II-47 BALANCING PIPE FOR PEAK-REDUCTION

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Introduction : The problem of the discharges of greater volume of runoff within shorter time intervals along with the stagnation of river improvement in urban areas, has led to the development of the concept of temporary storage facilities. A case of storm drain pipe as balancing pond is presented here.

Hydraulic Appraisal of Gated Storage Box : The existing facility as shown in the schematic diagram below, for the measurement as well as reduction of the peak discharge, in the sewerage system in Nerima-Ku, was studied. The result as shown in the figure beside was not found to be so effective, except in the case when the gate height was such that the overflow did not occur.

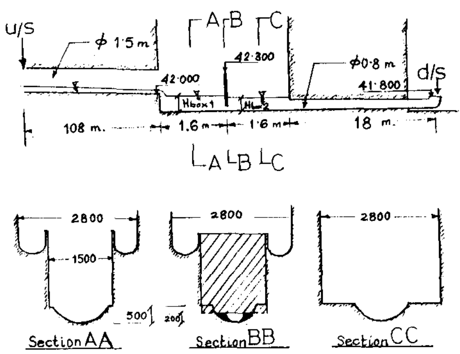
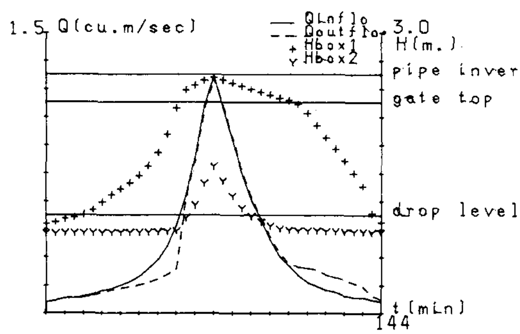


Fig.1 Existing Facility for Peak-Reduction in Nerima-ku



Drainpipe as Retention Pond : As an alternative, hence, a simple case of a single circular pipe with a 2-chord barrier was considered for analysis. The geometrical and some typical hydraulic conditions considered are shown in Fig.2.

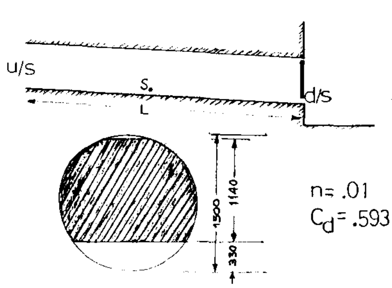


Fig.2 Pipe with Barrier considered for Analysis

Numerical exercise with an inflow discharge hydrograph of the shape shown in Fig.3 were carried out using an implicit finite difference scheme of complete Saint-Venant equations. Downstream boundary condition was taken as critical flow when water depth is less than gate opening, with the barrier acting as sluice gate otherwise. Coefficient of discharge C_d was assumed to be a constant which leads to non-discontinuous depth-discharge relationship. A typical outflow discharge hydrograph along with the depth at outflow section for the pipe length L=600m., bed-slope S_o=.0007 and inflow time to peak T_p=40 min. is also shown in Fig.3. The corresponding relative magnitudes of the various terms in the momentum equation as percentage of bed-slope is shown in Fig.4 where F,W,C, and A denote friction term, depth variation term, convective and local acceleration terms respectively. Fig.5 compares the water surface elevation profiles at the time of maximum outflow discharges, for the cases of different pipe lengths. The results of the analysis are shown in Fig.6. The numbers in parantheses ( ) and { } correspond to the lag time and the percentage peak reduction without barrier.

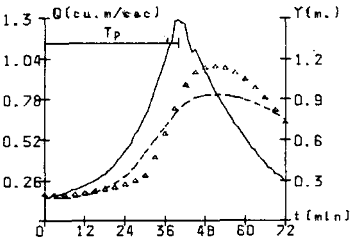


Fig.3 Inflow & Outflow Discharges ——Qin ---- Qout ^ depth

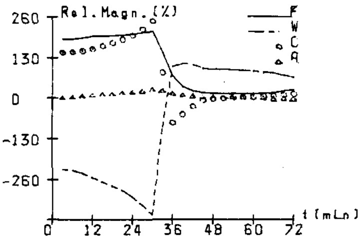


Fig.4 Relative Magnitudes of terms in Mom.eq. as % of Bedslope

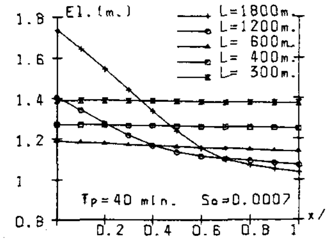


Fig.5 Water Surface Profiles at the time of maxm. Qoutflow

As can be seen from Fig.6, the arrangement can be said to be effective for peak reduction. The results presented are restricted to the cases where there occurs no overflow from the gate as well as no pressurized flow. For the cases of S_o=.0014 and T_p=80 and 120 mins., the overflow was found to occur for any length. The reduction of length beyond the lowest ones shown by ☐, for all the cases considered lead to overflow or pressurized flow. It can be summarised that

<1> Other conditions remaining same, peak reduction is more for milder slope. However, relative contribution of the barrier to the peak reduction is more for steeper slope, specially for large L

<2> Increase in peak reduction with length is more for shorter duration flood

<3> Rate of increase of peak reduction with increase in length becomes less as L increases. There exists some practical limit of L beyond which the barrier does not play any appreciable role in the further reduction of the peak. It can be seen in Fig.5 that, near the d/s section near the barrier, the profile is horizontal. And roughly speaking, if for a pipe length considered, the profile is horizontal for most of the reach of the pipe, the increase in the length of the pipe can be expected to cause further reduction in the peak discharge. But, if the profile remains no longer horizontal, and tends to follow the bed slope profile, at and near the upper reach, the further increase in pipe length does not produce any significant increase in peak reduction.

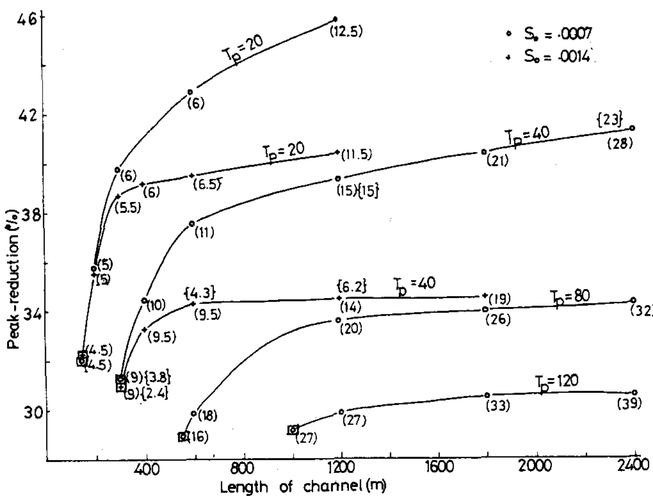


Fig.6 Results of the Numerical Experiments carried out

Conclusion : This simple study reveals the possibility of significant peak reduction by using the type of barrier mentioned and the existence of some optimum pipe length for the amount of peak reduction desired.