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Economics of sewerage schemes

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1. INTRODUCTION

Sewerage scheme is one of the costliest public utilities generally planned as non-revenue scheme by the State. It is therefore of paramount importance for developing countries like India to attempt cost optimisation for implementing sewerage schemes. An attempt is made to highlight some aspects which work out to savings in cost and time - if not both - during all the three phases of the project namely (i) Designing & planning; (ii) Construction and (iii) Operation and maintenance. Policies and planning parameters influencing the labour deployment, time & ease of operations & thus ultimately having impact on overall economics of the scheme have also been briefly discussed.

2. DESIGN OF SEWERS

- 2.1 The rigid RCC pipes are encased with concrete for structurally safe installation in accordance with the recommendations (Ref.1). The cost of encasement with concrete is quite high while time taken for installation of encased sewer is quite considerable. At times cost of encasement is higher than pipe cost itself!!
- 2.2 However a close look towards analysis (Ref.2) of structural loads and relevant soil mechanics shall reveal that if arching action of the soil is considered the relevant co-efficient for vertical trench load becomes reduction co-efficient rather than concentration co-efficient resulting in lesser load over the pipe. Due to arch action the pipe is subjected to

substantial lateral pressure and appreciable reduction in bending moments (Ref.3). It needs no explanation that the arching action is more effective as the height of cover increases and more conservative if effect of submergence is taken into account; while both these characteristics are predominantly present for normal urban sewer installations.

- 2.3 For normal sewer installations the impact factors of 1.3 to 1.5 used for computation of superimposed loads appear unreasonable obviously because impact factor reduces to unity at depths of 2.5 to 3 metres while sewers are normally installed at these or higher depths.
- 2.4 In view of above considerations, assumption of high pipe loads and low bedding factors prevalent in design procedure appear unnecessarily conservative at high cost. It is therefore felt that rational approach to structural design with due and justified consideration to above points shall result in adopting appropriate class of pipe with or without concrete encasement balanced with costs, man-days for installation and adequate structural stability and still giving substantial savings in overall installation cost of sewer.

3. INSTALLATION OF SEWERS:

- 3.1 Installation of sewers at depth of 4 to 6 metres which involves timber shoring, pumping and bailing out of water contributes to high cost, longer time and working against environmental considerations.

Secondly the skilled workers required for laying-jointing of sewers and construction of manholes remain idle for certain period as the time taken for these operations is shorter than for completing excavations to desired profiles. Hence if owner-departments made capital investments in steel sheet piles, excavators & other related construction machinery and recover the cost in the period as long as possible - which will be function of planned cyclic order of cities to be provided sewerage facility in a particular State - by hiring the same to construction contractors; the result would be savings in cost as well as time. This would also result in minimising use of timber to substantial extent & thus help in environmental protection - a gain in disguise! The construction contractor should be able to plan the execution so as to minimise the idle labour and open the sites which should be function of unbroken cyclic deployment of all the trades. This can be best achieved by a quantity surveyor who can develop histograms and charts of resources levelling for project manager.

3.2 Installation of sewer when desired as replacement of existing sewer coupled with increase in capacity of sewer, can be best achieved by newly developed sewer pipe insertion system developed in Britain claimed to achieve substantial reduction in disruption of civic life and major savings in excavation costs (Ref.4).

4. CONSTRUCTION OF MANHOLES:

4.1 Manholes are being constructed with bricks and concrete cost of which is spiralling high. If pre-cast RCC rings with interlocking projections are manufactured on industrial basis the construction of manholes shall be quicker with improved quality & reduced costs.

4.2 It is not necessary to provide cast iron steps for each and every manhole; as operation of going into the manhole is

not advisable from safety point of view while sewer cleaning rods can be operated without getting into the manhole. A portable ladder which can be put to use when absolutely needed - frequency quite low in view of above considerations - will work towards savings in cost and ease of operation & maintenance.

4.3 Recent developments of using fibre-reinforced concrete manhole cover and frames which are 50% cheaper than conventional cast iron frames & covers with identical duties also imparts substantial cost reduction for manholes with added advantages pilferage proof longer lasting products reducing frequency of replacements as compared to cast iron products.

5. CONSTRUCTION OF SEWAGE PUMPING STATIONS:

5.1 Normally a square or rectangular shaped basement with dry pit non-clog centrifugal pumps is adopted for sewage pumping station. Instead a circular shaped pumping station will result in economic structural design, speedier and safer construction by well sinking method and non-risky construction w.r.t. adjoining structures whose structural safety is otherwise at stake. The space requirement for construction activity is also less which is of immense importance in congested busy commercial city area.

5.2 Vertically mounted submersible pumps will further give reduction in size of pumping station but is not gladly accepted due to de-alignment problems of vertical shaft at a troublesome frequency.

5.3 In result it can therefore be concluded that circular pumping station with dry pit pumps may sometimes be found expensive but is economic if safety and speed of

construction & construction risks are also evaluated with due weightage.

6. CONSIDERATIONS TO SEWAGE TREATMENT AND EFFLUENT DISPOSAL

- 6.1 The conventional sewage treatment facilities are designed to meet standards as per IS 4764 which are superfine characteristics. To meet these requirements; if anaerobic treatment facilities are designed they are found high in capital cost & requiring adequate land, cost of which is spiralling with time in urban areas; while if aerobic treatment facilities are designed they are found to require high recurring cost due to energy requirement and demand for skilled personnels for even optimum efficiency of plant. These processes of either kind involve large structures needing again costly foundation treatments.
- 6.2 Recent studies, have established that fluid bed submerged media anaerobic reactors (SMAR) can be used to treat domestic wastewaters to achieve secondary effluent standards at high organic volumetric loadings and low hydraulic detention periods. The major advantage of treatment with SMAR is high savings on energy cost as compared to extended aeration systems or aerated lagoons. Another major advantage of this technology is savings on land requirement and higher energy recovery in the form of bio-gas (Ref.5).
- 6.3 It has been reported (Ref.6) that conventional method of designing settling tanks by fixing an overflow rate corresponding to the smallest particle size to be removed; yields uneconomical design and hence the design of settling tank with respective desired overall removal for given particle size distribution and density characters should be adopted. This approach will give economical design of

settling tank & minimise waste of capacity.

- 6.4 As regards construction of the plant, apt utilisation of stability of slopes for housing the aerated lagoons, aeration basins with trapezoidal shapes & the structure of like sizes & shapes should work towards savings in cost. Adoption of floating type of aerators minimising need for approach or operating walkways of permanent nature, also work out to savings in cost however small.
- 6.5 So far as effluent disposal is concerned rational approach must be given to the source of final disposal. If a saline stream, or ocean is available it would be enough if tolerance limits for inland surface waters subject to pollution (Ref.7) are satisfied, obviously, because it does not violate directive principles laid down by the authority (Ref.8) namely IS 4764; for water from these kind of sources are not used for drinking, bathing, or industrial purposes. Hence it is felt that treatment facilities producing highly polished effluent at high cost should be discouraged & process design should be limited to optimum standards in accordance with requirements of source of disposal.
- 6.6 In view of above considerations it can be concluded that rational approach to design of treatment facilities with due and justified thought to latest technology, optimum effluent standards those are really needed and to the site features; all taken cumulatively will result in substantial reduction in cost capital as well as recurring.
7. PLANNING OF STANDARDISATION OF ROAD SECTIONS, SPECIFICATIONS ETC.
- 7.1 It is a hard fact that the exhaustive planning regulations & policy guidelines (Ref.9) for accommodating underground

utility services seldom find field application due to practical field constraints & many times marred by unplanned development of city. Yet, it is felt, that cost optimisation & efficient maintenance of sewerage system is possible if precast concrete panels with high frequency of bituminous expansion joints are adopted for central road strip of say 2.5M width for two lane road & end road strips of similar dimensions for four lane road while sewers & manholes are housed in these strips.

- 7.2 Above considerations will help in installation and maintenance of sewerage system without disruption to traffic & other services and acceptable aesthetics for such operations. Adoption of concrete panels for these strips shall yield savings & ease in operative labours as well as arrest transmission of caving effects to carriage ways due to otherwise excessive haphazard excavations for installation & maintenance of sewers. If frequency of operations is low as in the case of large diameter (more than 400mm dia) sewers these road strips can be converted into road dividers, traffic islands, to derive advantage of added aesthetic & beautiful environments.

8. CONCLUSION

By way of proper co-ordination between technocrats, economists and planners a substantial cost optimisation and overall economics of sewerage scheme can be effected to which the authorities responsible for framing the policies and growth strategies of developing nations should give serious thought and direct the respective talents through suitable instruments of administration.

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