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## Rehabilitation of old water supply pipes

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OUT OF HUGE water in the earth only a tiny fraction is available for the use of humanity. The cost to transform it to potable one is becoming higher. The escalating construction cost and power, high level of waste making the service more expensive in one end, the enormous concentration of population causing strain to the existing infrastructure, posing serious problem of the basic health of the population on the other end.

The increase or expansion of the existing capacity of the present system is definitely a way to cope with the growing demand but in no way economical in terms of optimal use of finance and resource.

Loss of potable water in many of the water supply system accounts to more than 30%. As report received, in India, the cost of water losses accounts to US\$ 16 million per year. The distribution grid/pipe lines are one of the major contributor to this loss. It is only recently that it has been commonly realised that in order to run a water supply system efficiently more attention to be paid to service and rehabilitation and the reduction of water loss in the system as well as improvement of hydraulic efficiency of the pipelines not only make the water cheaper but also helps in augmentation of supply within the existing capacity.

Major improvements in an existing water supply may be obtained by cleaning the mains, identifying the corroded sections, leaky points and repairs the same. In some situations the old pipe lines need replacement/rehabilitation due to reduction of their hydraulic efficiency or for their structural deficiency.

Generally, the Department goes for spot repairing of the leaky places even for very old mains just to maintain the supply and have little scope to consider the long term benefit of the method. The huge loss of water through leaky points physically exposed are well appreciated by the authority but the huge hidden loss of power going every seconds to transmit water through an old main due to increased frictional resistance are generally overlooked or kept uncared for. The reduction of carrying capacity of the pipeline is caused due to effect of deposition and corrosion of the main.

The frictional coefficient 'C' may vary from 140/150 for smooth pipe to 40 to 50 for badly tuberculated pipe.

Head capacity curve drawn for a 24" dia pipe 5000 ft. long for varying 'C' value of 140, 105, and 70 as example may well show the difference of flow.

From the above result, it is observed that if the 'C' value decrease 50%, then the force required to pump the same quantity of water by 3.16 times which indicates to take

Table 1

Loss of head	Discharge in mgd for different value of 'C'		
	140	105	70
13.5	10.0	7.5	5.0
23.2	15.0	10.0	7.0
49.3	20.0	15.0	10.0

adequate steps to main the 'C' value as far as practicable for the overall economy of the system.

Rehabilitation of the main to recover the 'C' value or regain its structural strength may be a way but major constraint is the high investment. However, the cost benefit analysis in terms of life cycle cost of the main to be calculated to check up the viability of the project.

The rehabilitation of the water supply mains offer benefit of various quantifiable and non-quantifiable kinds. The major ones are:

- Positive impacts on health of the consumer.
- Long term benefit resulting from the strengthening/replacement of weak pipe sections and repair works.
- Optimum use of the existing infrastructure and deferring the immediate investment.
- Improved relation between consumers and supply authorities.
- Curtailment of maintenance expenses of the pavement and less interruption of traffic system.
- Less incidence of damage to other services.
- Update and complete existing drawings.
- Benefit through the sale of more water.

In seventies rehabilitation of 45", 60", 54" and 72" M.S. leaky main was done by way of encasing the same with 9" thick R.C.C. without disturbing the supply. But, of late it is found that the water is coming out and could not able to provide the main leak proof. On the other hand it has become an impossible task to locate the actual position of the damage of the steel main.

The rehabilitation of another stretch of 72" M.S. main was done by way of jacketing with M.S. plate inside the main. Welding the plates with mother steel main and finished with painting inside the epoxy based resin. Though the internal diameter of the main get reduced it is working satisfactorily. The main hindrance in planning this method of internal lining or rehabilitation is, it needs the portion of the main out of commission i.e. one supplementary main is required to divert its flow.

In late 80s 100 mt of an old 45" riveted main has been rehabilitated, as pilot project, by way of outside jacketing with 100mm thick plate. First the leaky spots are plugged and welded with small thin plates and then 10mm plate rolled to pipe of 1.5 mt long each with inside dia 1" more than the outside dia of the existing pipe placed over it in two halves and jointed by welding longitudinally and circumferentially. The outside surface of the plate is painted with anti-corrosive paints. The inter space between the outside of old main and the inner side of the newly rolled pipe fixed are grouted with cement.

The above process has given the structural strength and plugged up the leaks of the main. But the major hindrance of this method as found that:

- Extensive damage of the existing road surfaces.
- Damage to other utilities situated close by.
- Create hindrances to the flow of traffic.
- Tendency of deflecting of the running main due to removal of bed and again supported on newly filled up excavated soil.
- No improvement of inner surface i.e. 'C' value.

It has been noticed that the old main plates has tendency to tear out from riveted circumferential joints due to deflection and subsequently welded but it is exposing a risk of bursting.

In metropolitan city area this method has been found not to be very favourable, however, the work could be carried out without disturbing the City supply. Recently 100 and 150 mm dia. C.I. main laid in 19th Century were rehabilitated by withdrawing, cleaning and relaying in the same alignment/trench. During relaying process about 30% new pipe were used and the supply in that area has been improved considerably.

The rehabilitation approach by cast-in-place liner or inserted liner made of flexible polythene has been favoured since 1960s onward and is termed as no dig rehabilitation system. Though the inside dia of the old pipe is reduced by 70 to 100mm, however, improved friction coefficient actually increases capacity. Recently, in Calcutta two 30" C.I. main 250 m and 450 m length laid in the year 1870 and 1990 existing under Railway Track and very closed to the piers of a road bridge has been rehabilitated by insertion of 24" glass fibre reinforced poly pipe by pushing. Both the mains were leaky under the railway lines and abutment wall of the bridge and could not be repaired since few years due to inaccessibility. Only way thought to lay a new main as diversion that to became indefinite due to want of space available underground.

The G.R.P. pipes were jointed with collars (Reca coupling) with grooves for fixing rubber rings.

Two castor wheels have been assembled in Reca coupling at a distance of 500 mm along the perimeters to facilitate the smooth travel of the G.R.P. pipe within the C.I. pipe.

Two pits at ends of the pipe line and to pits at intermediate available position were constructed in each main for lowering the G.R.P. pipes and for the facility of placing geared winch for pulling operation.

The C.I. pipes have been cut and taken out of the pits to allow lowering of G.R.P. pipe. Prior to pushing/pulling of G.R.P. pipe, the inside of the 30" C.I. main is inspected and found that some of the joints had given out. To facilitate the smooth movement of the castor wheels the gaps are filled with concrete mixture.

A 5 tonne capacity ratchet winch is placed in the adjoining pit and the wire rope is taken out to the 1st pit. Now the first pipe 4 m long assembled with collars at both ends with castor wheel resemble a small trolley lowered and placed in the pit. The wire rope passed through the centre of the old pipe and G.R.P. pipe to connect a steel frame fitted in the back of G.R.P. pipe to have pull centrally. After the first pipe is pulled inside the old pipe leaving outside a small portion for jointing the 2nd pipe, assembled with a collar with castor wheels at back side, lowered and jointed with the first pipe by pushing. The rope is then passed through the second pipe and connected with the steel frame and pulled to move inside. Gradually one by one pipes are pulled in the entire stretch.

The same operation is repeated from other side of the pulling pit. Now, the two ends of the pulled G.R.P. pipes are connected with lay up joints. The same process is carried out till the entire length is completed. The end connections were made between (762 mm C.I. and 600 mm G.R.P. pipes by means of 762 mm x 600 mm G.R.P. reducer specially manufactured and connected by means of lay up joints.

The existing C.I. pipe had thickness of 25mm. The C.I. surface was scraped to make rough surface 300 mm long. Three serrations of 15mm wide and 10mm depth were made inside and four serrations of the same size outside surface of surface of the C.I. pipe in such a way, that the inside and outside serrations do not overlap. 200 mm width of the reducer section was laid up with glassfibre resin to match the external diameters of the C.I. pipe. The serrations were filled up with tax hoop glass with resin for better grip. The C.I. pipe was joined with the G.R.P. reducer by means of lay up both inside and outside.

In some sections between the pits, the pipe line was sagged and complete dewatering could not be done. In that particular stretch the first G.R.P. pipe was blind flange so that it could float in the water logged portion of the pipe.

The Collar (Reka Coupling) is so designed that it can take a deflection up to 3 degrees without leaking and as such the length profile of the G.I. pipe has been followed without difficulty. The G.R.P. pipe line laid was hydraulically tested to a pressure of 7 kg/cm<sup>2</sup> and the interspace between the G.R.P. and C.I. are filled up by cement grouting (Pressure grouting). The time taken to complete the refurbishing with G.R.P. pipes are three months for one 250 m and four months for the second 427 m and at a

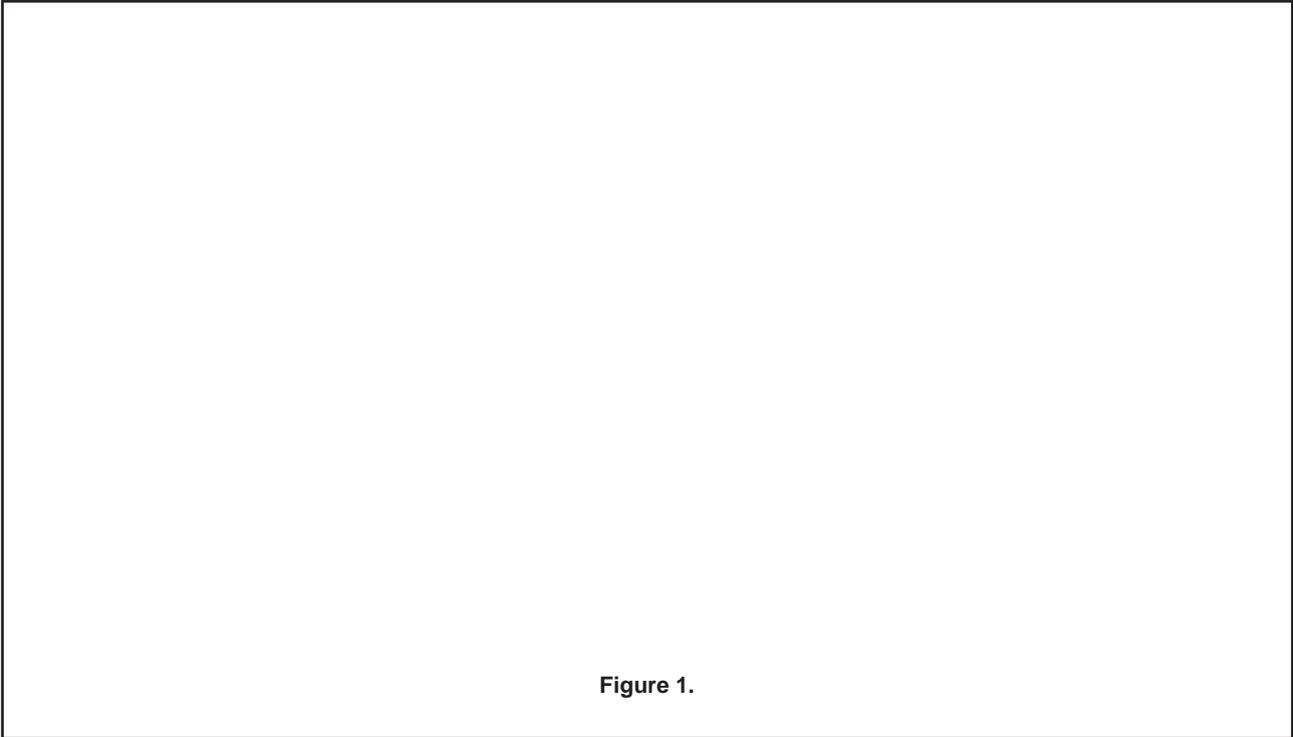


Figure 1.



Figure 2.

total cost of US\$ 123000. The refurbishing work was taken up one by one to maintain the city supply. This process at the present situation has been found to be most suitable and economical. The defects so far observed in this G.R.P. pipe pushing method is the difficulty in making the lay up joints. The lay up joints need not only completely dry surfaces but also need less humid environment and as such high powered electric lamps were used to keep the area heated and dry. It clearly indicates that there will be difficulty in repairing with or making lay up joints in monsoon period and impossible of repairing G.R.P. pipe leaks with lay up jointing under wet condition. The benefit of working in this method observed are:

- Costly jack pushing under Railway Track avoided.
- Open cut excavation avoided.

- Less time required for execution
- Economy under the present condition and situation.
- Existing underground space is utilised.

The above G.R.P. pipes were manufactured and the work of refurbishing was executed by M/s. Vicarb India Ltd., Nasik, Maharashtra, India.

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