TRANSIENT DAM-BREAK WAVE LOADING ON PIPELINES NEAR SLOPING BED

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INTRODUCTION

Extreme events such as tsunamis and floods have caused massive damaging consequences to nearshore infrastructures. This has been more significant recently due to a changing climate. Transmission pipelines are among such infrastructures and need to be protected against potential extreme events. Design of pipelines requires comprehensive understanding of the exerting hydrodynamic forces. Such pipelines are often placed on sloping beds in coastal areas. Therefore, to address the uncertainties and parameters involved in extreme hydrodynamic loading on pipelines near sloping bed, an experimental program was conducted at the hydraulic laboratory in WASEDA University, Tokyo, Japan. This study is a complement of another experimental research conducted by Ghodoosipour et al., 2019a & b to investigate loadings from tsunami-like dam-break waves on pipelines located on flat bed. Both research experiments are in line with the American Society of Civil Engineers, ASCE7 recommendation for studying tsunami loading on pipelines.

EXPERIMENTAL SETUP

Experimental program was performed at the hydraulic laboratory in WASEDA university, Tokyo, Japan. The flume was 14.0 m long, 0.40 m wide and 0.80 m high. Tests modeled on-land tsunami flow inundating on sloped coastal plains. This allowed for investigation of the hydrodynamic forces exerted on the pipe due to the tsunami wave-induced bores. Different slope levels as well as various flow conditions were tested to investigate their influence on exerted forces. Wave gauges and Electromagnetic Current Meter (ECM) were used to measure the time-history of water levels and velocity at different locations along the flume. High-speed cameras were also utilized for observing flow behavior from different angles and for deriving bore front velocity using PIV image analysis techniques.

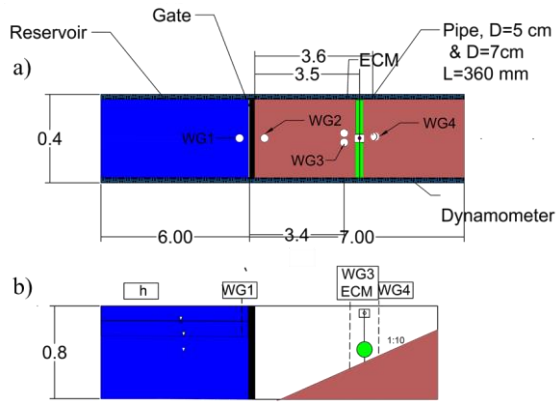

Figure 1- Experimental setting and instrument locations (a) plan view, (b) side view. (All dimension are meter)

Three different slope beds i.e., 1:10, 1:20 and a combination of slopes as 1:10+1:20 were tested and results were compared against the tests on the flat bed condition. The tested sloped bed configurations are shown in Figure 2.

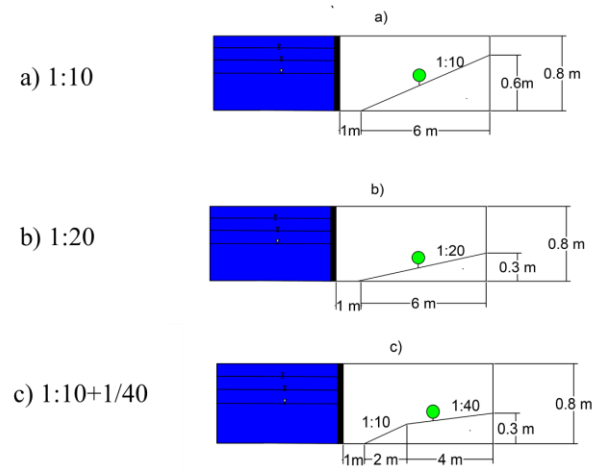

Figure 2- Three different sloped bed configurations tested in experiments.

RESULTS

Force time history results for flat bed and different slopes are shown in Figure 3(a) and (b).

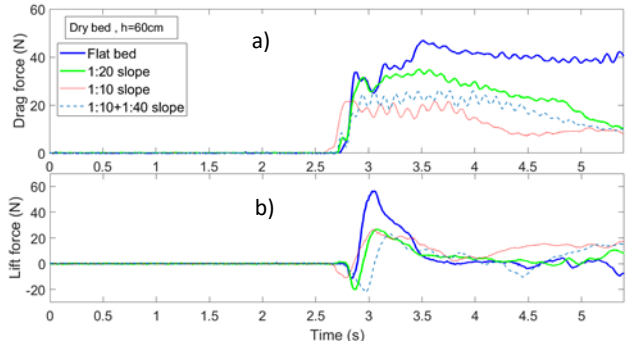

Figure 3- Time-history of the a) drag force b) lift force for dry-bed condition, h=60cm, flat bed, slopes: 1:10. 1:20, 1:10+1:40.

Results from testing different slope beds show that increasing the steepness of the bed slope leads to a decrease in drag force both at the time of bore impact as impulse force and later in the time-history. Induced drag force magnitude in the case of the combined slopes lies in between the steeper and milder slopes. The lift force peak on the flat bed, is significantly larger compared to

the three tested sloped beds. Changing the slope steepness did not change the positive lift force peak considerably.
Figure 4, illustrates results for the calculated resistance coefficient values as a function of the Froude number for the sloped bed cases tested in this study together with the calculated coefficients in previously tested cases on flat bed (Ghodoosipour et al. 2019 b).

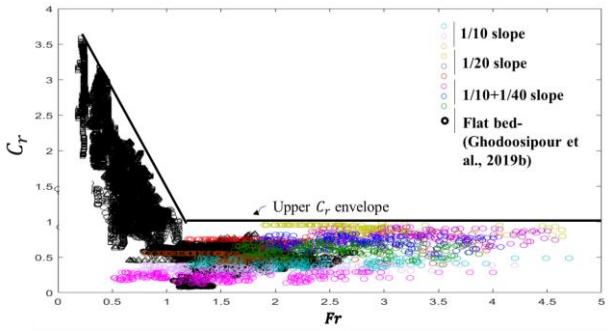

Figure 4. Calculated resistance coefficient vs. Froude number for the slloped and flat bed experiments.

CONCLUSIONS

This study presents results from investigating the loading on pipelines located on sloped beds induced by transient dam break wave. Findings from this study helps in characterizing the effect of different slope levels on induced loadings. Drag and lift forces were measured in different flow conditions and different slope levels. This study also aimed to calculate force coefficients in different tested configurations. Moreover results of this study will assist in better understanding of the phenomenon and the improvement of the results obtained from the previous study on flat beds.

REFERENCES

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