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Pre-Stressing - Manufacturing Process of Water Transporting Pipe

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Abstract— Pipes buried under the ground have to bear different kinds of loads such as soil, surface etc and have to withstand great internal pressures(water pressure).Hence strength of the pipes is an important parameter to judge the quality of the pipe.The main aim of this study is to find out how the manufacturing process of PCC pipes is done in the present industry and to know why still we are using these pipes for decades.

Index Terms— Prestress, water, strength, pipes, manufacturing, concrete, mortar.

1 INTRODUCTION

WATER , is an essential commodity which is required by every one for the day to day activity. Many places in the world have water crisis which has become a global issue. With the application of engineering principles (lift irrigation,pumping), however water is transported from surplus water zones to deficit water zones .

Though engineering principles lead to supply of water but during transportation, water is being lost because of evaporation, transpiration etc. Hence adoption of pipes to transport water is practiced. These pipes designed should with stand earthen load, impact loads, internal pressures etc.

As these pipes are needed in huge numbers , cost of project will increase to a great extent if pipes are costly. Compromising on quality may lead to less short term investment but in long-run , it leads to huge maintenance and replacement cost. Damage or leakage of pipes lead to loss of water and it is tough to discover the root cause.

Hence it is mandatory to use pipes which are effective enough to bear load, have resistance to cracking and are durable. Basically we use Prestressed Concrete Pipe (PSC), Prestressed Concrete Cylinder Pipe (PCCP), Bar wrapped Steel Cylinder Pipe (BWSC), Steel Pipe (MS), Reinforced Cement Concrete Pipe (RCC) and Penstock Pipe.

2 DISTRIBUTION TECHNOLOGY OF WATER

2.1 Supply of Drinking Water

A city / town is usually situated at a place far from water resource. Even if it is situated close to the water resource supply should be done through a certain means rather than going yo source and collecting. Hence in modern days we use distribution pipes for transportation of water. Distribution pipes should maintain a minimal pressure which should be neither high nor low, as high pressure leads to more wastage of water by the users where as low pressure leads to less /no movement of water which cannot fulfill the requirement of people.

Drinking water should be free from all corrosive/chemical substances as it may effect the health of people consuming it.

2.2 Supply of Irrigation Water

Basically the pressure involved in the supply of irrigation water is high compared to drinking water as quantity to be supplied is high. Though corrosion /chemical disturbances in the pipe doesn't impact the crops, but it is advised not to have such disturbances. Due to the failure of pipes, if water supply is stopped to a crop, then it may lead to huge loss to a farmer as the whole crop yield might get disturbed. Therefore pipes used for irrigation water supply should be effective and efficient.

Compromise in quality might be risky situation and hence economy may be given its freedom i.e., quality is first important and price is second.

3 COMPONENTS OF PRE-STRESSED CONCRETE CYLINDER PIPES(P.C.C. PIPES)

3.1 Steel Cylinder

Major component of a PCC pipe is the steel cylinder which has sufficient pressure to produce 1400kg/cm^2 minimum hoop stress in the cylinder wall assuring a completely water tight membrane.

3.2 Concrete Core

The concrete core has a high compressive strength concrete with a smooth inner lining surface. Smooth surface leads to easy flow of water. Inner core deals directly with the pressure of water and hence it should be seen that this layer is tested properly for strength.

3.3 Cement mortar coating

This component answers the question for corrosion. Applied by a high impaction process ,the rich dense cement mortar coating protects exterior surfaces of steel elements from corrosion.

3.4 High strength wire

Typical wrapping stress on this high tensile strength steel wire is

13200 Kg/cm^2. The wire tension pre-stresses the core resulting in an elastic structure. Due to this principle of pre-stressing load bearing capacity of pipe will be increased tremendously.

4 MANUFACTURING PROCESS OF P.C.C. PIPES

4.1 Fabrication

Mild steel sheet is wrapped and moulded into cylinders. Length of the mild steel sheet is based on the diameter of the pipe. Welding of the sheet is done thoroughly and tested. Cylinder is later tested for a load of 3.5 Kg/cm^2.

4.2 Moulding and In-lining

Steel cylinder is placed in a mould for centrifugal spinning. Concrete is poured in the cylinder in two layers 45mm each which leads to high compressive strength. Curing need to be done thoroughly for 3 days.

4.3 Winding

After curing for 3 days the steel cylinder undergoes winding by a high strength wire with a wrapping stress of 1300 Kg/cm^2.Elastic structure is hence formed .

4.4 Cement Mortar Coating, Joint and Curing

Due to the high impact process , the rich dense coating protects exterior surfaces of steel elements from corrosion. Permanent water seal is perhaps formed upon installation. Curing shall be done from 11-13 days , so as to achieve desired strength.

5 TEST RESULTS ON P.C.C.PIPES COMPARED TO OTHERS

5.1 Load test

Conventional pipes made of steel can be deflected when an external load acts on it because of their flexible nature. Steel pipes basically depend on the soil in which they are buried to resist horizontal deflection. So soil need to be replaced to have steel pipes which further adds burden to the cost of project.

5.2 Corrosion resistance test

Cement mortar in P.C.C. pipes maintain steel elements in an alkaline environment with PH level greater than 12.5 which leads to permanent inhibition of galvanic corrosion .

5.3 Resistance damages in normal handling

P.C.C.pipes are not fragile compared to concrete pipes. Installation is simple and transportation can be easy as manufacturing pipe size is correctly fit to the currently available vehicles in the market.

5.4 Economy and track record

P.C.C.pipes are substantially cheaper than conventional steel pipes . In economy point of view, these pipes are costly in short term than other pipes but in long term perspective they are cheaper.
In USA and European countries these pipes have excellent track record of 55 years in sewerage systems with very less maintenance.

6 COMPARISON OF PIPES

The comparison of different pipes is to be analyzed for the effective and efficient quality product.

TABLE 1

PIPE PRODUCTION CHART

Pipe name	RCC	PSC	PCCP	BWSC	MS
IS Code	IS 458	IS 784	IS 784	IS 15155	IS 1916
Diameter range(mm)	900-2400	350-2200	350-2200	250-1900	250-2500
Length range (m)	2.5	5	5-6.5	5-6.5	6-7.5
Design basis	Rigid	Rigid	Rigid	Rigid	Rigid
Lining	Concrete	Concrete	Concrete	Mortar	Mortar
Coating	None	Mortar	Mortar	Mortar	Mortar/Epr oxy
Joint	Rubber Gasket	Rubber Gasket	Welded/ Rubber Gasket	Welded/Rubber Gasket	Welded

Here, RCC means Reinforced Cement Concrete Pipes, PSC means Penstock pipes, PCCP means Prestressed Concrete Cylinder Pipes, BWSC means Bar Wrapped Steel Cylinder Pipes, MS means Mils Steel pipes.

7 CONLCLUSION

By the detailed values of tests conducted in laboratories it is found that P.C.C.pipes have high external load strength, corrosion resistance , resistance to damages in normal handling, excellent flow characteristics, substantially cheaper and excellent track record.
Applications of these P.C.C.pipes is not only limited to water transportation, it can also be used as outfall sewers, gravity sewer systems and storm water drains.
This study revealed the major process involved in manufacturing of P.C.C.pipes and gave some hope to use these pipes in water distribution system effectively.

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