SOME EXPERIMENTAL INVESTIGATIONS ON FIBRE REINFORCED CONCRETE

A PROJECT REPORT

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BONAFIED CERTIFICATE

Certified that report titled "**Some Experimental Investigations On Fibre Reinforced Concrete**" is the bonafide work of..DEPT....COPY.............Reg.No ...., who has carried out the research under my supervision. Certified further, that to the best of my knowledge the work reported herein does not from part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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Concrete is the most widely used construction material. Even though plain concrete is strong in compression; it is brittle in tension and develops micro cracks during curing, due to thermal expansion and contraction over a period of time. Deficiencies like brittleness poor tensile and impact strength makes concrete unsuitable for certain application.

Some of these deficiencies can be over come by the addition fibers to cement concrete. The addition of fibers improves current resistances. Fracture, toughness resistance to impact and shock.

The addition of fibers to cement concrete alters the crack propagation pattern making cracks propagation more controlled. This results in improved cracks resistance and higher strength. Steel fibers are extensively used in fiber reinforced concrete while non metallic fiber like carbon, glass, polyester, and natural fibers like cotton, coir and getting increasingly used.

In this project work, an experimental investigation has been carried out to study the compressive strength, split tensile strength, flexural strength, resistance to abrasion and water absorption using polyester fibers, metallic fibers and hybrid fibers to conventional concrete. The addition of fibers increases the strength properties of concrete moderately when compared with conventional concrete.

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LIST OF SYMBOLS AND ABBREVIATIONS

P1	Conventional concrete
P2	Concrete with 0.45% of polypropylene fiber added
P3	Concrete with 0.45% of steel fiber added
CA	Course Aggregate
CF	Compaction Factor
FA	Fine Aggregate
FST	Final Setting Time
HRSP	Super plasticizer
IS	Indian Standards
IST	Initial Setting Time
OPC	Ordinary Portland Cement
PWA	Saturated water absorption
W/B	Water bonding ratio
μ	Microns
FRC	Fiber reinforced concrete

INTRODUCTION

Chapter 1
INTRODUCTION

Fibres in concrete

Some of the features of fiber mesh, as per the manufacturers, are:

- Both steel and polymeric fibres have been used to reinforce concrete and consequently increase its toughness and crack resistance
- Fibre reinforced concrete can be used in some structural applications with a reduced amount or even without any conventional reinforcement
- One application of the fibres is to increase the load carrying capacity of concrete subjected to shear
- The addition of fibres to concrete effectively improves the shear strength of concrete, as the fibre transfer tensile stresses across crack surfaces
- It is made of 100 percent virgin polypropylene fiber which is manufactured to assured quality standard and designed to achieve maximum distribution and freedom from clustering in the mix.
- It is non-absorbent, alkali-tolerant and durable in concrete.
- It is available in a variety of lengths.
- In fibrillated or monofilament format to suit application.
- It can be added at the batching plant or on site at the recommended rate of 0.9 kg/m3 of concrete,
- It is compatible with all cements and admixtures and placeability of concrete is unaffected despite possible lower slump.

Why fibres?

Synthetic fibres have two effects on fresh concrete; they should that should help reduce subsidence and cracking. They reduce bleeding so solids in the concrete don't settle as much, and they increase the tensile strength.

- In general steel fibre length varies from 12.7mm – 63mm
- The diameter of the steel fibre varies between 0.45mm – 1mm.
- Modern steel fibres have shapes which includes round, oval, rectangular, & crescent cross sections.
- The polypropylene fibres are compatible with all cements and admixtures and placeability of concrete is unaffected despite possible lower slump.
- Concretes with 4 percent and 5 percent inch slumps; cover depths of 12.7, 19, and 25.4 mm and #6 and #8 bar was chosen.
- Each combination of these variables was tested three times with half of the specimens containing no fibres and other half containing 0.55 kg pounds of Fiber mesh MD fibrillated polypropylene fibres per cubic yard.
- The low-slump concrete, 12.7 mm, and 25.4 mm covers and #6 rebar matched specimens were used.
- The specimens were inspected for subsidence cracking 4 hours and 18 hours after casting Most of the cracks were visible while the concrete was still plastic,

Fibres arrest the cracking

- The difference in test results was dramatic. Subsidence cracks - some as wide as 18 mm occurred in all 36 of the fibre free concrete test specimens.
- But none in the 36 fibrous concrete specimens made with a 12.7 mm of cover, a #8 concrete.bar and a 127 mm slump

- Adding synthetic fibres at the dosage rates used typically increased the costs of the delivered concrete by 10 percent or more. But specifying the typical 609 mm cover depth for bridge decks can also increase the cost for continuous spans because more tension steel or a greater slab thickness over supports may be required.

- However, an increased cover depth reduces the rate at which chloride ions can penetrate uncracked concrete and reach the reinforcement.

- This delays initiation of corrosion by increasing the time until the chloride concentration threshold is reached.

- Thinner covers depths allow rebar to more effectively reduce the width of cracks from all sources - and the consequences of these wider cracks.

- So adding fibres and reducing cover depths may improve the durability of bridge decks and similar reinforced slabs adversely affected by cracking.

- Sometimes less than the specified value, fibrous concrete may provide added insurance, against subsidence cracking when cover depth is less than desired.

- However, before one can evaluate the benefits of fibre, actual bridge-deck field trails using fibrous concrete and thinner specified cover depths are needed.

Advantages

- Polypropylene fibres inhibits micro-cracking, bleeding and increase cement hydration in fresh concrete, thereby reducing surface permeability, dusting and wear.

- They distribute localised stresses, thereby reducing damage from impact, flexural fatigue, shatter, spalling and cracking in hardened concrete.

- They help in reducing maintenance and repair costs.

- They provide a tough and durable surface

- They help in saving time due to speed and convenience of concrete placing and flexibility.

- They can help in achieving a cost saving of over 50 percent in screeds and overlays in comparison to crack-control steel wire fabric.

According to the British Board of Agreement (BBA) test results, following properties of fibermesh are observed in fresh and hardened concrete.

- reduction in plastic cracking by 83-95 percent in fresh concrete.

- reduction in bleeding by 35-55 percent in fresh concrete.

- reduction in plastic settlement by 27-42 percent in fresh concrete.
- increase in freeze/thaw resistance by 82 percent in hardened concrete.
- increase in abrasion resistance by over 50 percent in hardened concrete.
- reduction in surface permeability by 79 percent in hardened concrete.

Applications

Some of the applications of Fibermesh include:

- long strip
- wide bay and large area fast-track pours
- composite slab
- Screeds
- toppings and overlays
- mortars and renders
- stamped, pumped, extruded and
- sprayed concrete
- water-retaining structures
- plaster and cement-based waterproofing treatments.

Major advantages of fiber on concrete

- Reduces shrinkage cracks / micro cracks.
- Increases abrasion resistance by more than 25%.
- Increases impact and shear resistance by 100%.
- Increases ductility, compressive, flexural and tensile strength.
- Reduces water permeability which prevents corrosion of primary steel.

Types of fibre commonly used in cement concrete

- Steel Fibres
- Synthetic Organic polymer fibres
  - ✓ Polypropylene
  - ✓ Nylon
  - ✓ Polyester
  - ✓ Rayon
  - ✓ Polyethylene
  - ✓ Cellulose acetate
  - ✓ PVA fibres
- Carbon
- Natural
- Asbestos
- Glass

These fibres are classified as fibrillated, monofilament, triangular fibre etc.Commonly used synthetic fibres in concrete are polypropylene and polyester fibres. Polyester and polypropylene fibres have comparable tensile strength and elastic modulus. Effect of high temperature on the properties of concrete reinforced with polymer fibres may be further studied.

Role of metallic fibre in concrete

The concept of steel fibre concrete is very old with substantial development in last two to three decades. Presently, the steel fibres as considered as structural fibres, as these enhance the strength of a great extent. Significant properties of steel fibre reinforced concrete are improved flexural toughness, impact resistance and flexural fatigue endurance. Short length fibres and some by long length fibres improve properties. It is possible to design optimum strength and serviceability behavior by judicious combination of long and short length fibres blend in the matrix.

Dosage of fibre volume increased

On tensile strength : The optimum percentage of fibre is (0.75 to 1).The tensile strength measurements were made SFRC members containing 0.75, 1% by volume of 0.195 cm, 0.125 cm and dia fibre of length 6 cm.

Effect of aspect ratio on strength of concrete

The volume fraction of fibres was kept constant and aspect ratio was varied through the length and diameter. It is that increases of aspect ratio the strength will also increase. There is however a limit up to which strengths increases progressively. In the case of long fiber non uniform distribution of fibers occurs, putting a limit on the aspect ratio up to which the strength increases.

MAIN THEME OF THE PROJECT

Chapter 2

MAIN THEME OF THE PROJECT

ROLE OF STEEL FIBRES IN CONCRETE

Steel fiber for concrete reinforcement

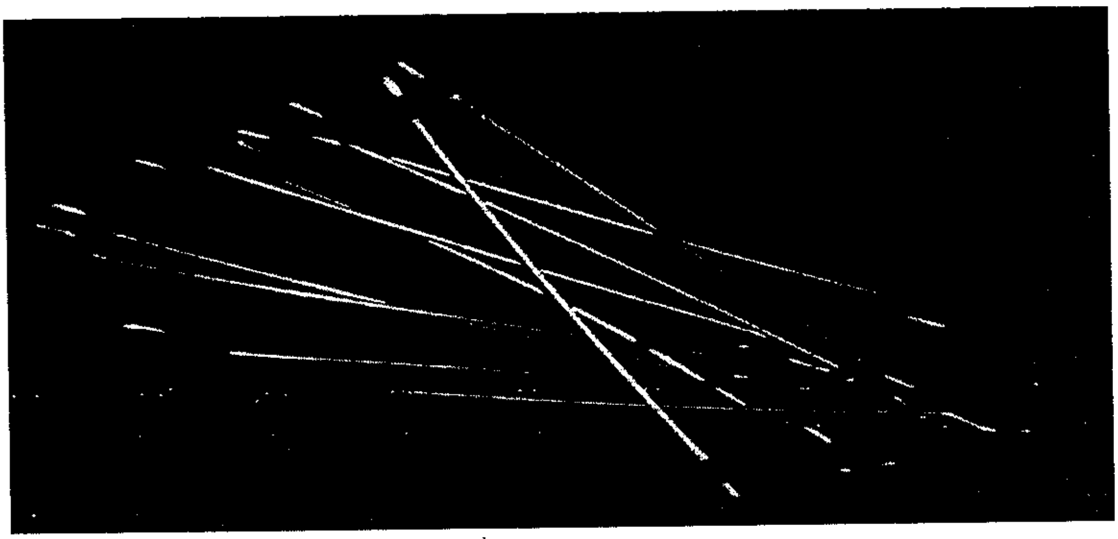


Fig.1 Steel fibre (Dramix type)

1. Application:

A. Moulding concrete. Can apply all kinds of concrete project, such as Air-port, Tunneling, Dam, Road, Bridge and Fire-proof project etc.

B. Ejection Concrete. Pretreatment of the wall of Tunneling, the Molding of The wall of Tunneling, Reinforcing treatment of the slope, Treatment of projection wall when mining, and repairing, reinforcing all kinds of concrete construction.

2. Technical advantages:

A. Improve mechanical performance of concrete

B. Provide uniform distribution throughout concrete with excellent mixing

C. Prevent agglomerating by adopt correct mixing method

3. Economic benefits:

A. Can extend the using life of project

B. Can reduce the thickness of concrete and save the quantities of concrete under the same intensity

C. Can take place of steel totally or partially

D. Replace in concrete the traditional mesh reinforcement.

E. Can reduce the workload of project, Shorten the processing period, Save the cost of project

4. Production style:

Hooked ends steel fiber, Flat head steel fiber, Needle-flat steel fiber, Corrugation steel fiber, undee steel fiber, Micro-steel fiber, stainless steel fiber. Also we can produce the fiber according to customer requirement regarding the diameter, length, shape and others

5. Length: 6-60mm.

6. Diameter: 0.2-1.0mm

7. Appearance: Clear and Bright

8. Tensile Strength: 800-2500mpa

9. Standard: Meets the requirements of ASTM A820 Type I

ROLE OF POLYPROPYLENE FIBERS IN CONCRETE

Polypropylene fiber pp fiber mesh form

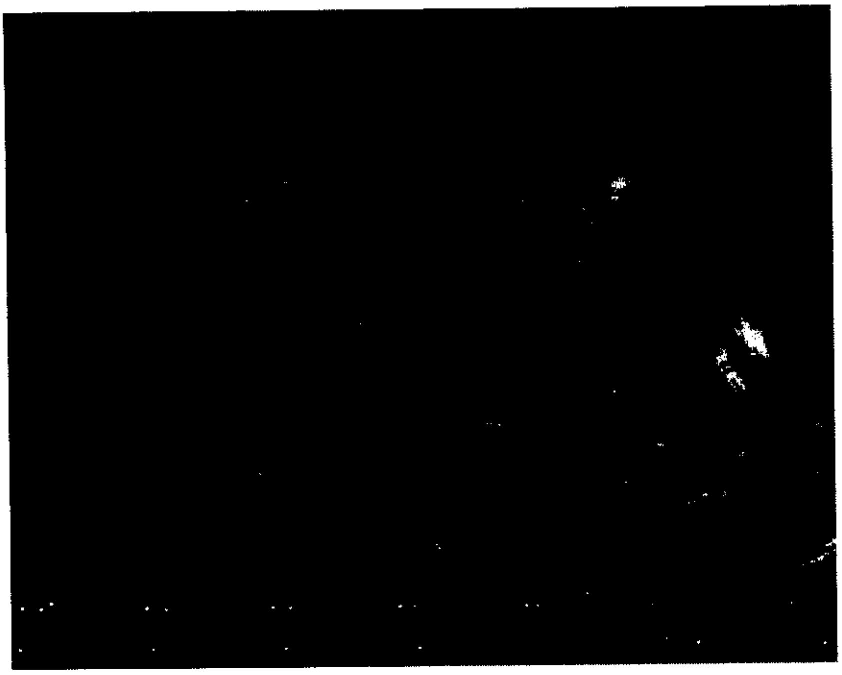


Fig.2 Polypropylene Fiber

Properties:

With polypropylene as its raw material, this fiber was produced by special technology.

- The products appear net-like structure with many fiber monofilaments connected.
- When the fiber was put into the concrete, the horizontal structure in fiber monofilament can be destroyed in the course of stirring owing to friction and rubbing, and the fiber monofilament or net-like structure will fully stretch, thus the concrete is reinforced by a great number (more than 7million pieces per sqm) of polypropylene fibres.

Applications:

- As a new type concrete-strengthening fiber, it becomes a new popular subject in the field of fiber concrete research and application after glass fiber and steel fiber.

1. Reinforced Functions to Concrete:

- Compared with steel fiber, full-dispersed polypropylene fiber has advantages in its thinness, large amount, non-water absorbency, strong acid & alkali resistance and similar elastic modulus with that of concrete.

The reinforced functions run as follows:

- Increase seepage resistance
- Prolong endurance
- Improve steel protection
- Increase cracking resistance
- Increase fire resistance
- Strengthen spurt & fatigue
- Improve tensile, bending & folding strength
- Improve plastic deformity
- Strong acid & alkali resistance and good endurance

2. Suitable Fields for Polypropylene Fiber-Mesh:

A). Projects like concrete road, bridge, airport road and basement like factory floor which strictly require cracking resistance. The life span of these projects will be lengthenedfor5-10years.

B). The walls of tunnels, mines, roofs and reservoir projects with special construction.

- When using spray technology in concrete construction, the polypropylene fiber added into the concrete can effectively decrease the spray concrete's deformation rate of the walls less than 8% and that of the roof less than 12%, and also can reduce the friction.
- It can improve the constructing efficiency and working environment and popularize the spray Technology.

C). River courses and dams, etc. The polypropylene fiber can improve concrete's resistance to crack and squirt and wear to lengthen projects' life span.

D). Military defense works, dock banks and piers, etc. This fiber can greatly strengthen the concrete's spurt resistance and heighten these projects' safety and lengthen their life span.

3. Brief specification:

- Density(g/cm3) 0.91+/-0.01
- Elastic Modulas (MPa) >3500
- Length(mm) 10, 15, 20, 24
- Equivalent Diameter (um) 100+/-50

- Shape Beam-like Net
- Crack Elongation(%) =10
- Acid &Alkali Resistance Strong
- Water-Absorbency No
- Tensile Strength (MPa) 346-560
- Melting Point (C. Deg) 160--170
- Tensile Ratio (%) 5-10

PACKING: Normal packing is 0.6kg or 0.9kg per bag, and 13.5kgs in a carton. Also can be made as per customer`s request. Water soluble bag is available also.

Concrete Cracking

Polyester fiber prevents the shrinkage cracks developed during curing there by making the structure/component inherently stronger. Future, when loads are imposed, as concrete approaches failure, cracks will propagate, sometimes rapidly. Addition of polyester fiber in concrete and plaster prevents/arrests cracking caused by volume change expansion & contraction.

Reduces Water Permeability

A cement structure free from micro cracks prevents water from entering and migrating throughout concrete. This in turn helps preventing the corrosion of steel used as primary reinforcement in the structure. This in turn improves longevity of the structure.

Reduces Rebound in concrete

Polyester fibre reduces rebound of concrete. The raw material wastage reduces and results in saving of raw material. More importantly it saves a great deal of labour employed for the job, which could be completed earlier.

Increases Flexibility

The modulus of polyester fibre is higher than the modulus of elasticity of the concrete or mortar binder. Thus polyester fibre helps to increase flexural strength.

Safe and easy to use

Polyester fibre are environmental friendly and non-hazardous. They easily disperse and separate in the mix.

Economical

Less than 1% of polyester fibre is sufficient for getting the above advantages. Thus it not only pays for itself, but results in net gain with reduced labour cost & improved properties.

EXPERIMENTAL DETAILS

Chapter 3

EXPERIMENTAL DETAILS

The objective of the experiment was to assess the properties of polypropylene, steel and hybrid in fibres blened concrete and study the various important aspects such as compressive strength, split tensile strength, flexural strength. Abrasion resistance water absorption of concrete.

Materials used

53 grade OPC was used throughout the investigation. Locally available river sand and crushed granite stones with maximum size of 20mm were used as fine aggregates and course aggregates. CT 2024 fibres for concrete.

Cement	-	53 grade OPC as per IS 12269
Coarse aggregate	-	Crushed blue granite, 20mm-60% & 16mm-40%, Fineness modulus =7.19 as per IS 383-1978
Fine aggregate	-	River sand, Zone II, Medium sand, Fineness modulus =2.68 as per IS 383-1978
Water	-	Potable water as per IS 456 – 2000
Dramix steel fibre.	-	Length: 6-60mm,Tensile Strength: 800-2500mpa.
Polypropylene fibres	-	Shape of fiber: special for improved holding of cement aggregates

Strength of concrete

- M25 (Strength-25 N/mm^2).
- The proportion arrived as per IS Method of mix design is

  0.45 : 1 : 1.34 : 2.83
  (F : C : FA : CA)

Type of test and specimen details

- Compression Tests for cubes (150×150mm).
- Compression Tests for cylinders (Internal dia 150±0.2mm ,tk 3mm & Height 300±0.1mm)& Split tensile test - To find out stress-strain characteristic of concrete.
- Flexural Tests for small beams (100×100×500mm)

TESTING ON INGREDINTS

Results on cement properties

The physical properties like fineness, consistency, setting time, soundness and compressive strength of OPC were studied as per IS 12296 – 1987 and the test results are shown in table1. The results showed that physical properties of cement satisfy the requirements of IS specification.

Table 1. Properties of Ordinary Portland Cement – 53 grade

Parameter Test	Results obtained	As per IS : 12269 1987
Fineness (m^2/Kg)	30.5	Minimum 225
Normal consistency (%)	30.5	--
Setting Time (minutes) Initial Final	 90 170	 Minimum 30 Maximum 600
Soundness Le – Chatlier Expansion (mm)	0.75	Maximum 10
Compressive Strength (Mpa) 3 days 7 days 28 days	 38.0 43.8 56.2	 Minimum 27 Minimum 37 Minimum 53

Results on fine aggregate properties

Definition for specific gravity

The specific gravity (G) of soil grains usually called soil is the ratio of weight in air of the given volume of dry soil solids at a stated temperature to the weight in air of an equal volume of distilled water as a stated temperature.

The physical properties like fineness modulus, specific gravity, bulk density where studied as per IS: 383 – 1978 and the obtained results were as shown in below table.

Table 2. Properties of fine aggregate

Test Particulars	Results obtained	As per IS:12269-1987
Fineness modulus	2.8	Medium sand
Specific gravity	2.6	2.55 minimum
Bulk densitykg/m3	1578.17	

Result on coarse aggregate

" Specific gravity"

The specific gravity (G) of coarse aggregate usually called coarse aggregate is the ratio of the weight in air of the given volume of dry coarse aggregate at a stated temperature to the weight in air of an equal volume of distilled water at a stated temperature.

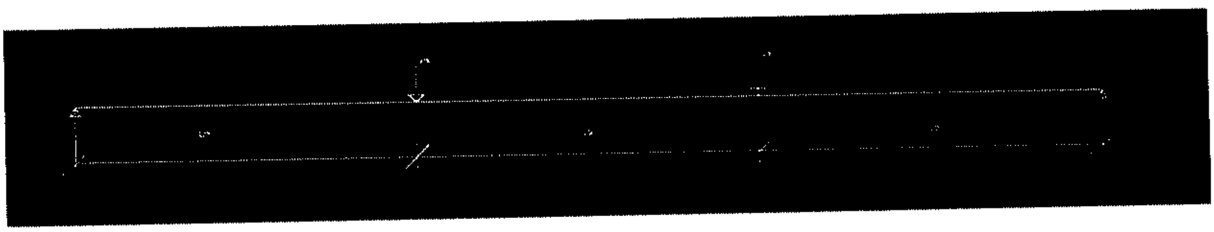
The physical properties of coarse aggregate like finess modulus specific gravity, bulk density, impact test and crushing strength test were performed as per IS 383-1978 and the test results obtained as shown below.

Table 3. Properties of Coarse Aggregate

Text Particulars	Result obtained	AS per IS : 1269 1987
Fineness modulus	5.90	5 to 7
Specific gravity	2.65	2.6 minimum
Bulk density	16.1	-
Impact value	31.5	<45%
Crushing value	34.5	<45%

The aggregate and crushing values were found to be with in the limits i.e the percentage of those values were less than 45%. The aggregate were found to be good sounding and angular in shape. It's well fit to be used in concrete.

Test set-up



For small beams

MIX DESIGN – M_{25} Grade

Design specifications

1. Characteristic compressive strength (28 days)	= 25 N/mm2
2. Maximum size of aggregate	= 20 mm (angular)
3. Degree of workability	= 0.9 (compaction factor)
4. Degree of quality control	= Good
5. Type of exposure	= Mild

Test data of materials

1. specific gravity of cement	= 3.15
2. specific gravity of coarse aggregate	= 2.60
3. specific gravity of fine aggregate	= 2.6
4.water absorption of coarse aggregate	= 0.5%
5. water absorption of fine aggregate	= 1.0%
6. free surface moisture for coarse aggregate	= Nil
7. free surface moisture for fine aggregate	= 2.0%

Design

1. Target mean strength of concrete (f_{ck}) = f_{ck} + ts

= 25 + 1.65*4

= 31.6 N/mm^2

2. Selection of w/c ratio from graph IS 1020 w/c = 0.5

3. Selection of water and sand content

For 20mm maximum size of aggregate and sand conforming to grading one II the water content per m^3 of concrete is 186 kg and sand content as % of total aggregate by absolute volume = 35%

For change in value in w/c, compaction factor for sand belonging to Zone III following adjustment is required.

Sl.No.	Change in condition stipuated for tables	Adjustments Required	
		Water content	Sand in total aggregate
1.	For decrease in w/c ratio by 0.6 – 0.5	-	0.05 = 1% 0.1 =2% (decreases)
2.	Compaction factor 0.9 – 0.8 = 0.1	1.5%	-
3.	Sand conformity	1.5%	- 1.5% for Zone II
	Total	1.5%	- 4%

For required sand content percentage of total aggregate

By absolute volume = 35 – 4%

= 31% = 0.31

Water content = 186 + 1.5% of 186

= 186 + 2.8

= 188.6 lit/^{m3}

Determination of cement content

W/c = wt. of water / wt. of cement

0.5 = 188.8/c

C = 377.6 kg/m^3

Determination of coarse and fine aggregate contents

Fine aggregate

$$V = (w + c/s_c + 1/p * f_a/s_{fa})* (1/1000)$$

Where

V = absolute of coarse and fine aggregate

= 100%-2% = 0.98

$$0.98 = (188.8 + 377.6/3.15 + 1/0.315 + f_a/2.6)* (1/1000)$$

F_a = 546 kg/m^3

Coarse aggregate

$$V = (1-P)/P * fa * (S_{ca}/S_{fa})$$

$$Ca = (1-0.315)/0.315 * 546 * (2.6/2.6)$$

Ca = 1188 kg/ m^3

Mix proportion's analyzed

M25 = 0.45: 1: 1.34: 2.83 and w/c 0.5

Concrete mix design

While designing the concrete mix, the important criteria considered are strength, workability of concrete. Various methods employed for concrete mix design such as ACI and IS procedures were referred to the mix properties were arrived based on IS specifications. The mix design details of concrete are listed in table 4.

Table 4. Mix design details of concrete

Description	Parameters
Grade of concrete	M25
Cement	377.6 kg/m³- OPC 53 grade IS 269-1976
Fine aggregate	546.49 kg/m³ -Sand confirming to zone II of IS 383-1978
Specific gravity fo F.A	2.6
Coarse aggregate	1186 kg/m³ - 20mm nominal size
Specific gravity fo C.A	2.60
Type & shape of C.A	Angular
Characteristic compressive strength	25 Mpa
Target mean strength	31.6 Mpa
Water cement ratio	0.5
Age of curing	7 days & 28 days
% of fibers added to cement	0.45
Mix properties	0.45 : 1 : 1.34 : 2.83
Workability	0.90 CF

Specimen details

The specimens used for the tests included cubes, cylinder and prisms. The details and dimensions of the specimens are given in table 5. Cubes were used for compression test, Cylinder for split tensile test and prisms for flexural test.

Table 5. Details of standard specimens

Type of test	Type of specimen	Dimensions in mm
Compressive strength test	Cubes	150*150*150
Split tensile test	Cylinders	150(dia*300 Depth)
Flexural test	Prisms	150*150*150 (Length)

Table 6.Casted specimen details

Type of concrete	No of cubes (150×150× 150 mm)	No of cylinders (150×300 mm)	No of prism(100×100 ×500mm)
Ordinary R.C	6	6	6
SFRC	6	6	6
PFRC	6	6	6

RESULTS & DISCUSSIONS

Chapter 4

RESULTS AND DISCUSSIONS

Formulas used

1. Compressive strength = P / A N/mm^2

2. Split tensile strength = 2P / pLD N/mm^2

3. Flexural strength = PL / BD^2 N/mm^2

Table 7. Compressive strength of ordinary cube results at 7 days

Sl.No.	Weight of cubes in (kg).	Volume of cube in cubic-meter.	Density of cube in (kg/m^3).	Load in (KN).	Area in (mm^2)	Comp.strength in (N/mm^2).
1.	8.405	3.375×10^-3	2490	379	22500	16.84
2.	8.497	3.375×10^-3	2518	340	22500	15.11
3.	8.460	3.375×10^-3	2507	347	22500	15.42

Table 8. Compressive strength of ordinary cube results at 28 days

Sl.No.	Weight of cubes in (kg).	Volume of cube in cubic-meter.	Density of cube in (kg/m^3).	Load in (KN).	Area in (mm^2).	Comp. strength = P / A in (N/mm^2).
1.	9.2	3.375×10^{-3}	2726.00	570	22500	25.40
2.	9.4	3.375×10^{-3}	2785.00	580	22500	25.80
3.	9.3	3.375×10^{-3}	2756.00	577	22500	25.60

Table 9.Compressive strength of steel fiber reinforced cube at 7 days

Sl.No.	Weight of cubes in (kg).	Volume of cube in cubic-meter.	Density of cube in (kg/m^3).	Load in (KN).	Area in (mm^2).	Comp.strength in (N/mm^2).
1.	9.5	3.375×10^{-3}	2814	392	22500	17.40
2.	9.8	3.375×10^{-3}	2904	380	22500	16.90
3.	10	3.375×10^{-3}	2963	362	22500	16.10

Table 10.Compressive strength of steel fiber reinforced cube at 28 days

Sl.No.	Weight of cubes in (kg).	Volume of cube in cubic-meter.	Density of cube in (kg/m³).	Load in (KN).	Area in (mm²).	Comp.strength in (N/mm²).
1.	9.5	3.375×10^-3	2814	600	22500	26.60
2.	9.2	3.375×10^-3	2725	605	22500	26.90
3.	9.0	3.375×10^-3	2667	620	22500	27.60

Table 11.Compressive strength of polypropylene fiber reinforced cube at 7 days

Sl.No.	Weight of cubes in (kg).	Volume of cube in cubic-meter.	Density of cube in (kg/m³).	Load in (KN).	Area in (mm²).	Comp.strength in (N/mm²).
1.	9.3	3.375×10^-3	2756.00	385	22500	17.10
2.	9.1	3.375×10^-3	2696.30	380	22500	16.90
3.	9.2	3.375×10^-3	2725.00	399	22500	17.70

Table 12.Compressive strength of polypropylene fiber reinforced cube at 28 days

Sl.No.	Weight of cubes in (kg).	Volume of cube in cubic-meter.	Density of cube in (kg/m³).	Load in (KN).	Area in (mm²).	Comp.strength in (N/mm²).
1.	9.0	3.375×10^-3	2667.00	615	22500	27.40
2.	9.3	3.375×10^-3	2756.00	610	22500	27.10
3.	9.2	3.375×10^-3	2725.00	623	22500	27.70

Table 13.Split tensile strength of ordinary concrete at 7 days

Sl.No.	Weight of the Specimen in (Kg).	Load carrying capacity in KN.	Split Tensile Strength in N/mm²=2P/pLD
1.	14.0	140	1.98
2.	13.8	135	1.90
3.	14.2	132	1.86

Table 14.Split tensile strength of ordinary concrete at 28 days

Sl.No.	Weight of the Specimen in (Kg).	Load carrying capacity in KN.	Split Tensile Strength in N/mm².
1.	14.0	200	2.82
2.	14.8	207	2.92
3.	14.5	190	2.68

Table 15.Split tensile strength of SFRC at 7 days

Sl.No.	Weight of the Specimen in (Kg).	Load carrying capacity in KN.	Split Tensile Strength in N/mm².
1.	13.8	168	2.37
2.	14.0	160	2.26
3.	14.2	170	2.40

Table 16.Split tensile strength of SFRC at 28 days

Sl.No.	Weight of the Specimen in (Kg).	Load carrying capacity in KN.	Split Tensile Strength in N/mm².
1.	14.2	240	3.40
2.	14.5	235	3.32
3.	14.6	232	3.28

Table 17.Split tensile strength of PFRC concrete at 7 days

Sl.No.	Weight of the specimen in (kg).	Load carrying capacity in (N).	Distance between crack to support in (cm).	Flexural strength (f_b) in N/mm²=PL/BD2
1.	12.8	6250	19.0	2.50
2.	13.3	6500	18.5	2.60
3.	13.0	6400	17.0	2.56

Table 18.Split tensile strength of PFRC concrete at 28 days

Sl.No.	Weight of the Specimen in (Kg).	Load carrying capacity in KN.	Split Tensile Strength in N/mm².
1.	13.8	220	3.10
2.	14.2	225	3.18
3.	14.5	215	3.00

Table 19.Flexural strength of ordinary reinforced concrete at 7 days

Sl.No.	Weight of the Specimen in (Kg).	Load carrying capacity in KN.	Split Tensile Strength in N/mm².
1.	14.5	154	2.18
2.	14.8	160	2.26
3.	13.5	148	2.10

Table 20.Flexural strength of ordinary reinforced concrete at 28 days

Sl.No.	Weight of the specimen in (kg)	Load carrying capacity in (N)	Distance between crack to support in (cm)	Flexural strength (fb) in N/mm²
1.	13.0	8500	18.0	3.40
2.	13.3	8750	17.5	3.50
3.	13.2	8800	17.0	3.52

Table 21.Flexural strength of steel fiber reinforced concrete at 7 days

Sl.No.	Weight of the specimen in (kg)	Load carrying capacity in (N)	Distance between crack to support in (cm)	Flexural strength (f_b) in N/mm²
1.	13.0	7500	16.5	3.00
2.	13.2	7700	17.2	3.10
3.	13.0	7400	18.5	2.96

Table 22.Flexural strength of steel fiber reinforced concrete at 28 days

Sl.No.	Weight of the specimen in (kg)	Load carrying capacity in (N)	Distance between crack to support in (cm)	Flexural strength (f_b) in N/mm²
1.	13.1	10500	17.5	4.20
2.	13.2	10400	16.5	4.16
3.	13.4	11150	15.8	4.46

Table 23.Flexural strength of PFRC at 7 days

Sl.No.	Weight of the specimen in (kg)	Load carrying capacity in (N)	Distance between crack to support in (cm)	Flexural strength (f_b) in N/mm²
1.	13.5	6800	17.2	2.72
2.	13.8	6850	18.5	2.74
3.	13.2	6700	18.2	2.68

Table 24.Flexural strength of PFRC at 28 days

Sl.No.	Weight of the specimen in (kg)	Load carrying capacity in (N)	Distance between crack to support in (cm)	Flexural strength (f_b) in N/mm²
1.	14.0	9800	17.0	3.92
2.	13.2	9500	16.5	3.80
3.	13.8	9900	18.0	3.96

Table 25.Test results of P1 concrete at 7 days strength

Identification of specimen	Strength properties	Test Result(Strength in N/mm²)
Cube	Compressive	15.79
Cylinder	Split tensile	1.91
Prism	Flexure	2.55

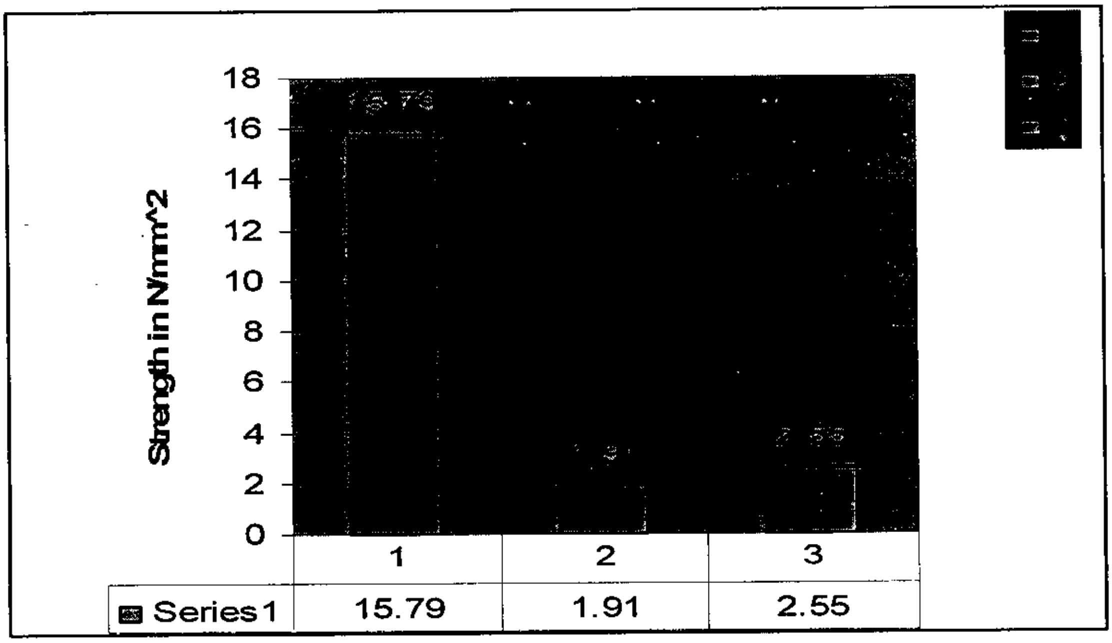


Fig.3

Table 26.Test results of P2 concrete at 7 days strength

Identification of specimen	Strength properties	Test Result (Strength in N/mm²)
Cube	Compressive	16.8
Cylinder	Split tensile	2.34
Prism	Flexure	3.02

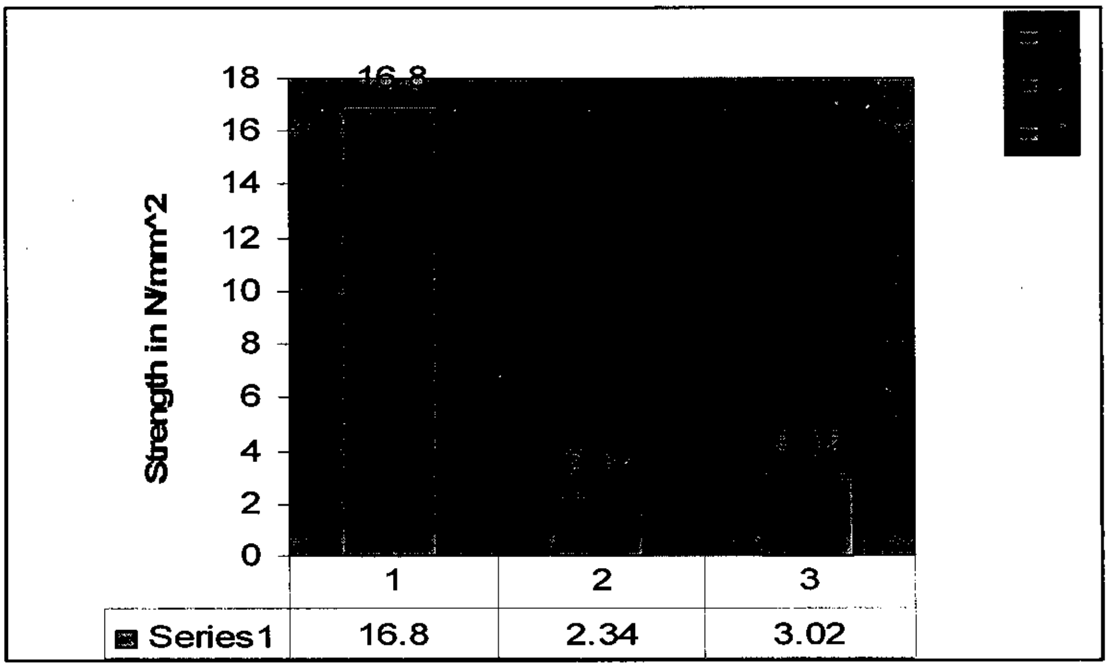


Fig.4

Table27.Test results of P3 concrete at 7 days strength

Identification of specimen	Strength properties	Test Result (Strength in N/mm²)
Cube	Compressive	17.23
Cylinder	Split tensile	2.18
Prism	Flexure	2.71

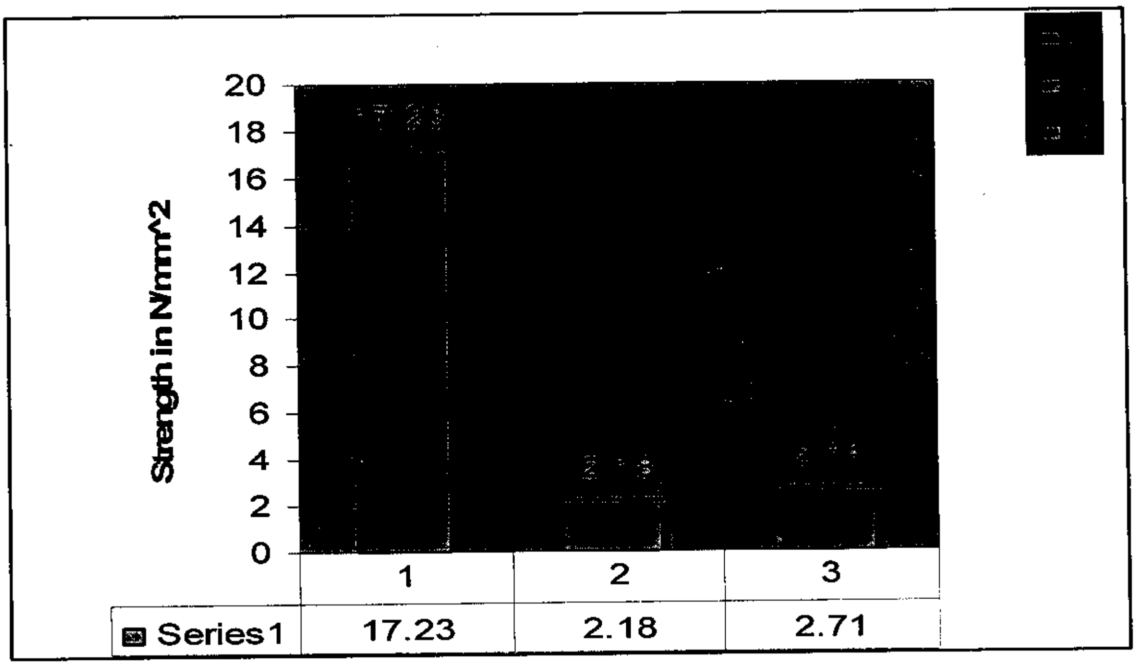


Fig.5

Table 28.Test results of P1 concrete at 28 days strength

Identification of specimen	Strength properties	Test Result (Strength in N/mm²)
Cube	Compressive	25.6
Cylinder	Split tensile	2.81
Prism	Flexure	3.47

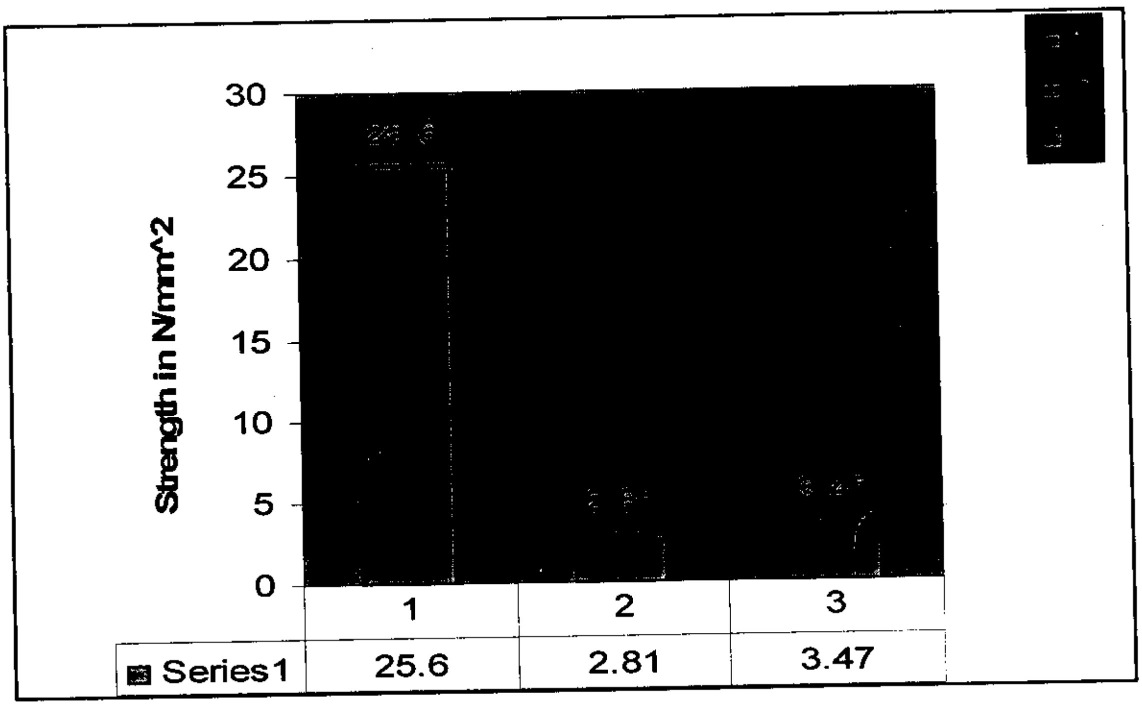


Fig.6

Table 29.Test results of P2 concrete at 28 days strength

Identification of specimen	**Strength properties**	**Test Result (Strength in N/mm²)**
Cube	Compressive	27.03
Cylinder	Split tensile	3.33
Prism	Flexure	4.27

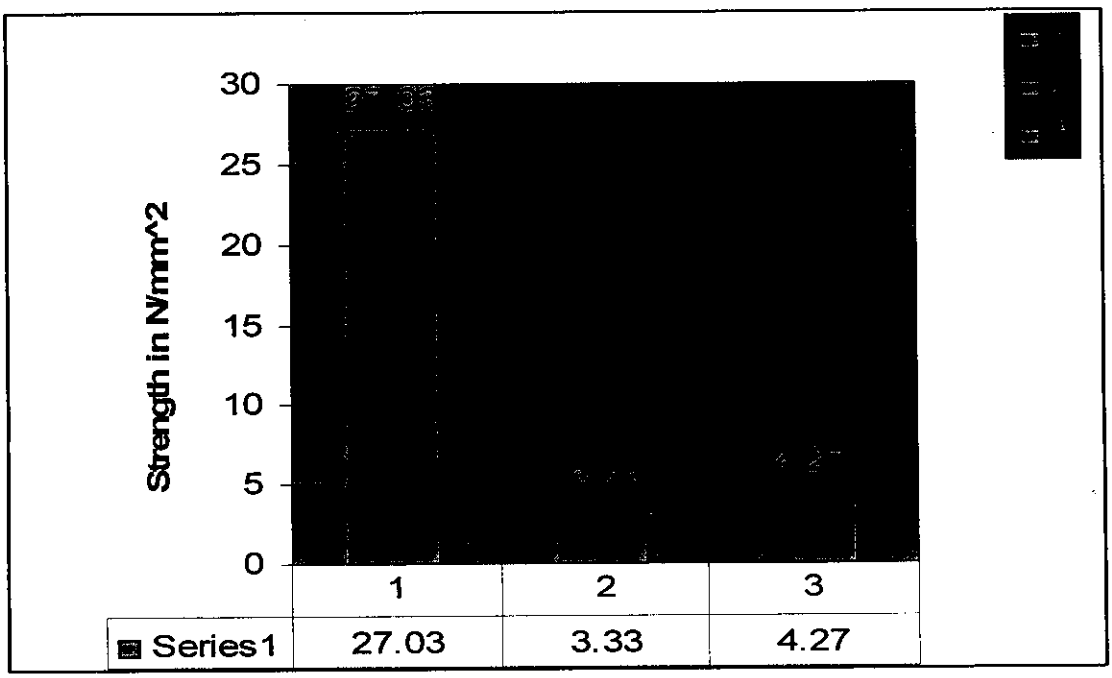


Fig.7

Table 30.Test results of P3 concrete at 28 days strength

Identification of specimen	Strength properties	Test Result (Strength in N/mm²)
Cube	Compressive	27.4
Cylinder	Split tensile	3.09
Prism	Flexure	3.89

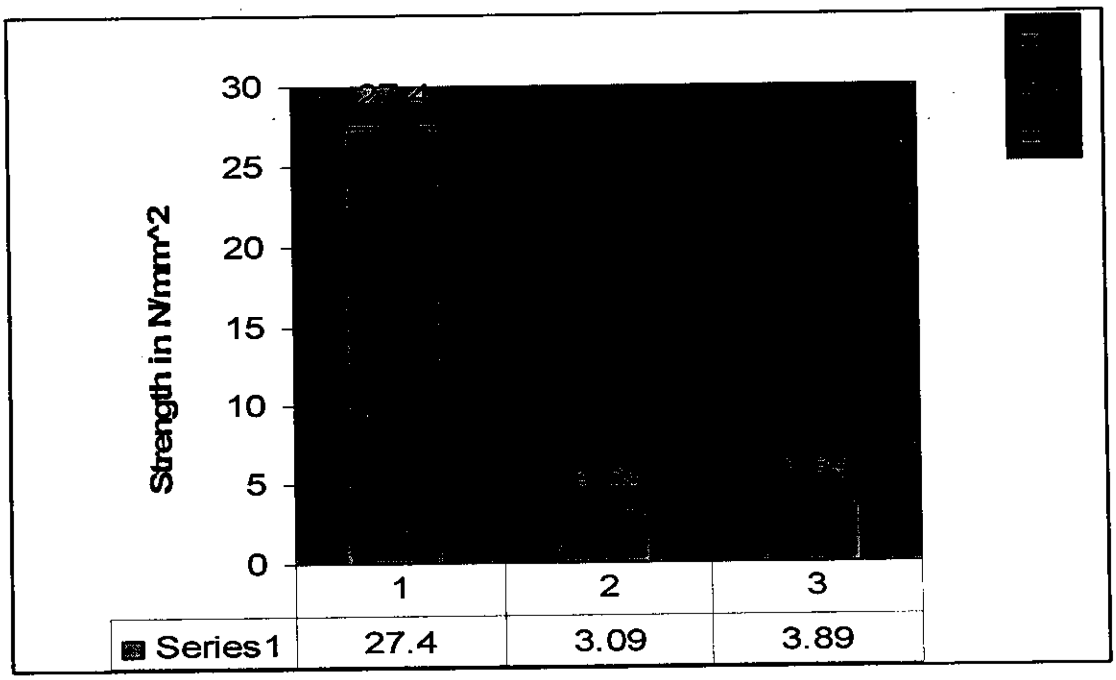


Fig.8

COMPARISION OF COMPRESSIVE STRENGTH TEST RESULTS

Comparison of P1, P2 and P3 types concrete at 7th day strength

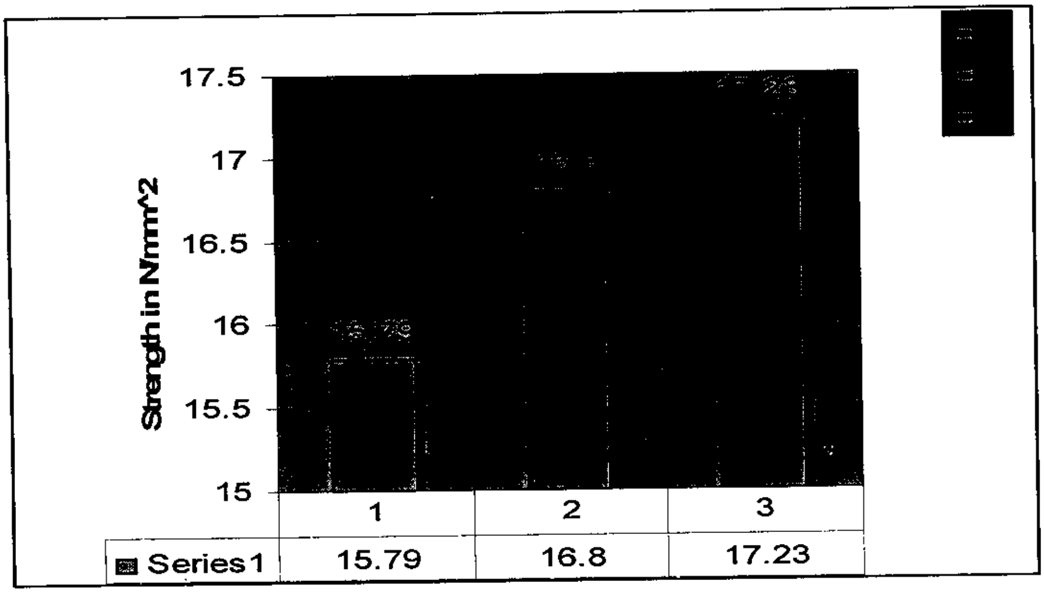


Fig.9

Comparison of P1, P2 and P3 types concrete at 28th day strength

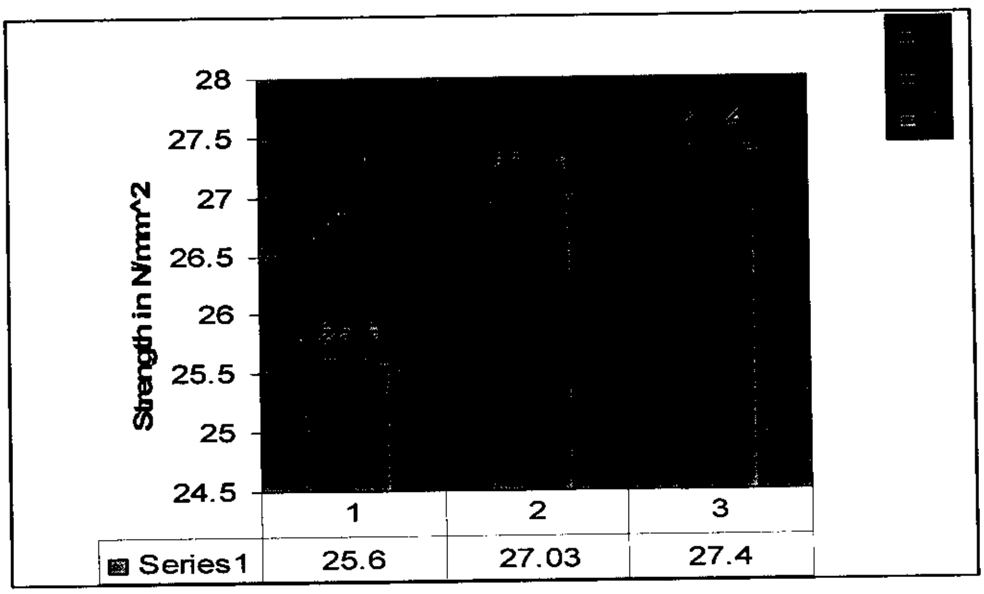


Fig.10

COMPARISON OF SPLIT TENSILE STRENGTH TEST RESULT

Comparison of P1,P2 and P3 type of concrete at 7^{th} day strength

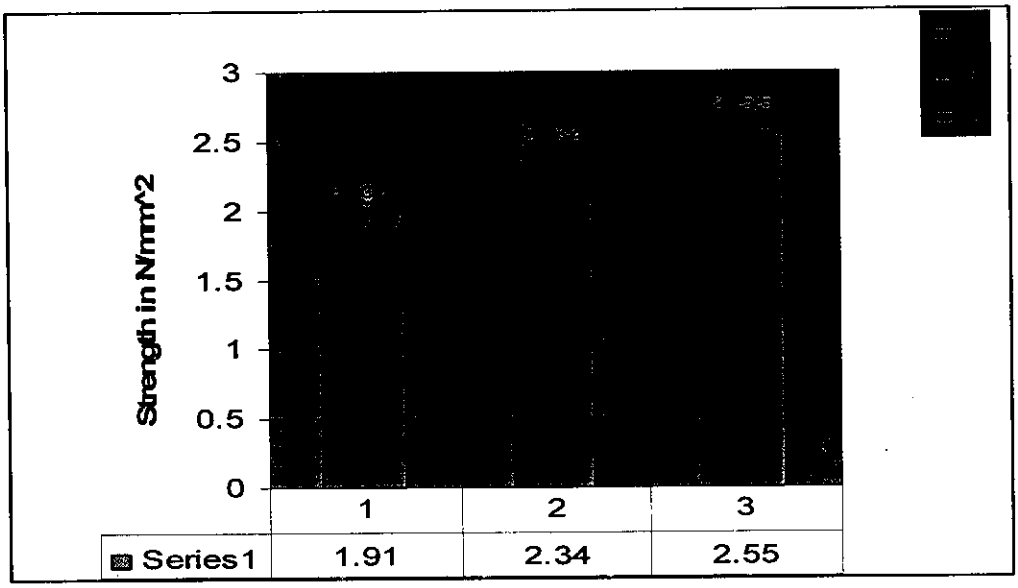


Fig.11

Comparison of P1, P2 and P3 types concrete at 28^{th} day strength

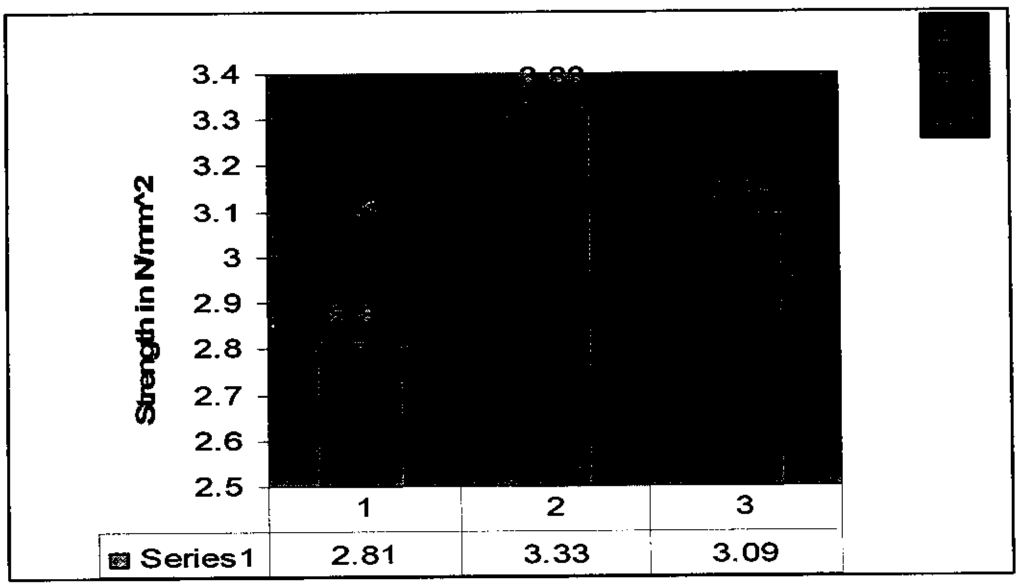


Fig.12

COMPARISON OF FLEXURAL STRENGTH TEST RESULT

Comparison of P1,P2 and P3 type of concrete at 7th day strength

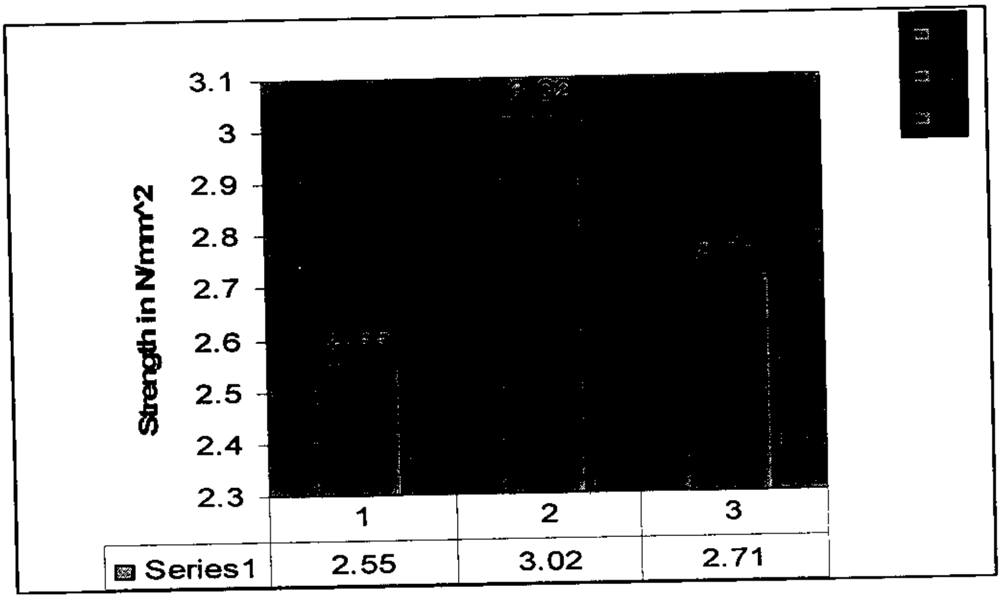


Fig.13

Comparison of P1, P2 and P3 types concrete at 28th day strength

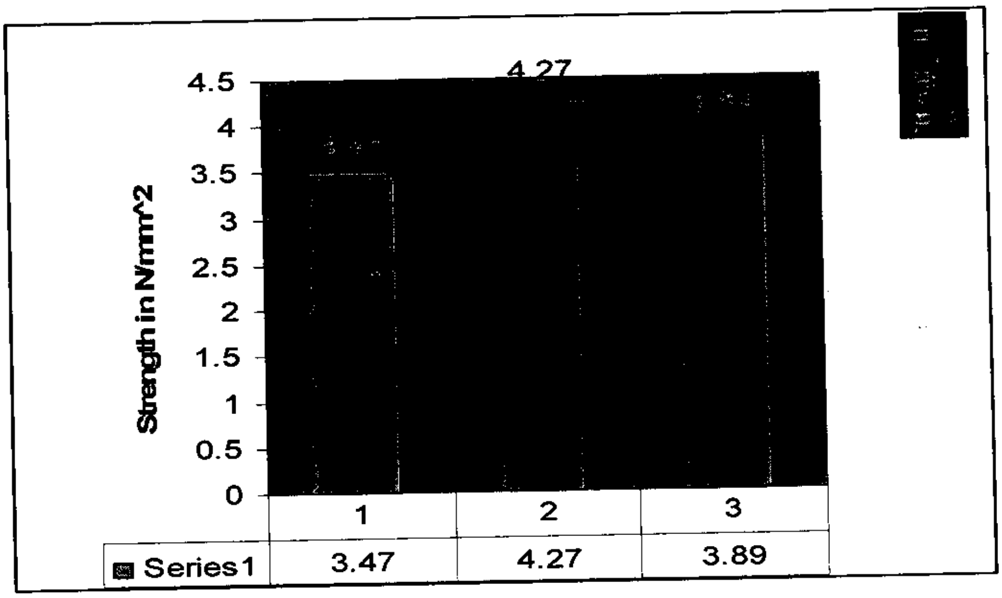


Fig.14

Discussions

By using these three test results we have obtained the following details from the graphs:

1. When compare to the compressive strength of P1 & P2 concrete, P3 has slightly increased in its strength.

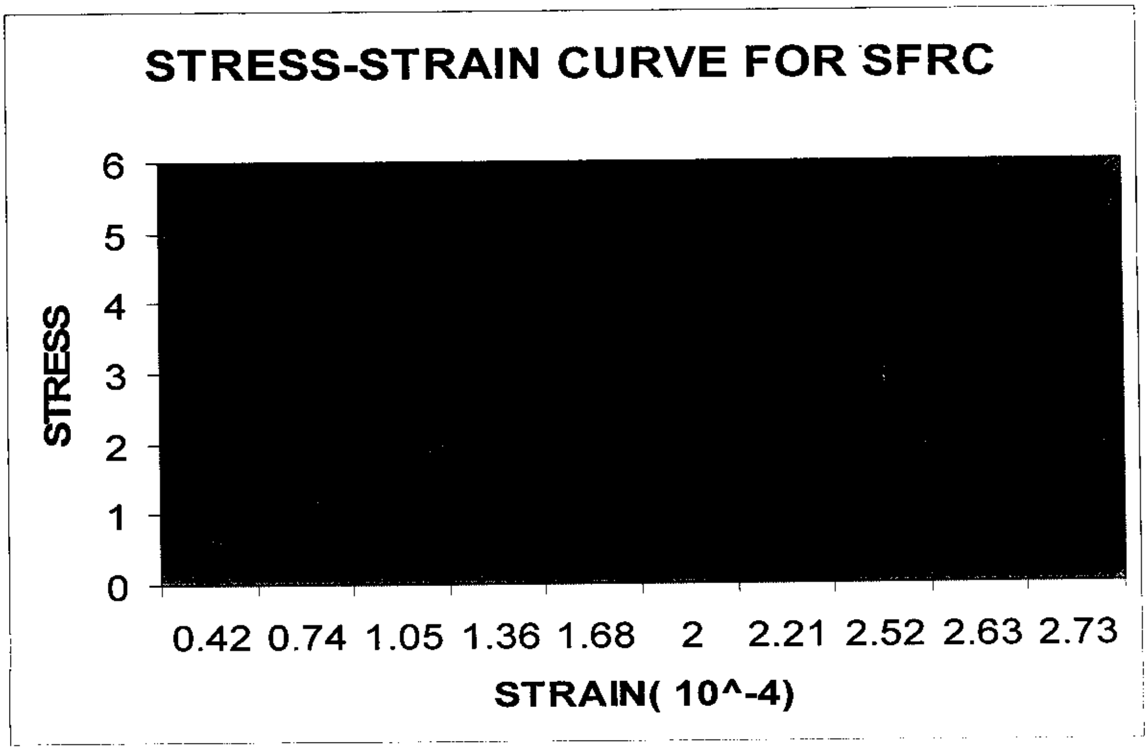
2. When compare to the split tensile strength of P1 & P3 concrete, P2 has increased in its strength.

3. When compare to the flexural strength of P1 & P3 concrete, P2 has increased in its strength.

STRESS-STRAIN RESULTS OF SFRC

Sl.No	Load in KN	Stress in N/mm²	Deformation in mm	Strain
1.	10	0.565	0.008	4.20*10^-5
2.	20	1.131	0.014	7.30*10^-5
3.	30	1.697	0.020	0.10*10^-5
4.	40	2.263	0.026	0.13*10^-5
5.	50	2.829	0.032	0.16*10^-5
6.	60	3.390	0.038	0.20*10^-5
7.	70	3.960	0.042	0.22*10^-5
8.	80	4.527	0.048	0.25*10^-5
9.	90	5.092	0.050	0.26*10^-5
10.	100	5.658	0.052	0.27*10^-5

STRESS-STRAIN CURVE FOR SFRC



Interpretation of test results

In general , concrete with polypropylene and steel fibers show increasein strength that plain concrete. The optimum dosage of fiber content is 0.5% to the weight of cement for compressive,tensile and flexural strength of concrete.This is due to the improved performance towards crack resistance.

Compressive strength of concrete

The use of polypropylene and steel fibers results in improved compressive strength. The 7 days and 28 days compressive strengths of concrete with polypropylene fibre have 9% and 5% higher strength than conventional concrete. The polypropylene fibers are strong enough to bridge micro cracks, there by increasing the load carrying capacity of the whole mass. Unlike in ordinary concrete, in fiber concrete cracks are distributed all over the specimen at failure. This is due to increased stress redistribution capacity of the fiber concrete.

Split tensile strength of concrete

The addition of steel fiber results in 24% increase in split tensile strength at 7 days and 16% increase in split tensile strength at 28 days. The split tensile strength was found to be nearly the same as plain cement concrete for lower steel fiber contents.

Flexural tensile strength of concrete

The flexural tensile strength increases by 22% at 7 days and 12% at 28 days due to the addition of polypropylene fibers. When polypropylene fiber concrete was subjected to 2 point loading, it gave sample warning before failure which couldn't be expected in ordinary concrete.

CONCLUSION

CONCLUSIONS

Based on the experimental investigation, the following conclusions are drawn with in the limitations of test results.

1. Polypropylene and steel fiber concrete shows higher strength than plain concrete.

2. There is no change in the workability of concrete with or with out polypropylene fibers.

3. There is a slight change in the workability of concrete while adding steel fibers.

4. The addition of polypropylene fiberes shows considerable reduction in cracks during fresh and hardening stages.

5. The rate of increase in strength with and without polypropylene and steel fibers depend on the mix proportions of concrete.

6. When compare to the compressive strength of P1 & P2 concrete, P3 has slightly increased in its strength.

7. When compare to the split tensile strength of P1 & P3 concrete, P2 has increased in its strength.

8. When compare to the flexural strength of P1 & P3 concrete, P2 has increased in its strength.

REFERENCE

REFERENCE

1. S.S.Siddque and C.B.Kulreja, Apllications in FRC – Civil Engineering Practice.

2. B.H..Bharat kumar and others, Experimental Investigation of FRC- Civil Engineering Practice- Vol.2.

3. IS 456-2000, Plain and reinforced concrete-Code of Practice,Bureau of Indian standards, New Delhi.

4.IS 2386 (Part III), Indian standard, Methods of tests for aggregates for concrete, Bureau of Indian standards.

5. IS 383 – 1970 , Indian standard foe specification for coarse and the fine aggregate from natural sources for concrete,Bureau of Indian Standards,New Delhi.

6. IS 10262 – 1982, Indian Standards ,on recommended guidelines for concrete mix design,Bureau of Indian Standards,New Delhi.

7. SP 23 – 1982, Hand on concrete mix design.

8. IS 516 – 1959, Indian Standards of, method of test for strength of concrete, Bureau of Indian Standards,New Delhi.

9. IS 5816 – 1970, , Indian Standards of,Method of test for spilit tensile strength of concrete cylinders, Bureau of Indian Standards,New Delhi.

10. Ramakrishnan.V,1987-Materials and properties of fibre reinforced concrete.In proceedings of International Symposium on FRC,Chennai, India,SFRC,PP:2.3-2.23.

PHOTOGRAPHS

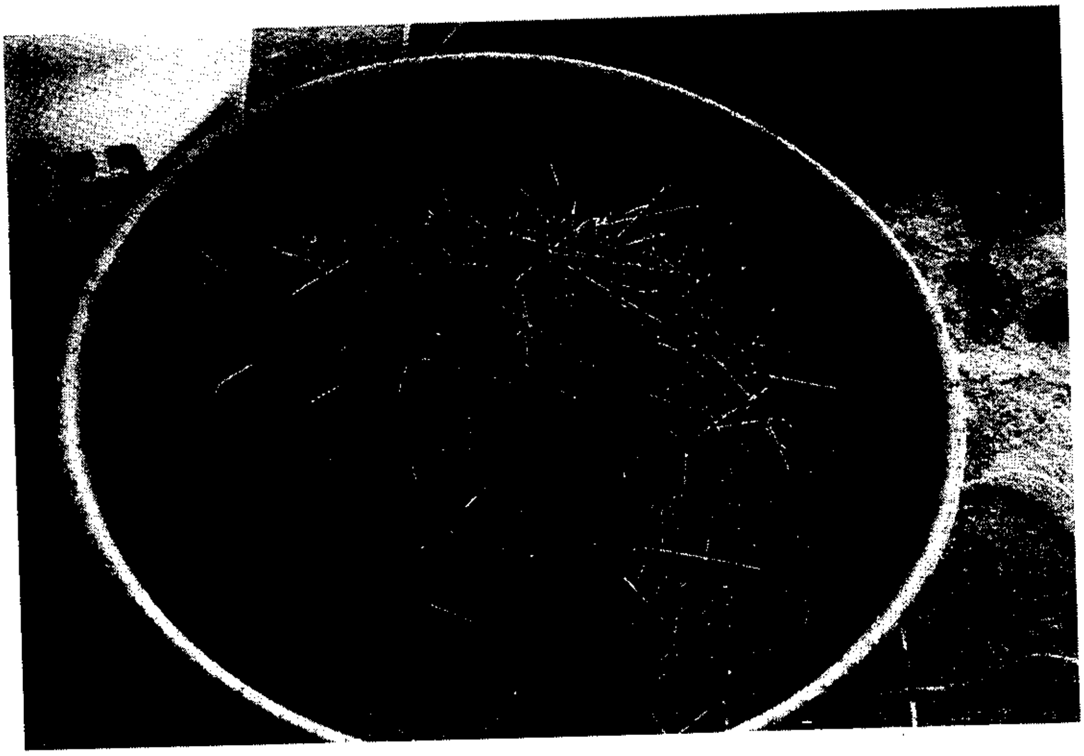


Fig.15 **DRAMIX STEEL FIBRES**

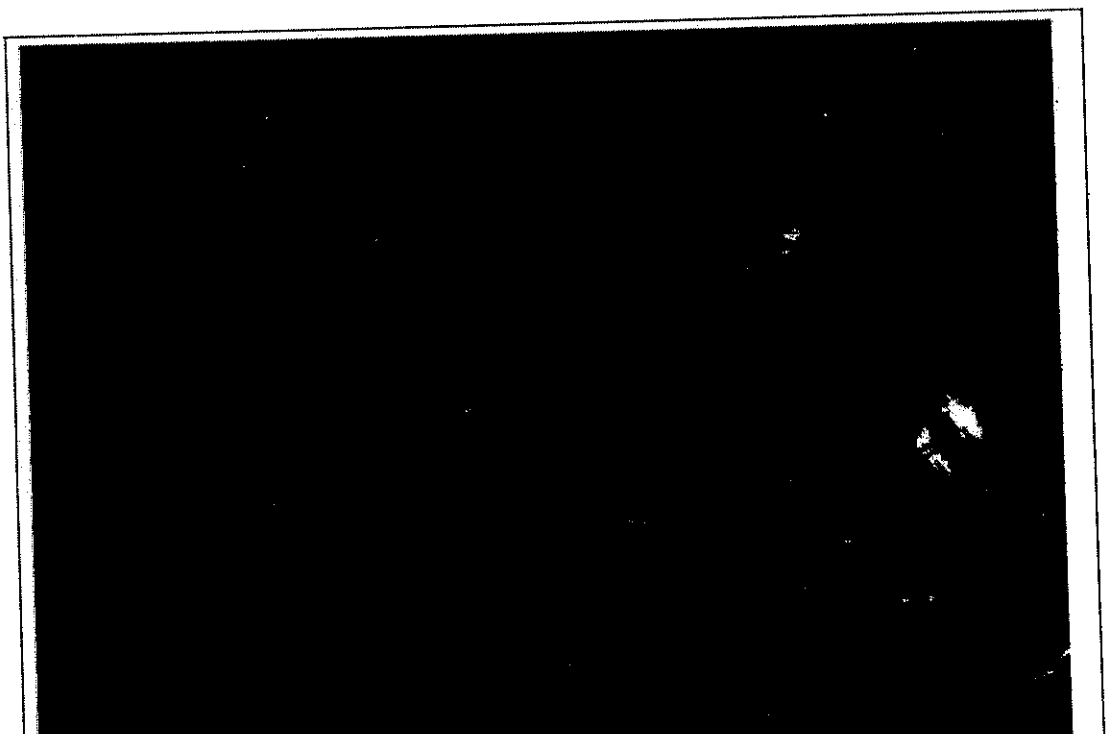


Fig.16 **POLYPROPYLENE FIBRES**

Fig.17 **MOULDS ARE BEFORE CASTING**

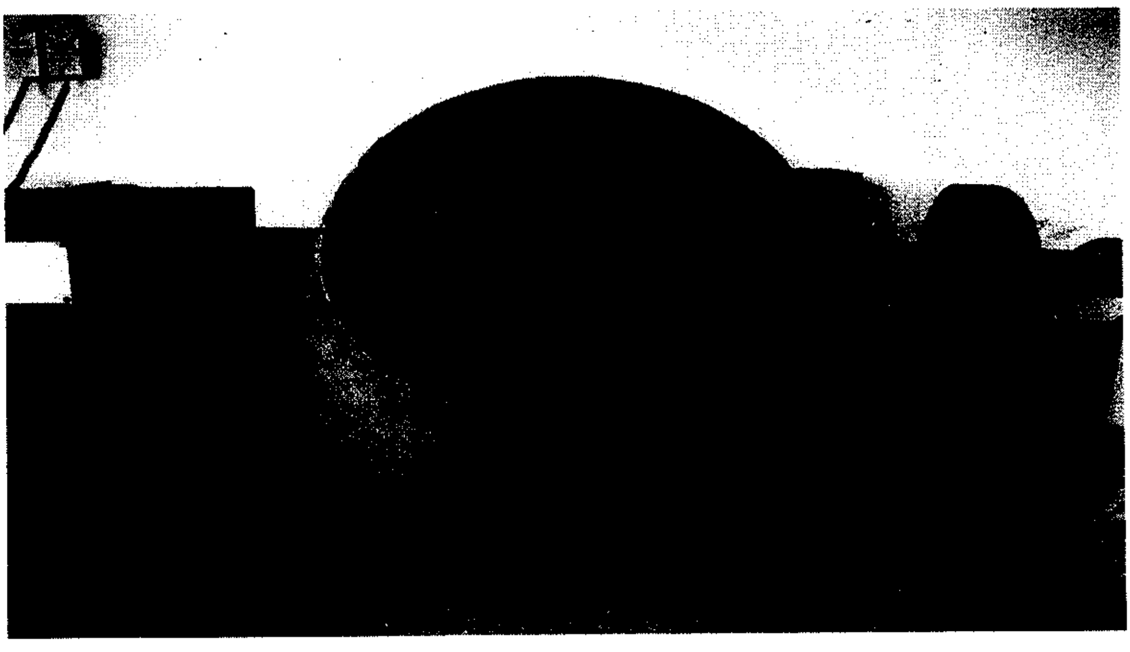


Fig.18 **CONCRETE MIXING STAGE (MACHINE MIXING)**

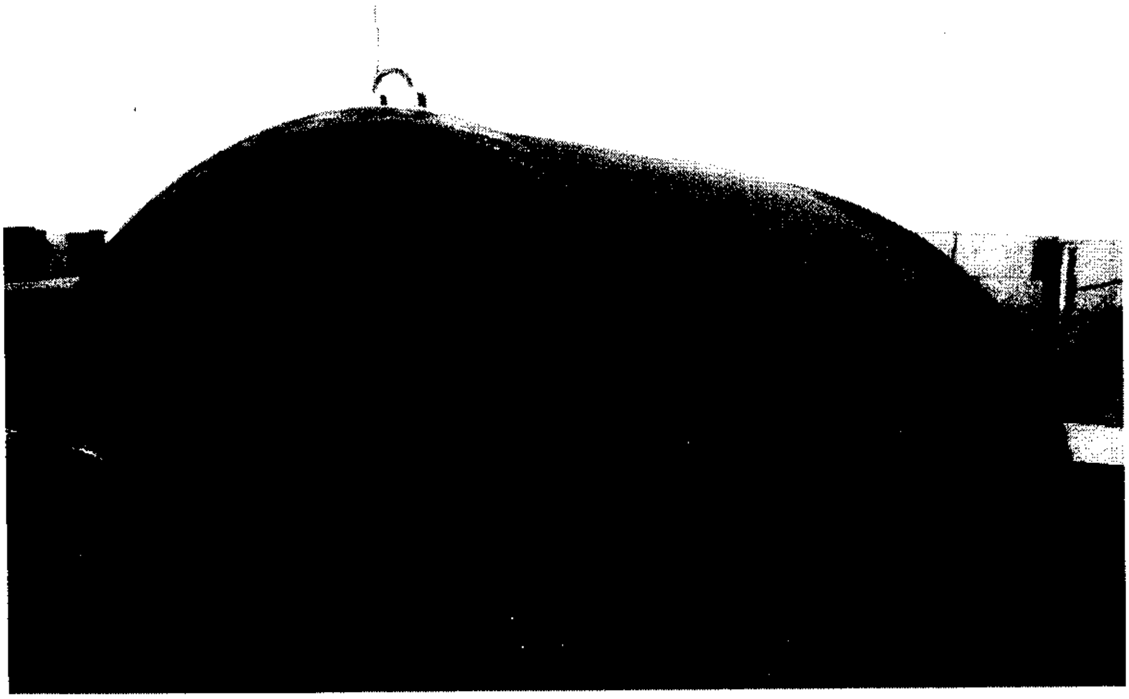


Fig.19 **ADDITION OF STEEL FIBRES INTO THE CONCRETE**

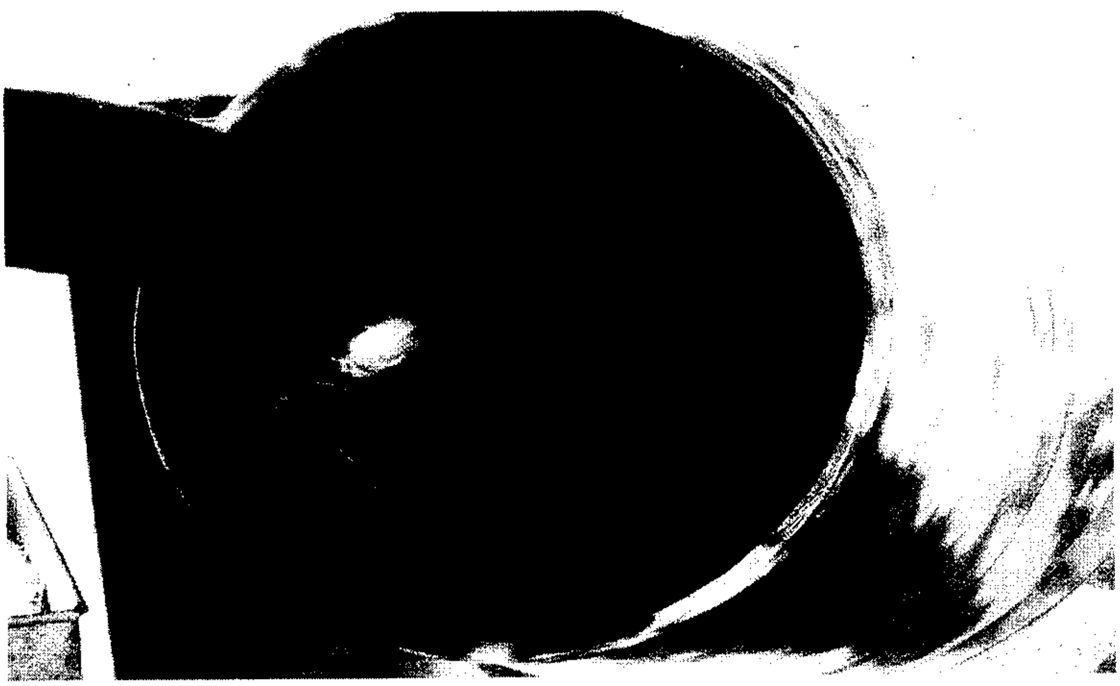


Fig.20 **ADDING OF POLYPROPYLENE FIBRES INTO THE CONCRETE**

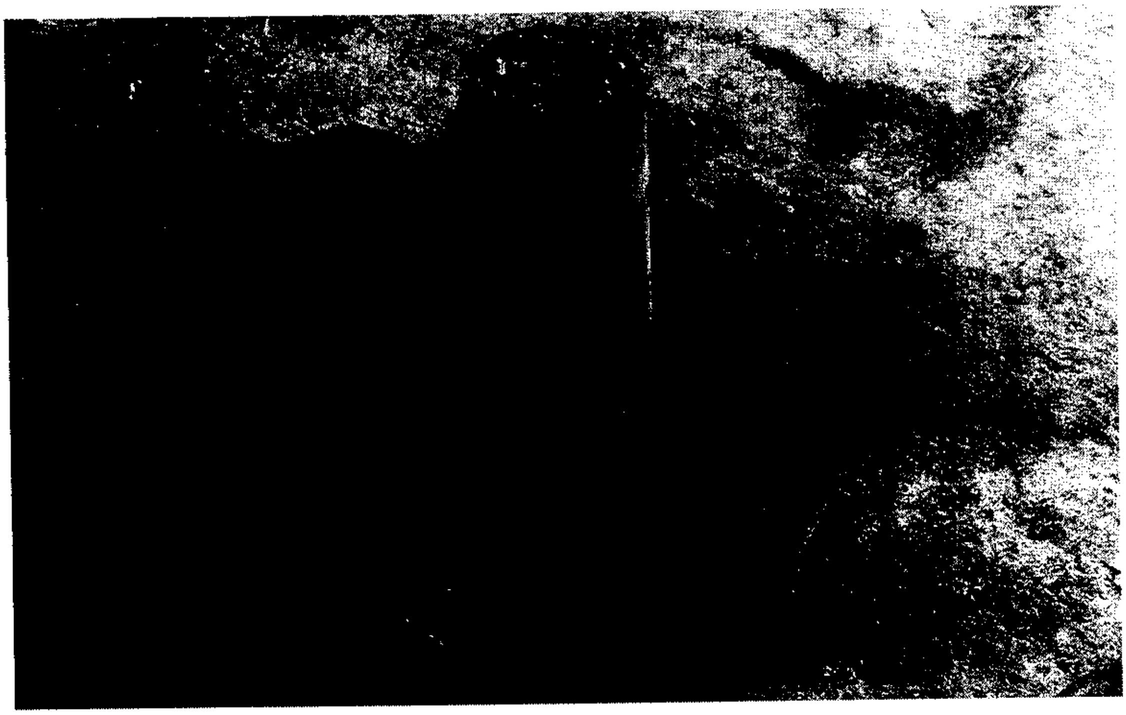


Fig.21 **SLUM - CONE TEST**

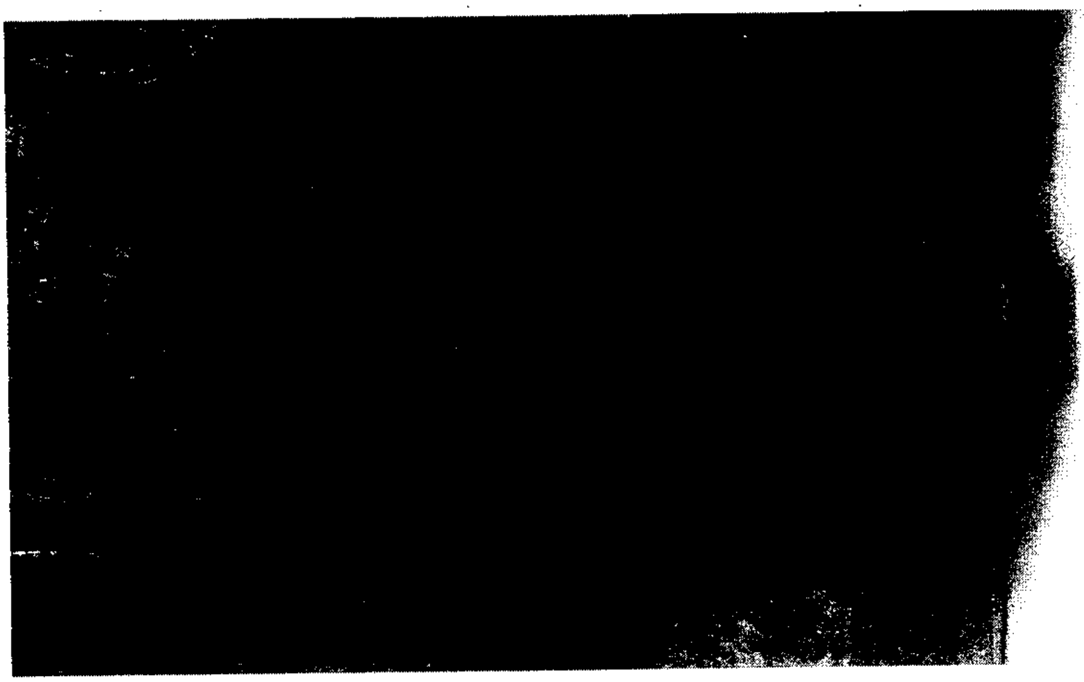


Fig.22.1 **MOULDS ARE AFTER CASTING (CUBES)**

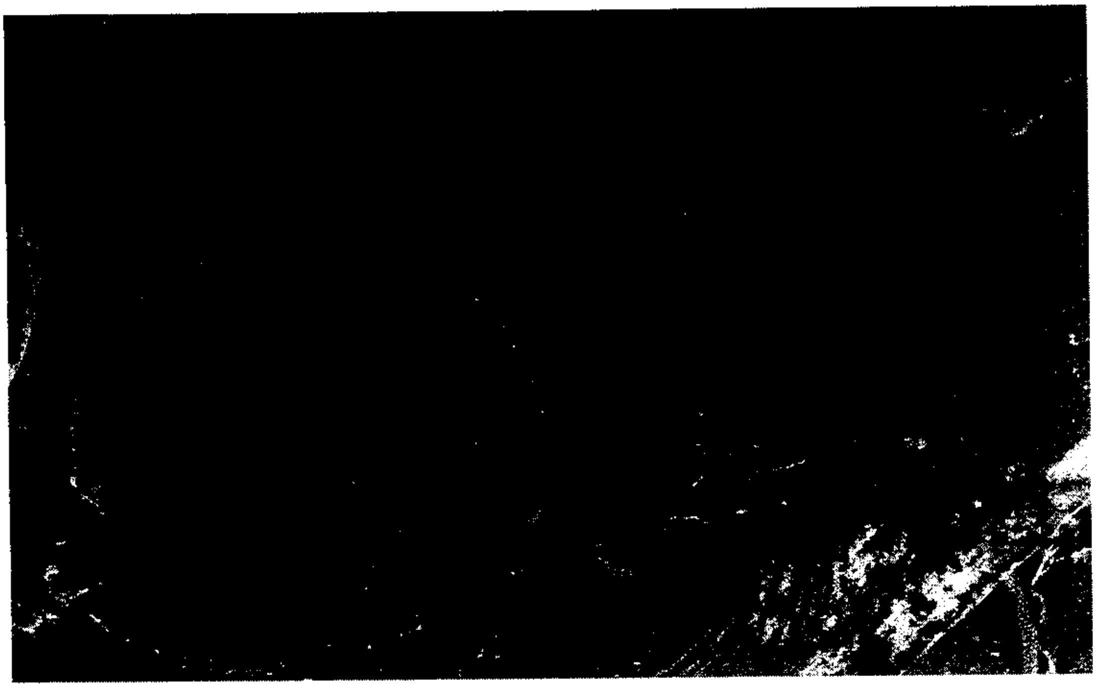


Fig.22.2 **MOULDS ARE AFTER CASTING (CYLINDERS)**

Fig.22.3 **MOULDS ARE AFTER CASTING (PRISM)**

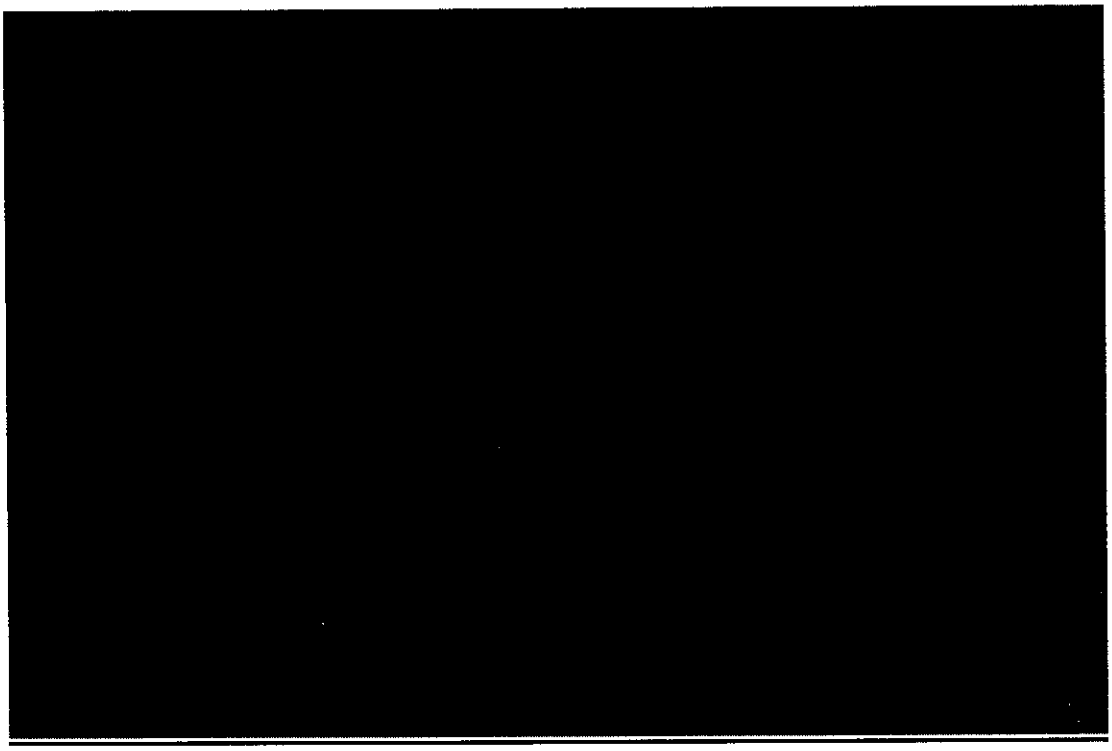


Fig.23 **CUBES ARE IN CURING**

Fig.24 **CUBES AFTER CURING**

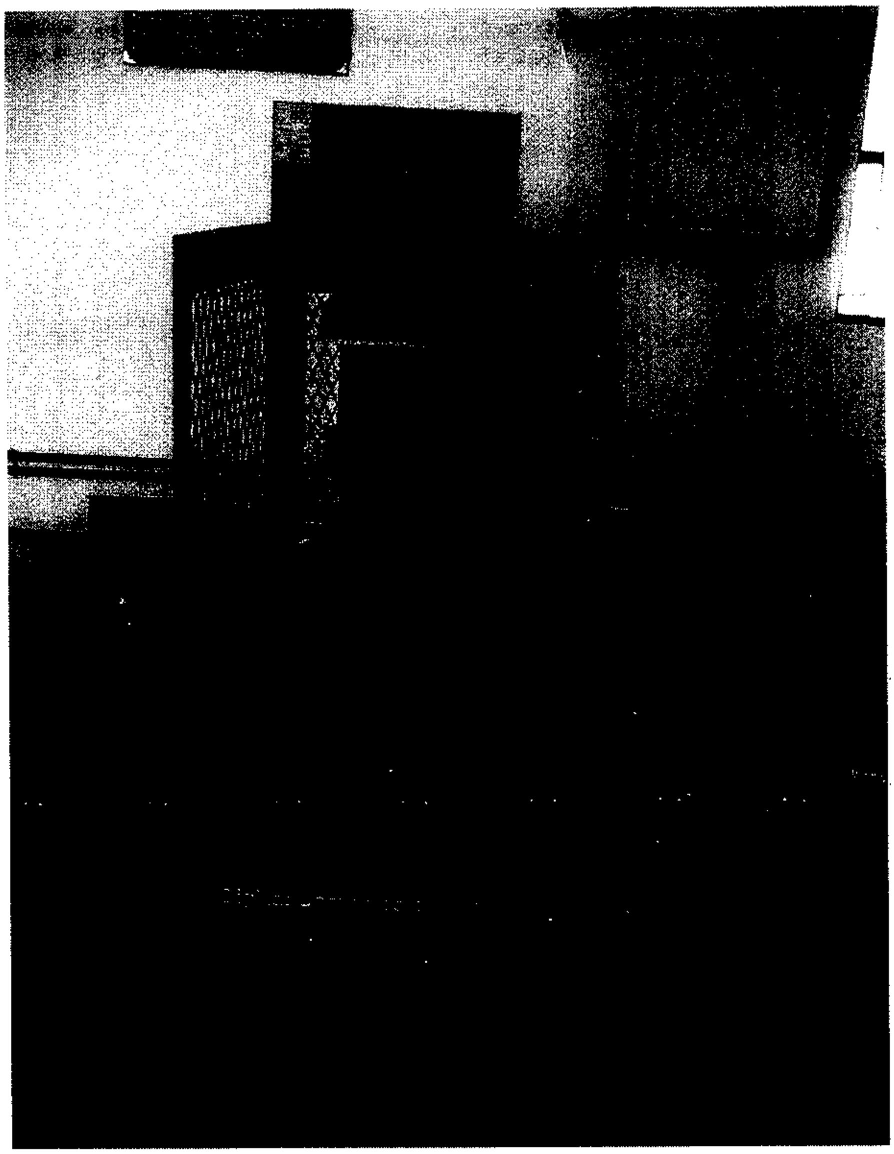


Fig.25 **COMPRESSION TESTING MACHINE**

FLEXURAL TESTING FOR PRISM

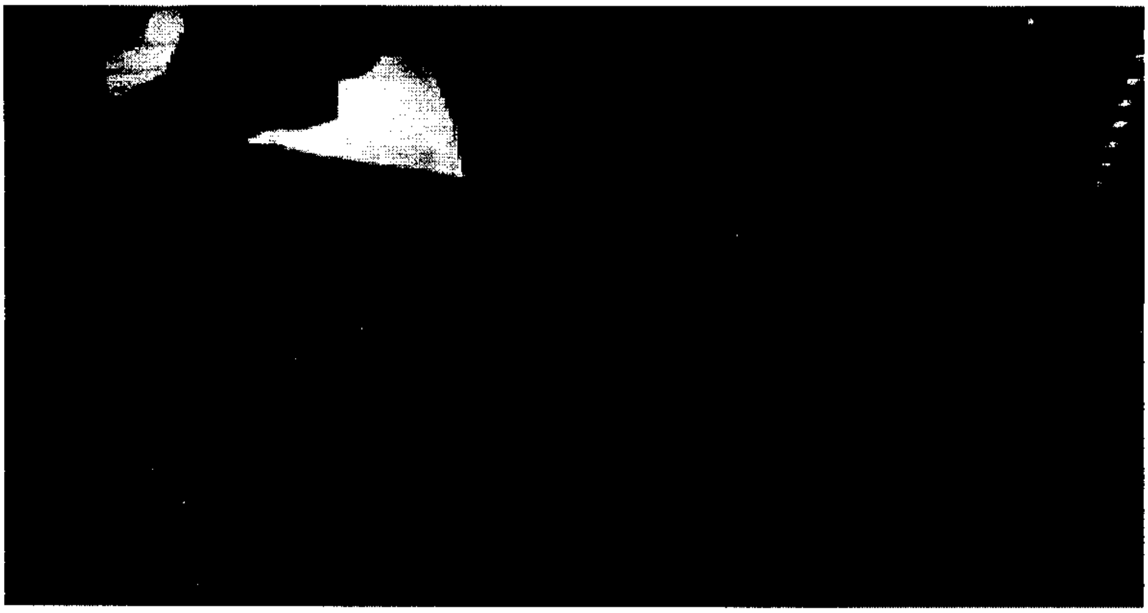


Fig.26.1**DISTANCE MARKING IN THE PRISM**

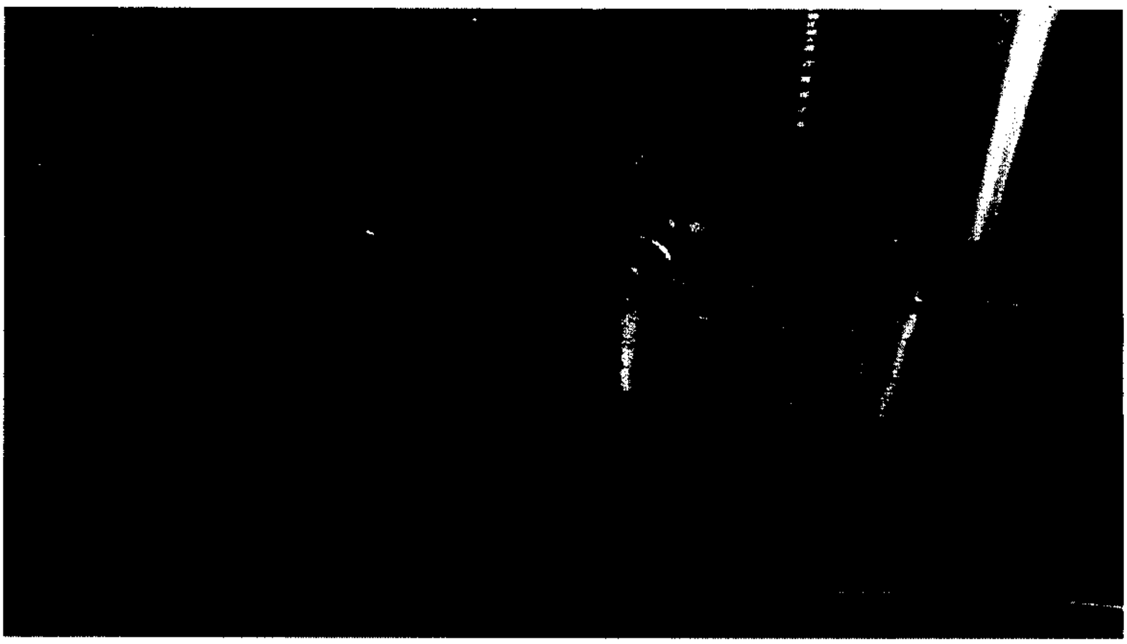


Fig.26.2 **PRISM FITTED WITH FLEXURAL TESTING MACHINE**

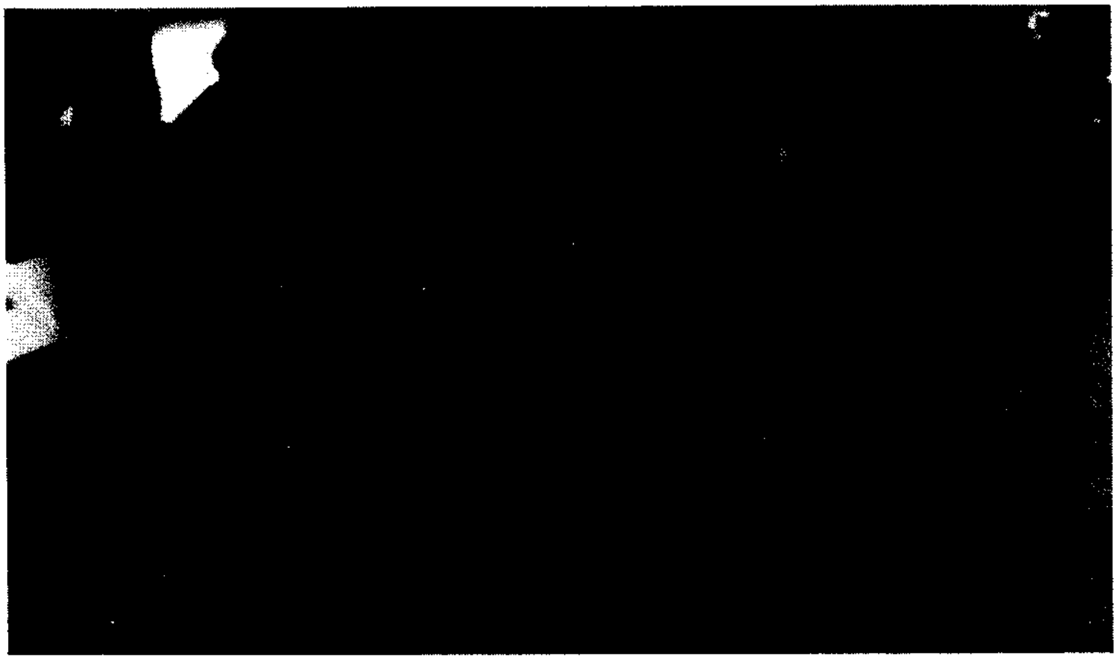


Fig.26.3 **INSERT THE STEEL PLATE FOR LOAD APPLYING**

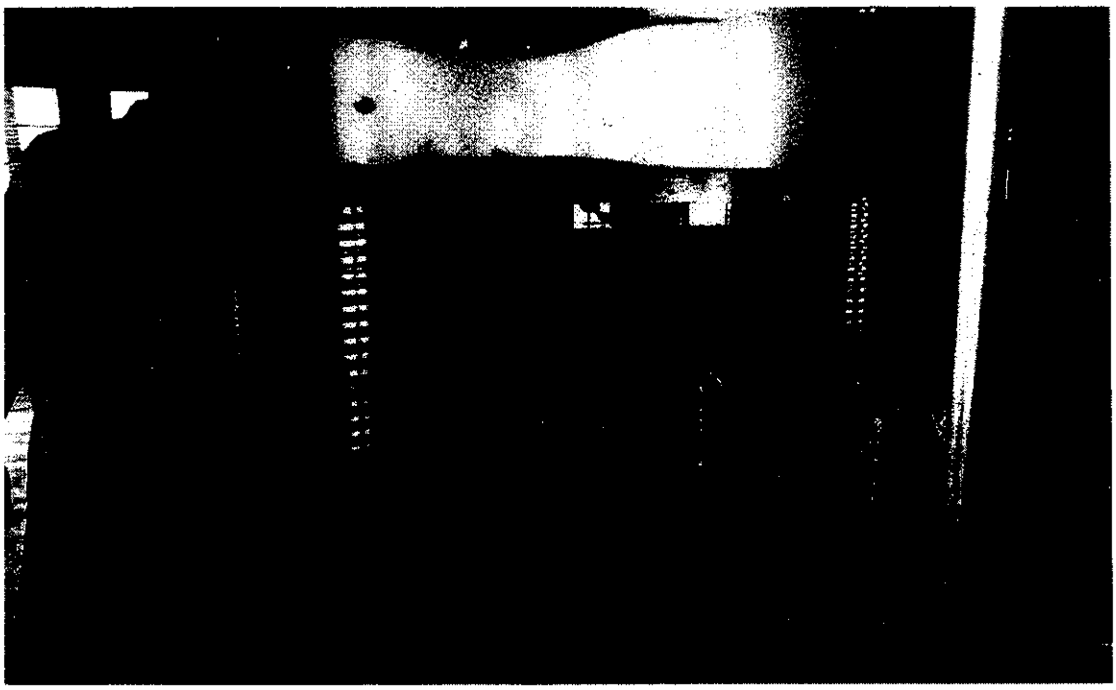


Fig.26.4 **LOAD APPLYING STAGE ON TOP OF THE PRISM**

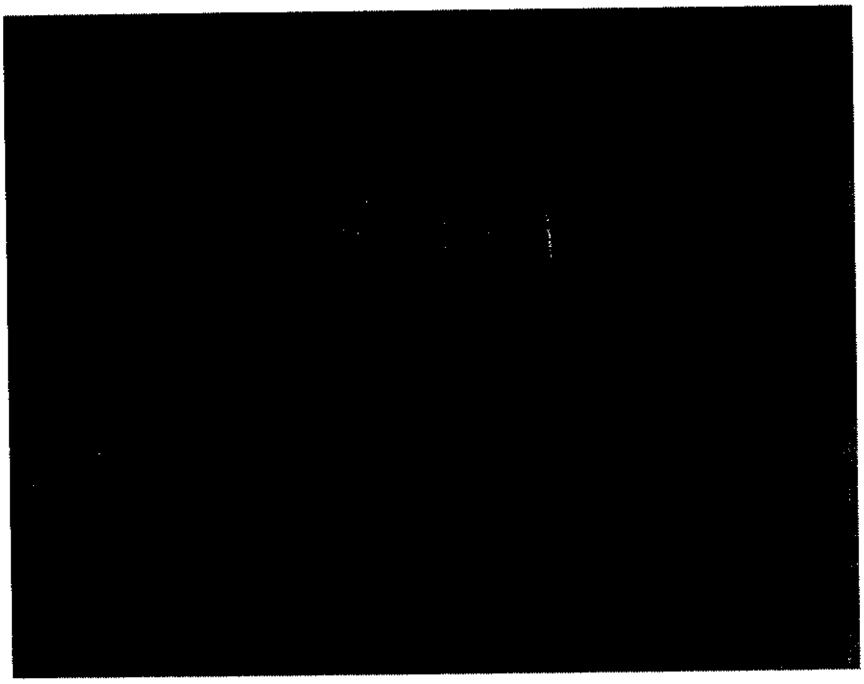


Fig.26.5 **POSITION OF CRACKING WHEN LOAD APPLYING**