



10th WEDC Conference

Water and sanitation in Asia and  
the Pacific : Singapore : 1984

## Sewer laying in Calcutta slums

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### INTRODUCTION

#### Slums in CMD

One of the biggest cities of Asia, Calcutta, is situated on the bank of the river Ganges in the Eastern part of India, about 1500 km from New Delhi, the Capital of India. About 9 million people live in the Calcutta Metropolitan District (CMD) which has 39 local bodies within it, spread over an area of 1425 km<sup>2</sup> on the two banks of the river Ganges. The city of Calcutta, along with its adjoining areas, has got vital importance in regional and national economy. Founded on a marshy swamp, about 300 years back, this city grew up in a most haphazard, unscientific and unhygienic way ever since its inception. Slums started growing from the middle of last century to accommodate large inflows of migrants from different parts of the country because of the increase in job opportunities caused by rapid industrialisation. Slums consist of several contiguous huts, each hut having three to eight cubicles with one family living in each cubicle. These huts, which were built up in an unplanned manner in whatever land that was available from landlords, are made up of mud, bamboos, tiles, ironsheets etc. and no substantial part of them is made of reinforced concrete, brick, steel, iron or any such materials.

#### Conditions in the Recent Past

The population of a slum varies from 100 to 20,000 with a density ranging from 400 to 2500 persons per hectares. Some 3,000 bustees are scattered all over CMD. One out of every 3 persons in CMD live in slums. The slums are characterised by over-crowding. It is quite usual to find more than 5 persons sleeping in a small room of about 10 m<sup>2</sup>. The population pattern is broadly controlled by occupation, religion and language - the industrial workers working in the same organisation living in the same area, daily labourers from other parts of the country have their own pockets or the Muslim workers are brought together in one area by their common way of living.

The slum dwellers were so long denied the basic minimum civic needs. Most of the huts were without any water supply connection. One spot tubewell was, in many cases, shared by many slum dwellers. The per capita water supply was thus very much less than the basic minimum requirement. The result was that people had to fall back upon unprotected

water supply sources, which create health hazards.

There were even no service latrines in each hut, and there were no arrangements for collection of human faeces in a sanitary way. All these caused faecal contamination of water and soil. Also there was no proper arrangement for collection and disposal of solid and liquid wastes of the area. In most cases, there were a few unlined drains which collected storm water, and discharged them in the nearby pond or in the roadside drain which remained stagnant with slush and filthy matters.

#### PREPARATION OF SCHEME

In consideration of the fact that the unhygienic and unhealthy condition of the environment in a slum area, as detailed above, is dangerous to public health, the Calcutta Metropolitan Development Authority took up a massive programme for improvement of the environmental conditions of the slums. As a part of the said programme which has made considerable progress, sewers were laid in Calcutta slums. In designing the sewers to be laid in slum areas, a rational method of design has been adopted with the following criteria: frequency 2 months, run off coefficient 70%, inlet time 15 minutes,  $n = .015$ . Once the design is finalised, the project report is prepared, indicating design considerations. Detailed drawings are also prepared showing the layout of the sewers including the dias and slopes, location of street inlets, sectional drawings of manholes and street inlets.

#### EXECUTION OF PROJECT

##### Award of Contract

The actual execution is done through local contractors. Sealed tenders are invited from bonafide, experienced and reliable contractors, for which contract documents have to be prepared. The first step is to prepare a bill of quantities showing probable items of works, quantity, unit, rate and amount. This is prepared on the basis of departmental schedule of rate for different items of works involved for sewer laying works. The contract documents consist of (i) Detailed Notice inviting tender, (ii) Clauses of contract, (iii) Schedule of items of works with amounts, (iv) contract drawings,

(v) Special terms and conditions (e.g. regarding protection/diversion of underground utilities, provision of caution board, road sign etc.).

Offers of the intending tenderers, who are also required to submit earnest money, are opened on the date specified in the notice inviting tender, in their presence. The offers are then evaluated and the contract awarded after observing other formalities, and the contractor is asked to complete the works within a specific period. They are also asked to submit a programme of works. If, after studying the layout plans, it is found that the area has to be divided into a number of parts for quicker execution of work, a number of contracts are entered into.

#### Construction Operations

The following operations are done in sequence for sewerlaying works.

Layout: With the help of the layout plan, the layout of the sewers to be laid in the area has to be given. In giving the layout, it has to be seen that the laying work starts from the downstream side in general. In some cases, layout had to be given at the upstream side in consideration of facility of movement of light vehicular traffic, but in such cases, levels at keypoints have to be properly maintained.

Excavation and Sheetting: At this stage, existing road crust was first picked up and excavation continued along the desired alignment with the help of shovels and minor hand tools. After reaching a depth of about 2 metres, timber sheetings were driven to prevent collapsing of the trenches.

Excavation was continued up to the desired depth with driving of timber sheeting well below this depth for proper gripping. The sheetings should be sturdy and not less than 5 cm thick supported bystruts, and should be closely driven. The depth of excavation has to be checked with the help of site rails (placed at distances of 150 metres or so) and boning rods.

Dewatering and Bedding: The general ground water table being high in this part of the country, trenches excavated beyond 2.5 m - 3 m get filled up with subsoil water; then there is leakage from house drainage connections, existing watermains etc. in the trenches. Hence dewatering of the trenches has got to be done with portable pumps so that bedding can be laid. Slushes and mucks were removed manually from the trenches before laying concrete cradle bedding as per specifications, for which detailed drawings are available. The slopes of the bed finally laid are checked with the help of site rail and boning rod as before.

Pipelaying and Jointing: The work of pipe laying was done after the concrete bed had set, and the slopes and levels had been checked. The pipes were jointed with collar joints. Gaskets made out of jute thread, soaked in cement slurry were placed in the annular space between pipes and collars. A layer of bitumastic compound was placed in the grooves provided at the end of the pipes.

Backfilling: After laying and jointing of pipelines have been completed, backfilling is done with excavated materials, which are to be dumped layer by layer (each layer not excluded 20 cm.) watered and rammed.

Road Restoration: As per practice, after backfilling, the road has to be restored temporarily up to jhama consolidation level, opened to traffic, allowed to be settled, and finally restored after a considerable period of time.

#### EXPERIENCES DURING EXECUTION

##### Limited Working Space:

The lanes in the slums, where the sewers were laid are narrow, the width ranging between 3 to 5 metres. The work had to be carried out with minimum inconvenience of the local beneficiaries, and minimum dislocation of light vehicular traffic. The following general steps were taken in consultation with local beneficiaries.

(i) For the safety of the pedestrians, barricades were erected with bamboo fencing along the site of excavation after allowing some width from the edge of trench for movement of workmen.

(ii) When a particular stretch of road was closed for sewer laying work, a survey was conducted with local leaders for finding out alternative routes for diversion of light vehicular traffic. Necessary road signs and caution boards were next placed in proper locations.

(iii) Unless the work in a particular section had advanced sufficiently, excavation in the next stretch was not permitted to be taken up. Very little space was left on the sides of the trench excavated for laying sewerlines, as the lanes are narrow. As such excavation could not be done with excavators, nor could rammers be used, it had to be carried out by local labourers with the help of pick axes, shovels etc. The spoils excavated could not be dumped by the side of trenches for removal away from the site. Instead, spoils were to be carried away from the trench by head load to a distance of 200 m in some cases due to non-availability of open space. For the same reason, construction materials had to be stacked far away from the site and carried by head load to the actual spot for construction.

All these added to construction cost and delayed progress of work, which could not be avoided, the situation being as it is.

#### Difficult Soil Conditions:

In case the excavation depth is large, caving of sides of the trench is expected. As such, close timber sheeting was done to protect the side of the trenches, the sheeting being driven with adequate grip length beyond the trench bottom. But in one or two cases, even after precautions as above were taken, the trench became filled up with sand after a depth of about 3 metres was reached. Excavation beyond this depth could not be reached as, after removal of spoils from this depth, sand flowed into the trench and filled up the space up to that depth, again and again. This is because of sand boiling, which was countered in one case by spreading bamboo skin and matting on the trench bottom immediately after excavation and by holding it tightly with shoring. In this case, other operations like spreading soling, casting concrete bedding and laying of pipes had to be completed very quickly so that movement of soil could not take place. In another case, all attempts to counter sand boiling failed. Sheet piling could not be done due to limited working space and as the vibrations during sheet piling would damage the properties close to the trench. The alternative was to lay the pipes at the maximum depth that could be reached, and to change the design of the system. This situation, again, supports the statement made elsewhere in this paper that sewer lines should be laid from the downstream end. In the slum areas, tall buildings exist by the side of huts in narrow lanes. When the excavation was deep and close to these buildings, particularly in sand boiling conditions, it was apprehended that, due to movement of soil, the foundations of buildings would get exposed, endangering the safety of the structures. The situation was tackled by excavating trenches for shorter lengths in these portions, and completing all operations from excavation to pipe-laying in the shortest possible time. As a measure of additional precautions, timber sheetings were left in the trenches after back filling in these stretches. This was for restricting the movement of soil so that the buildings were not rendered unsafe.

#### Existence of Underground Utility Lines:

A number of existing utility lines like watermains, electric lines, gas pipes, telephone lines, became exposed at the time of excavation of trenches. These lines are maintained by different utility agencies. Hence coordination has to be maintained with all these agencies right from the stage of project preparation. All available

information regarding underground utilities were collected from all these agencies. Arrangements were to be made for protecting these utility lines as per the requirement specified by the concerned public utility agency. Thus water and gas mains were not only slung, but to take care against displacement of pipes or leaking of joints, brick pillars were constructed under the pipes to give them support at short intervals. Timber posts were placed across the trench with sufficient bearing on either side at intervals and exposed cables were slung with coir rope. Routine inspection during excavation was arranged along with different utility agencies. In some cases, required information was not available at all from utility agencies. In such cases, excavation was carried out slowly and carefully. Thus when an electrical junction box was exposed or a smell of gas was perceived, the concerned utility agency was immediately contacted, keeping the work suspended temporarily. Work was resumed again only after the concerned agency had taken the necessary steps and given the green signal. The existing water mains are rather old. Damage of ferrule connection and water main was reported frequently. Bursting of water mains caused flooding of trenches, which not only caused serious dislocation in the progress of work, but also cut off supply to the consumers. The situation was tackled by contacting the concerned utility agency, whose help is often required in plugging the main and repairing the damaged pipe. The trench was again to be dewatered and ferrule connection restored. In one case, where the depth of excavation was small, the head room available between trench bottom and the network of utility line was so small that the workers had a difficult time in laying and jointing pipes. In some other cases, the pipes could not, due to presence of utility lines, be lowered vertically in the trench, but were lowered at some other distant point and dragged to the proper place. In some other cases, the alignment of the existing water main fouled with that of the proposed sewer line. In such cases, water line was run above sewer line, taking care that the water line did not pass through the manhole. For this purpose, the shaft of the manhole was modified in one case and the water line was diverted to pass outside the manhole in some other cases. In another case, it was apprehended that the cable lines which were slung would get damaged as they were subjected to tension during excavation. As such, the timber sheeting was left in the trench even after backfilling.

## CONCLUSION

It must be admitted that a water borne sewerage system is not only the most appropriate solution, but also the only feasible solution for slum areas in Calcutta. The work of laying sewer lines in limited working space and under difficult soil conditions in the presence of existing underground utility services can be best tackled by an Engineer, when he maintains good coordination with different utility agencies, so that the problems faced while working in the trenches can be solved properly and promptly. He also has to take into confidence the local beneficiaries so that they cooperate and bear with the authorities for the inconvenience caused temporarily.

## ACKNOWLEDGEMENT

The author thankfully acknowledges the encouragement received from Mr. A. K. Chatterjee, Deputy Director CMDA, who also had similar experience in laying sewer lines in Calcutta streets, in preparing the paper.

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