional cracks form in places of minor defects. The development of such micro cracks is the main cause of inelastic deformations in concrete. It has been recognized that the addition of small, closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and uniformly dispersed fibers to concrete would act as crack stop and would substantially improve its static and dynamic properties.

Steel fiber:

We all know that concrete is weak in tension and strong in compression in order to compensate the tension in the concrete we use either reinforcement or fibers in concrete it is hard to reinforce very thin members so we use fibers to reinforce thin members. Fiber is a small piece of reinforcing material possessing some characteristic property. Fiber is often described with a parameter called “aspect ratio”.

Types of Steel fibers:

Flat End Fiber:

FE (Flat End) fibres are straight fibers with flattened, enlarged ends for improved anchorage. FE fibers can be applied with minimum rebound loss. The typical tensile strength of the wire is 1200MPa.

Fig 1: Flat end fiber

Hooked End Fiber:
HE (Hooked End) fibers are straight fibers with additional hooked ends. The shotcrete fiber can be used in all shotcrete applications. Commonly used with dosage of 25 to 50 kg/m^3, depending on ground conditions. The HE fiber is shot with low rebound losses. The typical tensile strength of the wire is 1200 Mpa.

Fig 2: Hooked End Fiber

TABIX Fiber:
TABIX is an undulated steel fiber (1100 Mpa) used in slope and wall applications without overhead projection.

Fig 3: TABIX Fiber

Glass fiber:
Glass fiber likewise called fiberglass. It is material produced using to great degree fine filaments of glass Fiberglass is a lightweight, to a great degree solid and powerful material.

Types of Glass Fiber:
AR-glass – Alkali Resistant glass made with zirconium silicates. Used in Portland cement substrates.
C-glass – Corrosive resistant glass made with calcium borosilicates. Used in acid corrosive environments.
E-glass – Alkali free, highly electrically resistive glass made with alumina-calcium borosilicate. E-glass is known in the industry as a general-purpose fiber for its strength and electrical resistance. It is the most commonly used fiber in the fiber reinforced polymer composite industry.
ECR-glass – An E-glass with higher acid corrosion resistance made with calcium aluminosilicates. Used where strength, electrical conductivity and acid corrosion resistance is needed.

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R-glass – A reinforcement glass made with calcium aluminosilicates used where higher strength and acid corrosion resistance is needed.
S-glass – High strength glass made with magnesium aluminosilicates. Used where high strength, high stiffness, extreme temperature resistance, and corrosive resistance is needed.
S-2 glass – Glass similar to, but with somewhat improved properties with, S-glass.
"S-2" is a brand name originally created by Owens-Corning but spun off in 1998 and is now a registered trademark of AGY Holdings Corp.

E-glass fiber types:
E Glass fiber is available in the following forms:

Strand - a compactly associated bundle of filaments. Strands are rarely seen commercially and are usually twisted together to give yarns.
Yarns - a closely associated bundle of twisted filaments or strands. Each filament diameter in a yarn is the same, and is usually between 4-13m. Yarns have varying weights described by their 'tex' (the weight in grammes of 1000 linear metres) or denier (the weight in lbs of 10,000 yards), with the typical tex range usually being between 5 and 400.
Mechanical properties:

Table1: Glass Fiber Properties

Fiber type	Density ing/cm^3	Tensile strength in Mpa	Modulus of rigidity in GPa	% Elongation
A-glass	2.44	3300	72	4.8
AA-glass	2.7	1700	72	2.3
C-glass	2.56	3300	69	4.8
D-glass	2.11	2500	55	4.5
E-glass	2.54	3400	72	4.7
ECR-glass	2.72	3400	80	4.3
R-glass	2.52	4400	86	5.1
S-glass	2.53	4600	89	5.2

Environmental properties of E-Glass Fiber:

Table 2: Environmental Properties of E-Glass Fiber

Environmental Properties	
Resistance Factors 1= poor , 5= excellent	
Flammability	5
Fresh Water	5
Organic Solvents	5
Oxidation of 500C	5
Sea Water	5
Strong Acid	5
Strong Alkali	5
UV	5
Wear	5
Weak Acid	5
Weak Alkalis	5

Fly ash:
Fly ash is by-product obtained from the thermal power plants obtained from combustion of coal. Generally fly ash has higher impact on the environment because of presence of heavy metals like mercury, cadium, boron. Fly ash being a byproduct was been used in landfilling as solution for solid waste disposal purpose where in which these heavy metals leach through this landfills and effect the health of the surrounding population. But India is only country whose 70% of population depends on thermal power which means higher coal consumption resulting in higher fly ash production which should properly disposed.

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Cement:
Cement is the major ingredient in assembling of concrete. The qualities of concrete will be incredibly influenced by changing the Cement content. The Cement used in this project is Ordinary Portland Cement of 53 grade confirming to IS 12269 – 1987.

Fine aggregate:
Aggregates of size ranges between 0.075mm – 4.75mm are generally considered as fine aggregate. The Fine aggregate are selected as per IS-383 specifications.

Coarse Aggregate:
Sizes of aggregates above 4.75mm are generally considered as coarse aggregate. The maximum size of coarse aggregate used in this experimental work is 20 mm and 12 mm, and chips also have used 20% that is size of 12mm passing and 10mm retaining. A good quality of Coarse aggregate is obtained from nearest crusher unit.

Super plasticizer:
Plasticizers are used to reduce water/cement ratio and attain the same strength. The plasticizer used in this experiment is Conplast SP430 DIS.

MIX DESIGN
Mix Design for M25
The steps involved in the design of concrete mix as per IS: 10262-2009 ,IS: 456-2000.

Proportions:

M-25 CONCRETE MIX DESIGN		
As per IS 10262-2009 & MORT&H		
I	**Stipulations for Proportioning**	
1	Grade Designation	M25
2	Type of Cement	OPC 53 grade confirming to IS-12269-1987
3	Maximum Nominal Aggregate Size	20 mm
4	Minimum Cement Content (MORT&H 1700-3 A)	320 kg/m3
5	Maximum Water Cement Ratio (MORT&H 1700-3 A)	0.45
6	Workability (MORT&H 1700-4)	50-75 mm (Slump)
7	Exposure Condition	Normal
8	Degree of Supervision	Good
9	Type of Aggregate	Crushed Angular Aggregate
10	Maximum Cement Content (MORT&H Cl. 1703.2)	450 kg/m3
2	**Test Data for Materials**	
1	Cement Used	OPC 53 grade
2	Sp. Gravity of Cement	3.15
3	Sp. Gravity of Water	1.00
4	Sp. Gravity of 20 mm Aggregate	2.86
5	Sp. Gravity of Fine Aggregate	2.6

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CASTING

This experimental program consists of the following steps:

- Casting
- Curing
- Testing

Preparation of Moulds:

Metal moulds preferably steel moulds or cast iron moulds for prevention of distortion. The moulds are manufactured in such a manner where it can be subdivided and attached again easily, so that the specimen won't be facing any damage.

Cubes:

Each trail of 15 cubes is casted for 7 days, 28 days and 90 days for compressive Strength test and 28 days (HCl curing) and 28 days (H_2SO_4 curing). The dimension of the cube specimen is 150mm x 150mm x 150mm.

Cylinders:

Each trail of 6 cylinders is casted for 28 days and 90 days for split tensile strength test. The dimension of the cylinder is length=300mm and diameter=150mm.

Beams:

Each trail of 6 beams is casted for 28 days and 90 days for flexural strength test.
The dimension of the beam is 500mm x 100mm x 100mm.

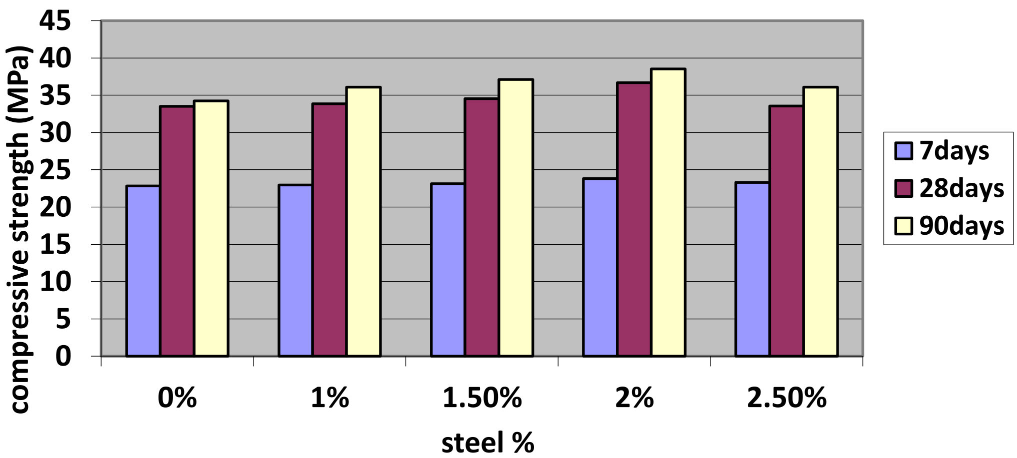
Testing and Results of Specimens

Compressive strength: The compression test is carried out on specimens cubical or cylindrical in shape. Prism is also sometimes used, but it is not common in our country. The end parts of the beam are left intact after failure in flexure and, because the beam is usually of square cross section, this part of the beam could be used to find out the compressive strength.

Compressive Strength = P/A

Steel %	Compressive Strength		
	7 days cubes (MPa)	28 days cubes (MPa)	90 days cubes(MPa)
0%	22.84	33.52	34.25
1%	22.96	33.84	36.08
1.5%	23.15	34.56	37.1
2%	23.82	36.68	38.52
2.5%	23.3	33.56	36.1

Table 3: Compressive strength of steel fiber reinforced fly ash concrete



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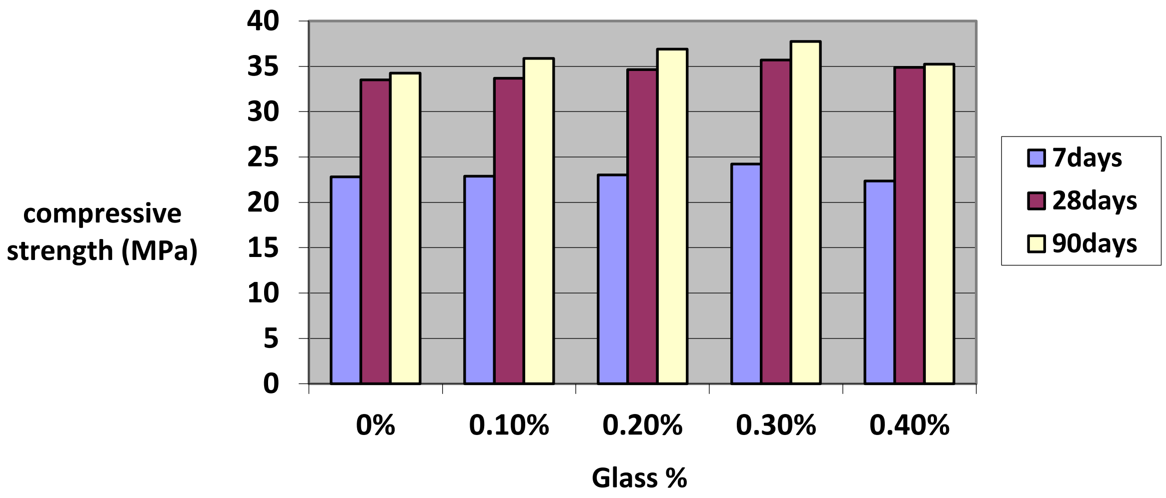
Graph 1: Compressive strength of Steel fiber reinforced fly ash concrete

Glass %	Compressive Strength		
	7 days cubes (MPa)	28 days cubes (MPa)	90 days cubes (MPa)
0%	22.84	33.52	34.25
0.1%	22.9	33.67	35.86
0.2%	23.04	34.65	36.89
0.3%	24.23	35.68	37.76
0.4%	22.34	34.89	35.23

Table 4: Compressive Strength for Glass fiber reinforced fly ash concrete



Graph 2: Compressive strength of Glass fiber reinforced fly ash concrete

Split Tensile Test:

Split Tensile strength is obtained by applying crushing load on the cylinder surface. Split Tensile strength of concrete is calculated by casting 150mm diameter and 300mm cylinders. The test results are presented here for the split tensile strength of 28 days and 90 days of testing.

Table 5: Split Tensile Strength for Steel fiber reinforced fly ash concrete

Steel %	Split Tensile Strength	
	28 days cubes (MPa)	90 days cubes (MPa)
0%	3.2	3.4
1%	3.58	4.14
1.5%	3.92	4.52
2%	**4.12**	**5.12**
2.5%	3.82	4.32

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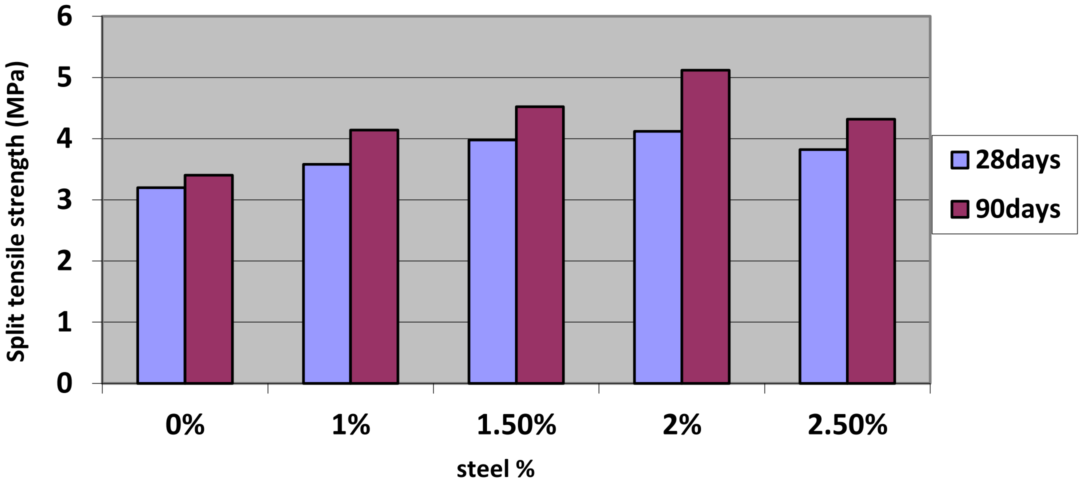
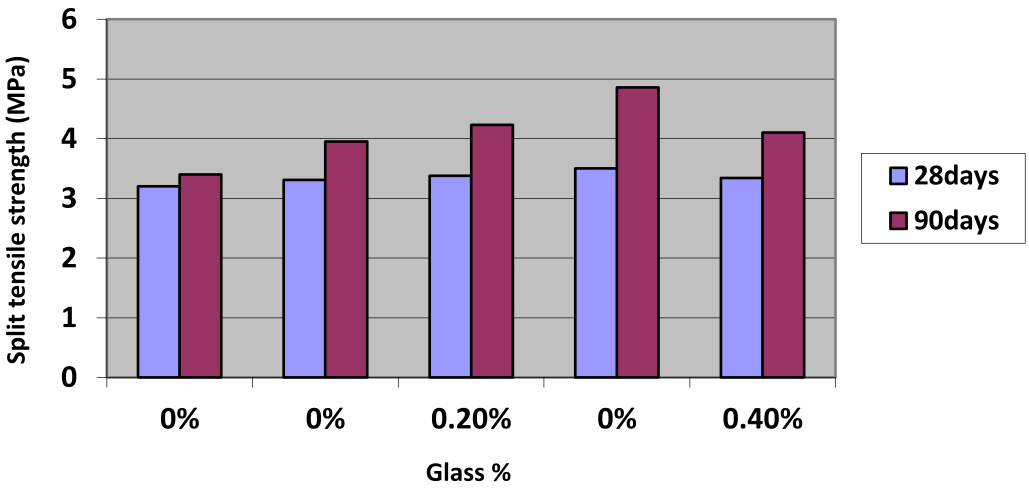


Graph 3: Split Tensile Strength for Steel Fiber reinforced fly ash concrete

Table 6: Split Tensile Strength for Glass Fiber reinforced fly ash concrete

Glass %	Split Tensile Strength	
	28 days cubes (MPa)	90 days cubes (MPa)
0%	3.2	3.4
0.1%	3.31	3.95
0.2%	3.38	4.23
0.3%	3.5	4.86
0.4%	3.34	4.10



Graph 4: Split Tensile Strength for Glass Fiber reinforced fly ash concrete

Flexural Test:

Flexural test was performed on beams size of 500mm × 100mm × 100 mm size by placing them on universal testing machine find out the flexural strength.

Table 7: Flexural Strength for Steel Fiber reinforced fly ash concrete

	Flexural Strength

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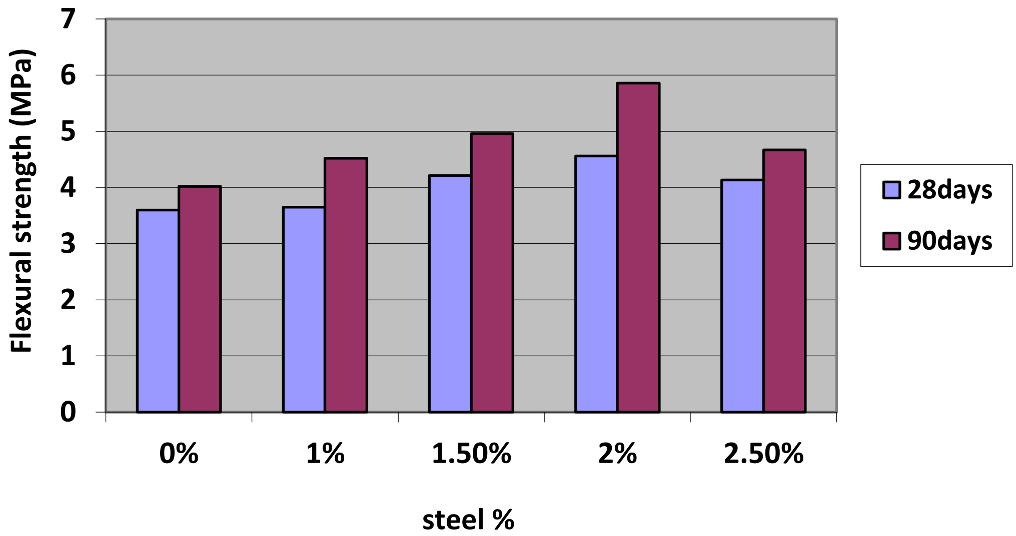
Steel %	28 days cubes (MPa)	90 days cubes (MPa)
0%	3.6	4.02
1%	3.65	4.52
1.5%	4.21	4.96
2%	4.56	5.86
2.5%	4.13	4.67



Graph 5: Flexural Strength for Steel Fiber reinforced fly ash concrete

Table 8: Flexural Strength for Glass Fiber reinforced fly ash concrete

Glass %	Flexural Strength	
	28 days cubes (MPa)	90 days cubes (MPa)
0%	3.6	4.02
0.1%	3.96	4.35
0.2%	4.19	4.86
0.3%	4.32	5.34
0.4%	4.05	4.5

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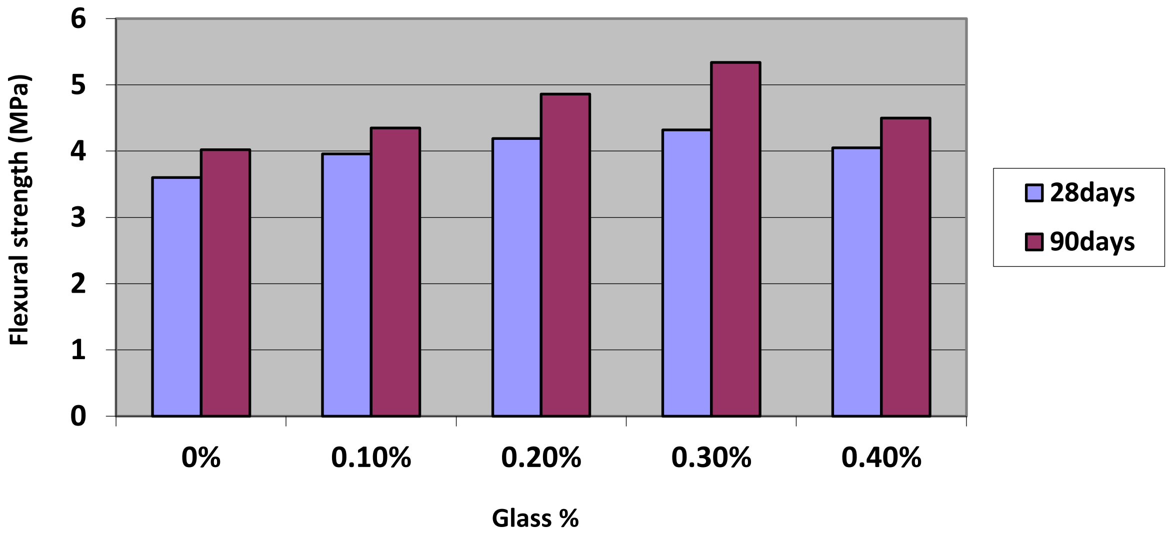

Graph 6: Flexural Strength for Glass Fiber reinforced fly ash concrete

CONCLUSIONS

In this experimental study the comparative study is done between steel fiber and glass fiber based fly ash concrete.

- The replacement of fly ash to the cement optimum is 25%.
- The increase in mechanical strength for M25 grade for partial replacement of Steel fiber (2%) for 7, 28 & 90 days of curing.
- The increase in mechanical strength for M25 grade for partial replacement of Glass fiber (0.3%) for 7, 28 & 90 days of curing.
- The results show that steel fiber is more effective than glass fiber.
- This study shows that compressive strength, split tensile strength and flexural strength are higher when steel fiber is added to the fly ash concrete than glass fiber.

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Address of the materials

[1] Stewols India Pvt Ltd Nagpur Industrial Estate, Kamptee Road, Uppalwadi, Nagpur-440026, India
[2] HI-TECH FIBER GLASS MATTINGS (P) LtdRegd. Office: 3-6-361/19, Basheerbagh, Hyderabad

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