A REVIEW PAPER ON PIPE BURST RISK ANALYSIS BY SURGE 2000

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Abstract: Present work is a review of surge analysis of water supply mains, which has been done earlier. Transients can introduce large pressure forces and rapid fluid accelerations in to a water distribution system. These disturbances may result in pump and device failures, system fatigue and pipe ruptures or bursts and even the intrusion of dirty water. Proper analysis of transient and risk factors of existing networks helps in the formulation of low-cost, long-range non-destructive pipe condition assessment. In this study, risk assessment of pipe network is carried out using Surge 2000. The analysis dealing with pumping mains has been designed as per the design and hydraulic data available and as per the guidelines of Central Public Health and Environmental Engineering Organization (CPHEEO).Several case studies have been carried out on this topic earlier, some of them I have reviewed and trying to make a conclusion and further scope of the study.

INDEX TERM*:* Surge, water supply mains,fatigue,pipe burst

INTRODUCTION AND LITERATURE

Water hammer (or hydraulic shock) is the momentary increase in pressure inside a pipe caused by a sudden change of direction or velocity of the liquid in the pipe. Water hammer can be particularly dangerous because the increase in pressure can be severe enough to rupture a pipe or cause damage to equipment. A common instance of water hammer could be observed by turning off a shower instantaneously. The action emanating as a result of water hammer or surge sends a loud thud through the house. This can cause loosening of joints and bursting of pipelines if the pressure is high enough.

Lingireddy, et al. [1] carried out the analysis of pressure surge in pipeline system resulting from air releases. In their research, they noted that since air valve are integral parts of a long pipeline passing through elevations. Pressure surge propagation is quite inevitable. Pressure surge will occur due to the release of air accumulated in a pipeline in the course of transmission. But the effect of this would be reduced to a minimum if proper sized surge suppression device like orifice plate is installed in the system. The work specifically considered the pres-sure reduction in a pipeline system when a 12.5 mm orifice was installed in pipeline compared to a 75 mm ori-fice also installed. The pressure surge when a 12.5 mm orifice plate was installed reduced to about 30 meter of water while the pressure when a 75 mm orifice was in-stalled was still as high as 168 meter of water from a surge pressure of 210 meters of water.

Rajeshwari raj[1] 2013 carried out an analysis of water transmission mains failed due to surge analysis by using basic software known as Surge Analysis Program (SAP). It is a real time failure case study of a pipe laid in Una, Himachal Pradesh. The transmission main was a 13 kilometre long pipe with 7.9 kilometres as pumping main and 5.1 kilometres as gravitational main. The analysis deals with mainly pumping mains. With adequate installation of protection devices, the maximum piezometric heads along the chainage ranged from 527.957 m to 530.6 m at a chainage of zero metre and 7920 m respectively. Thus, with the use of adequate surge protection devices the maximum piezometric head records a drop of 28.83 %, thus placing the pipeline in safe limits. Similarly, the negative pressures have also been completely eliminated.

Rani Seema[1],Setia Baldev[2] Nit Kurukshetra2014 carried out an analysis of water transmission mains.In initial section a 1000mm DI K-9 water supply rising main has been laid from Narwana Branch to canal water Pump House Ismailpur and up to canal based water works, Ambala city. Out of 14.3 km pipeline, the pipe from Narwana Branch to pump house has been laid under gravity and rest of the pipe has been laid as rising main from canal pump house to canal based work. Previous analysis was carried out for 3 no. of pump with discharge 0.999 cumec and it was found safe in respect of pipe thickness as per IS 8329: 2000 (re-affirmed 2005) Indian Standard for Centrifugally Cast (Spun) Ductile Iron Pressure Pipes for Water, Gas and Sewage – Specification (Third Revision). After three trials fourth trial has been made for 4 no. of pump and minimum thickness has been unsafe for 1.332 cumec discharge, while it is safe for 0.999 cumec discharge.

Malppan John Preeji[1] carried out the study large pressure forces and rapid fluid accelerations in to a water distribution system. In this study, risk assessment of pipe network is carried out using Surge 2000. Water supply network of Adatpanchayat of Thrissur district in Kerala is selected for this study, as the possibility of transients exists in the area due to its undulating topography. Digital pipe network is created in ArcMap 10 by compiling data collected from GIS, available construction drawing, and report. It is then imported to Surge 2000 and modelled for steady and transient state. Transient analyses of the system were carried out for the worst cases like pump trip/shut down and valve operations by using Surge 2000, which is based on wave characteristic method. The pipe burst risk factors for maximum pressure; minimum pressure and transient force were also formulated. The control measures were suggested with the help of Surge 2000 and found that the risks of the system failures were mitigated by the application of control measures. This study helps to estimate the approximate number of the pipe which are out of service, and can easily formulate a pipe network maintenance plan in advance to avoid the occurrence of burst pipes.

SIGNIFICANCE OF STUDY

(1) The present work is surge analysis of water transmission main in the city of Ambala. The pipe line had been designed for providing water from Narwana Branch to canal water Pump House Ismailpur and up to canal based water works, Ambala city.

The raw water outlet connection of canal based water supply scheme Ambala city was from Pinjokhra minor which generally runs for 15 days during running period of canal and remains closed for next 15 days of the month due to which a great problem was faced by Public Health Engineering Department to provide sufficient water supply to the inhabitants of Ambala city during the closer period of canal. The NSL at Ismailpur is 256.79m whereas at canal based water works is 268.64m. The inlet pipe to receiving chamber is approximately 3.5m.

Existing Conveyance System:

The pipe parameters are as follows

i. Total length of the total pipeline = 14 km
ii. Diameter of pipe = 1000 mm
iii. Material of the pipes = Ductile Iron (DI) Pipes
iv. Specification of pipes = K9 pressure pipe

Study Area:

Longitudinal Profile:

Figure given below has been drawn from the data given in the level book, source: PWD PHE Division, Haryana, Ambala City

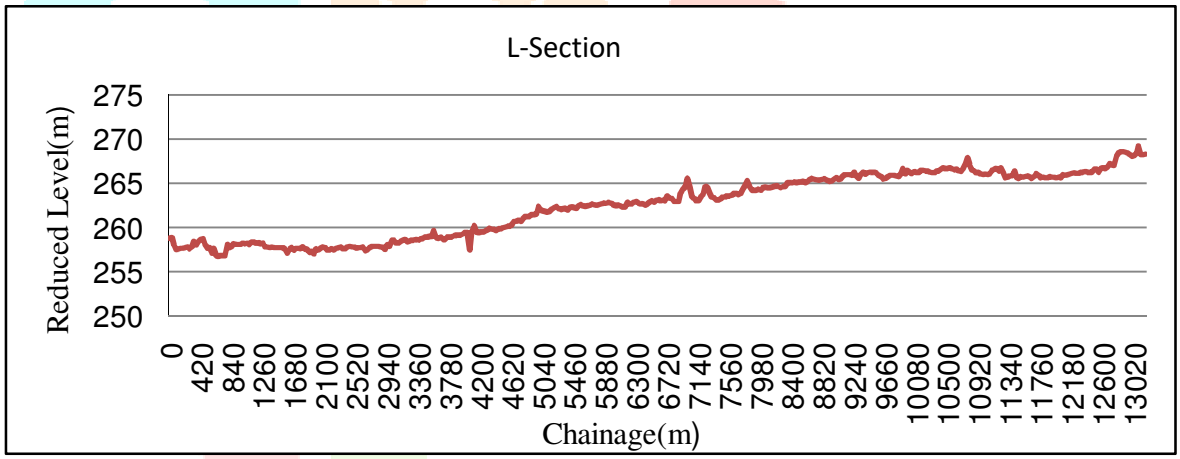
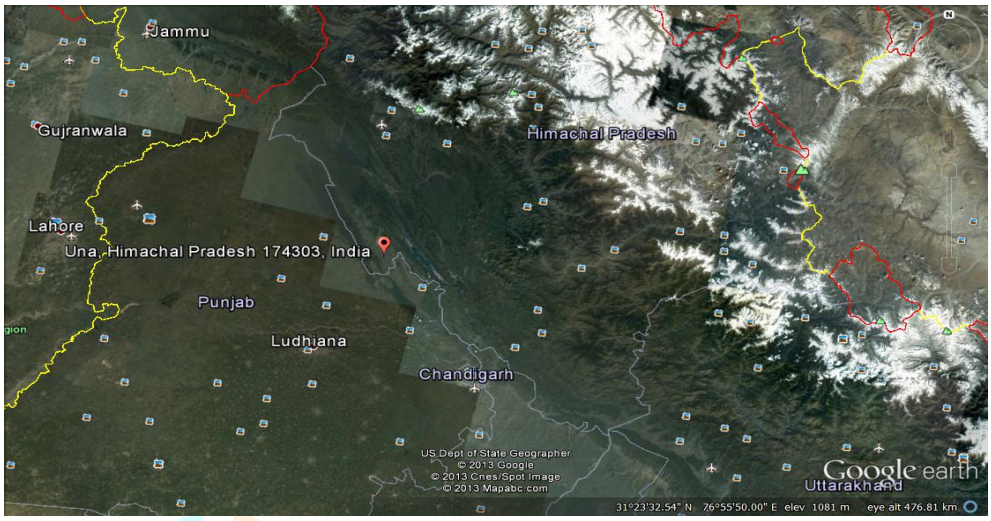


Figure Topographical detail of the pumping main area

(2) The pipe line had been designed for providing water supply to the group of villages of 17 nos. gram panchayats from Kohdra to Tutroo in Kutlehar area in Tehsil Bangana, District Una, Himachal Pradesh. The details of the study area and the data of pipeline was obtained from Jindal Saw Ltd., New Delhi.



Study Area

On-site observations

Following observation of the pipe laid were made and noted as following:

a) Pipes:

v. Length of the total pipeline = 7920 m

vi. Diameter of the pipes = 250 mm

vii. Material of the pipes = Ductile Iron (DI) Pipes

viii. Specification of pipes = K9 pressure pipe

b) Jointing:

i. Jiffy Joints

ii. Flanged sockets

c) Discharge through pipes = 45.44 lps.

d) Centrifugal pump of 2 x 100 HP was provided to the system

e) Visual observations

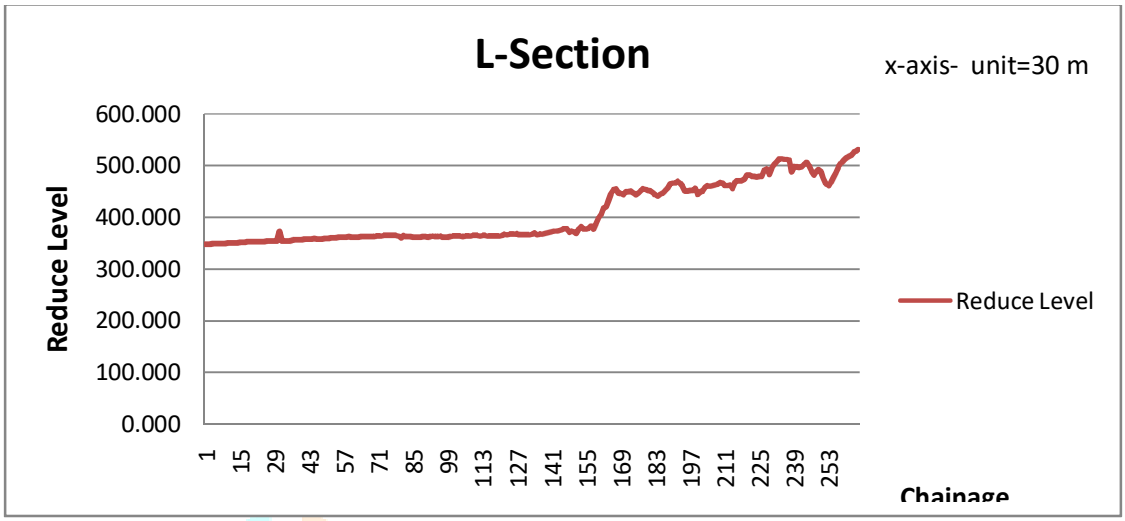
Many visual observations were made and the failure was found due to one of the factors mentioned bellow:

a. Improper laying of pipes

b. Leakage

c. Faulty Jointing

Topographical detail of the pumping main area



Highest elevation observed was 530.60 m at 7920 m chainage from the starting point and minimum elevation was 352.365 at 0 m or starting point.

(3) The AdatGrammaPanchayat is located about 6 km north-west of Thrissur Corporation and surrounded by Kolazhy, Kaiparamb and TholurPanchayaths. The Panchayath is located near the suburban belt of Thrissur Corporation. The topography of the study area, the AdatGrammaPanchayat of Thrissur is an undulating type. The supply scheme includes a pumping main from sump at Puzhakkal to tank at Vilangankunnu and gravity main from tank at Vilangankunnu.The pumping system consists of a sump of 42000litres capacity at Puzhakkal, 250mmAC pumping main and a GL tank at Vilangankunnu.

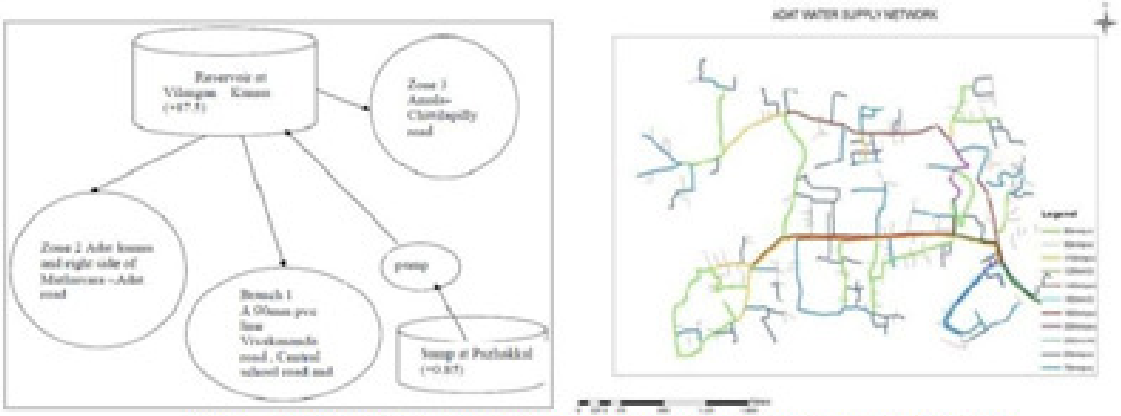


Fig. 1. (a) Study area; (b) Adat water supply scheme in ArcMap10

RECOMMENDATION

i) One number surge relief valve is to be placed on the headed pipe just after the pump house. More than one valve may be provided on the same line to improve the reliability of arrangement.

ii) The air relief valves are recommended to be provided at every one KM of the pipe alignment and in addition to this also at all the location where the pipe gradient changes.

iii) Proper vertical and horizontal alignment should be maintained to provide sagging and shifting of the pipeline.

iv) Supports and pedestal should be provided at adequate locations, especially under the joints of the pipeline.

v) Proper levelling of ground and laying of joints

vi) For durable pipeline system due care must be taken for maintenance of the pipeline.

vii) Air valves and pressure relief valves are suitable for mitigating negative pressure and high pressure in a gravity main.

SUMMARY AND CONCLUSION

In earlier analysis a DI 1000 K9 pipe has been designed as per the design and hydraulic data available. The 1000mm pipe line has been found safe at 0.999 cumec discharges and after sensitivity analysis it was not safe for discharge 1.332 cumec while using 4 no. of pump at a time. As per the guidelines of CPHEEO Manual, The following ratios of air valves to conduit diameter provide common but rough estimate of needed sizes**:**For release of air only =1:12, For admission as well as release of air =1:8.Based on the study, the following conclusions were made. Steady state analysis and transient state analysis of complex networks can be done using Surge 2000.In the transient analysis of pumping main, pump trip was obtained as the worst case. The pipes in the rising portion of pumping main were in risk while pump trip. A closed surge tank located near the pump was found as the protection device in pumping main for mitigating the risk. The presence of severe negative pressure exists in the gravity main during transient simulations. Air valves and pressure relief valves are suitable for mitigating negative pressure and high pressure in a gravity main. Gravity main with all control measures is safe against all simulated transient events.

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