

## Some Failure Patterns in Small Diameter Water Pipelines in the City of Houston

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**Abstract:** In this study, types of water pipeline failures in the City of Houston were investigated. Based on limited data, the most common failure mode was circumferential crack which always happened in small diameter cast iron or asbestos cement pipes. Based on preliminary analysis, the failure was a combination of corrosion and mechanic forces.

### 1. Introduction

Water pipelines are made of asbestos cement, concrete, ductile iron, cast iron, steel and PVC. Numbers of failures of water pipelines are being reported regularly. Failure modes include circumferential cracking, longitudinal cracking, spiral cracking, corrosion pits and joint failure. Causes of failures are very complex and diverse and can be related to age, pipe materials, construction and ground conditions. The most common failure is circumferential cracking on aged small diameter cast iron and asbestos cement pipes, (Marker (2001)). For example, Marker (2001) reported failures of small diameter gray cast iron pipes in the city of Toronto. The cause of failure was due to bending forces in the small diameter pipe. The bending forces could be produced by the non-uniform soil movement due to expansive soils. Baracos (1955) also analyzed the pipe breakage data of cast iron and asbestos cement water mains in the city of Winnipeg in Canada and found the expansive soil movement amounted to as much as 20 mm and could cause 0.5% of rotation at the tightened joints. It was noted that the movement in corrosion-weakened pipe caused flexural or joint failures.

### 2. Objectives

The objectives of this study are as follows: (1) document the data for type of failure; (2) identify the causes of water pipeline failures in the City of Houston.

### 3. Discussion

In our study, we found that circumferential cracks could be partial circumferential cracks (Figure 1) due to bending and fully circumferential cracks due to temperature changes (Figure 2). Based on the monthly break data from July 2003 to February 2008, when the temperature fluctuated by  $\pm 10^{\circ}\text{F}$  which could add to the cause of failure (Figure 3), the failure rate was higher just after the largest fluctuation in temperature. It was also found that most cast iron pipes were corroded internal and external and average ages of those pipes was about 40 years. Therefore corrosion also played an important role in the failures.



Figure 1 Partial Circumferential Cracking



Figure 2 Full Circumferential Cracking

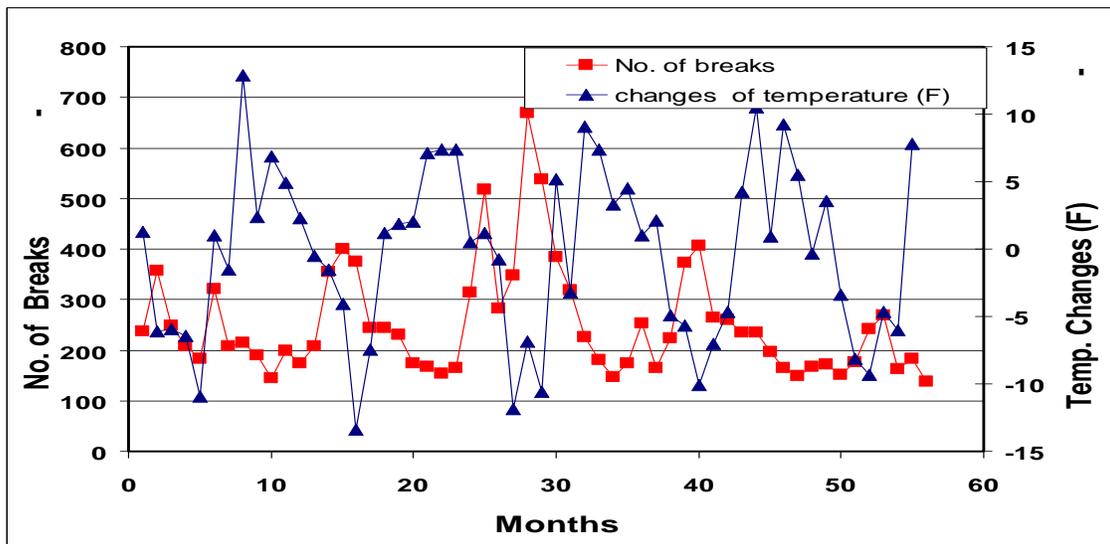


Figure 3 Changes of temperature compared to number of breaks each month

### 5. Conclusion

Based on limited data, circumferential cracking was most common failure mode in small diameter cast iron and asbestos cement pipes. Besides these two materials being weak in tension, especially the aged pipes, failures were caused by bending induced by non-uniform soil movement, corrosion and temperature effects.

### 6. Acknowledgements

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### 7. References

1. J. M. Maker (2001), "Failure Modes and Mechanisms in Gray Cast Iron Pipes", Underground Infrastructure Research 2001, Waterloo, Ontario, June 10-13.
2. Baracos (1955), "Effects of Physical Environment on Cast Iron Pipe", Journal of American Water Works Association, Vol.42, pp.1195-1206.