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Full Length Research Article

THE MODEL OF PILLAR SCOURING PROTECTIVE USING CONCAVE-SIDED CURTAIN

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ABSTRACT

Rivers posses dynamic characteristics that may change accordingly. During equilibrium state, the river flow can be potentially disrupted by the presence of bridge piers causes changing in the patterns of river flow and vortex formation around the pillar which eventually results in pillar scour. This study aims to determine the effect of the water flow velocity on the spacing lengthwise and distance transverse of the pillar using curtain variation technique; to investigate the basic alteration of elongated and transverse distance of the curtain before and after the placement curtain model on the pillars; and to compare between the depth of pillar scour resulted in this study and that observed in empirical research. This is an experimental study using three different models including a land line model with a cross-section shape of the trapezium, hekxagonal pillar and curtain sided concave models. The observation was performed towards the flow rate (*Q*), the flow velocity (*v*), flow depth (*h*), the elevation depth of scour (ds) for a specified time. The results show that the flow rate tends to decline from *0.50 m/sec*., and reduced to *0.20 m / sec* after passing through the curtain. The alteration of channel base around the pillar tend to decrease after the placement of curtain models. Before the placement of various curtain models, the depth of scour base ranges from (ds) *4-6 cm*, and this number changed to *0.5 cm - 1.5 cm* after the placement of curtain model in front of the pillars.

INTRODUCTION

The bridge is one of the critical infrastructure therefore maintaining the function and ability of the bridge during traffic flow plays a key-role in economic circulation. For this purposes, a continuous examination upon the bridge condition should become an integral part in the system management of the bridge. Bridge Examination should be performed as an early identification of any potential damages hence any effective and efficient treatment can be carried out in accordance with the conditions of the damage. Bridge damages can be resulted from several conditions including loading factor, environmental and natural disasters. Current destructive force of water flow also contributes to the damages. One reason is that the headwaters area has damaged, causing an increase in water flow. Also, the river bed degrades due to illegal sand mining. This inreasing damages various building infrastructure such as bridges, dams or sabo dams. Pillar scouring is commonly caused by disturbance toward the pillars and water flow, however this may return to its balance state resulting from sedimentation process. The impact of pillars construction on the river causes the water flow toward the pillar hits the pilar itself and moves perpendicular towards the canal bed causing agradation and degradation processes. Bridge collapse is mostly caused by the failure of the bridge to maintain the stability of its pillars during load transfer. Some problems found in cross-river bridges have been linked to the failure of under-bridge structure including pillar stability in supporting the bridge. In some cases, this failure led to the collapse of the bridge.

In some cases these were caused by bridge scouring. Kandasamy and Menville (1998) in 1973 investigated and stated that a number of 383 bridge damage has occured worlwidely. Of this number, 25% were caused by bridge piers, 72% due to the abutment. Link *et al*. (2008) stated that during 1960-1984, 108 bridge damages occurred. Of this number, 29 of damage caused by abutments-linked scouring, 6 of the 10 bridge damages in New Zealand also caused by abutments, in addition to the 70% of the expenditure allocated for bridges repairing and maintenance due to the abutment scour.

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This research will be carried out using model of concave-sided curtain and will emphasis on the water flow characteristics and the changes of canal bed after passing through the curtain. It is expected that results obtained from this study will be superior than those in previous studies considering the curtain model is effective reducing or mitigating the scour around the pillars. For this goal, we will examine the application of scouring reducer model such as concave-sided curtain. Placing such curtain next to the pillars is capable to reduce bridge scouring around the piers.

MATERIALS AND METHODS

This study is an experimental and literature research . The testing method applied in this study is for testing the raw materials and flow testing to determine the type of flow and discharge using a scour reducer model.

Canal Model

The canal models used in this study are cross-section trapezium-shape land canals grounded overlaid with granulated materials. The geometric shape of these canals is a straight line with permanent wall, the canal base is 0.50 m in width and 0.20 m in height and a experimental canal is 15 in length.

Pillar Model

Pillar models used in this study were made of concrete blocks which were formed according to the intended model. This study applied a model of hexagonal pillars with a height of 40 cm and a width of 5 cm. The pillar models were located in the middle of the canal model at a distance of 15 m from the upstream

Curtain Model

Curtain models used in this study are made of concrete blocks which were formed as the model. This study applied concave-sided curtain with a height of 40 cm and a width of 5 cm. This curtin model was placed before the bridge pillar models with various distance between the pillars and curtains.

RESULTS AND DISCUSSION

This study applied hexagonal pillars with concave-sided curtain jetting time is t: 15 minutes, 40 minutes and 60 minutes. The data obtained includes the speed, (v), flow depth (h), discharge (Q) and the basic topography of surrounding curtains and pillars. The effect of longitudinal distance (L) on the flow velocity (V) before and after placement of the curtain models can be seen in Fig. 5 and Fig. 6.

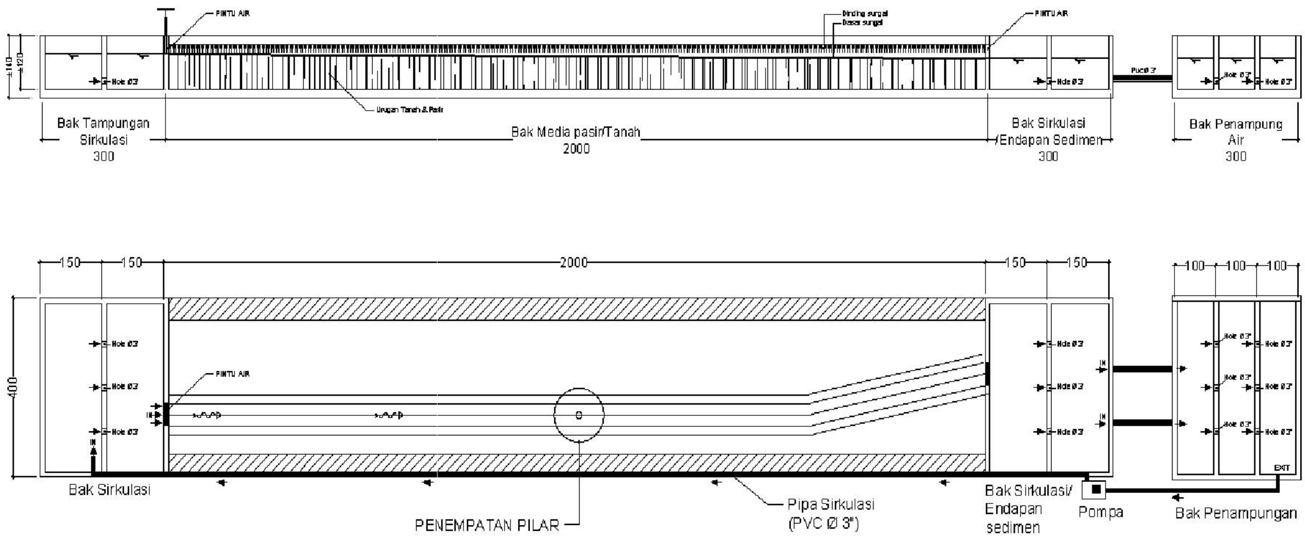

Fig. 1 a Model of open canal with trapezoid cross-section

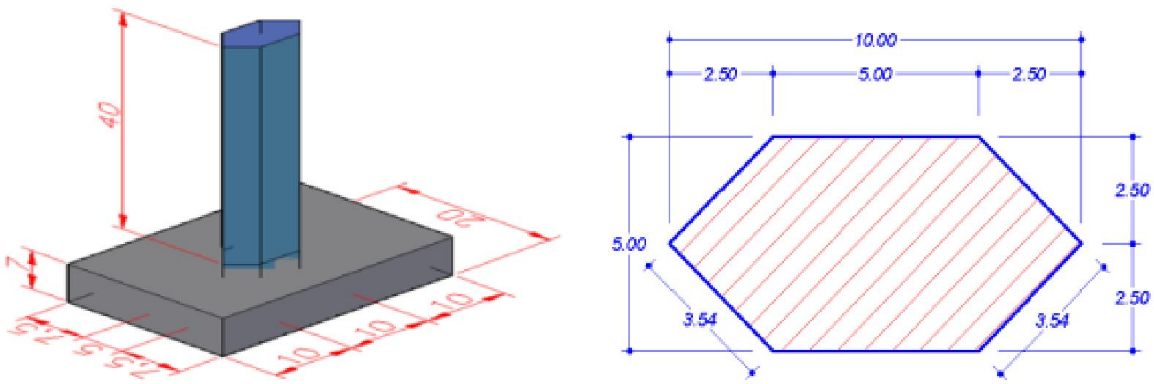

Fig. 2. Hexagonal pillar model

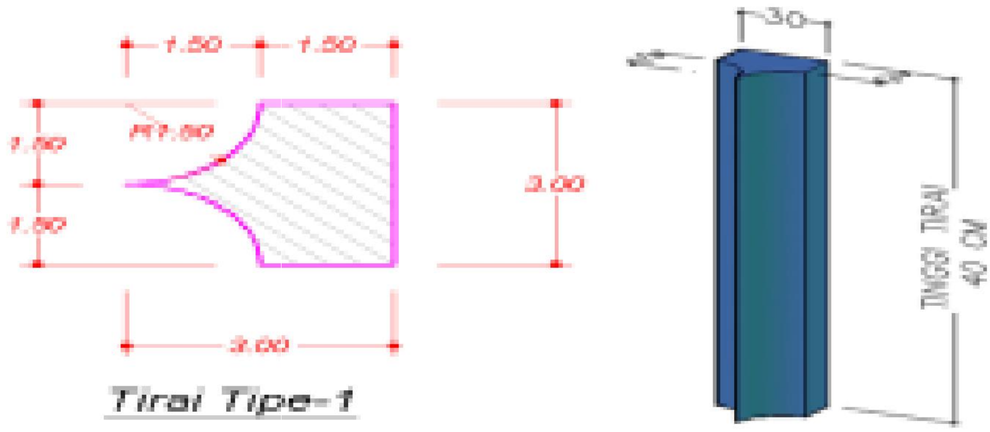

Fig.3. Concave-sided curtain models

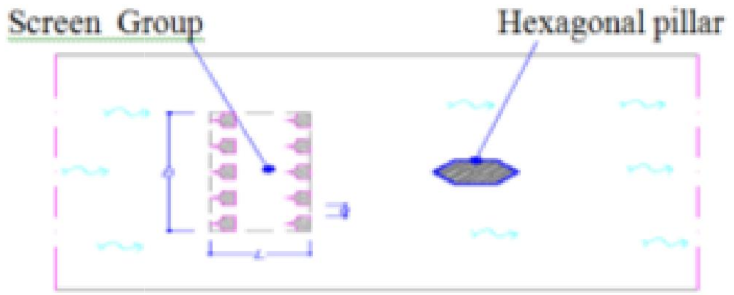

Fig. 4. Placement curtain models and pillars of the bridge

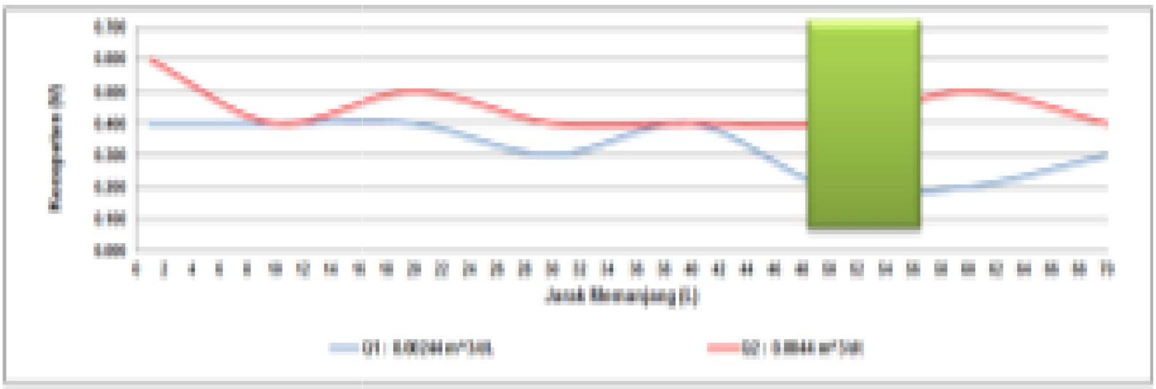

Fig. 5. Distribution of flow velocity before placement of the model curtains

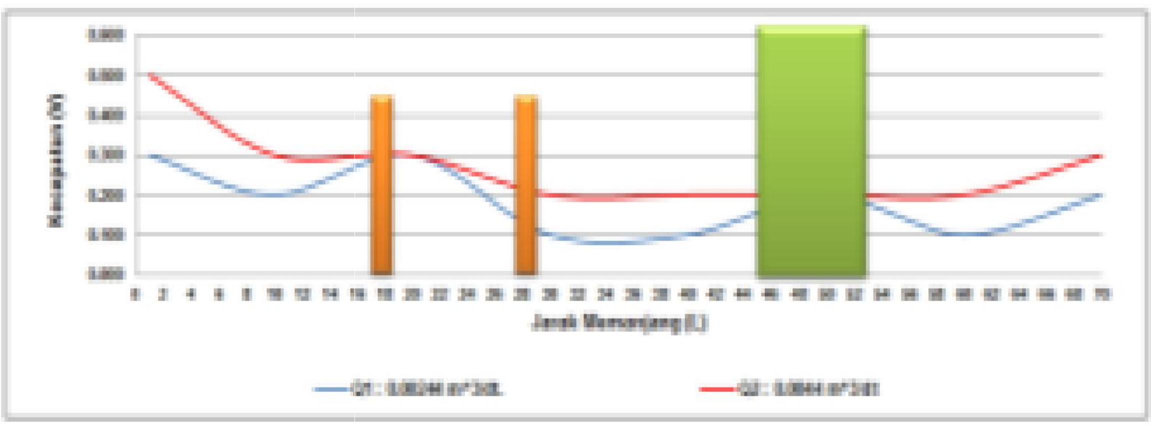

Fig. 6. Distribution of flow velocity on the curtain models

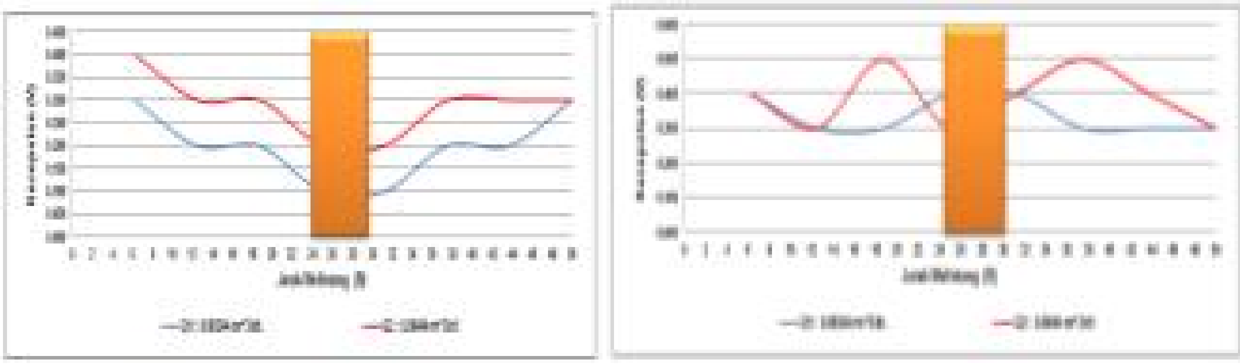

Fig. 7. Distribution of flow velocity before and after imple-mentation of the modelcurtain to discharge Q_1 and Q_2

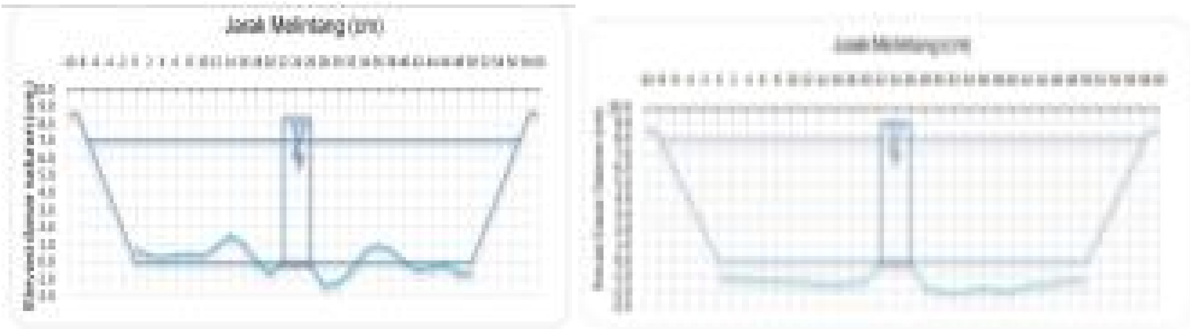

Fig. 8. The changes of canal bed cross section before and after application of the curtain model

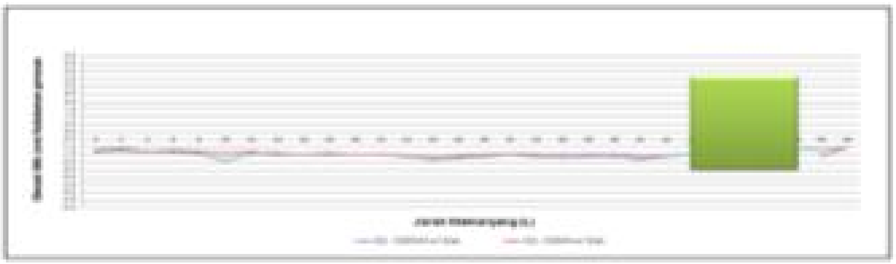

Fig. 9 The basic change of longitudinal direction before placement curtain models

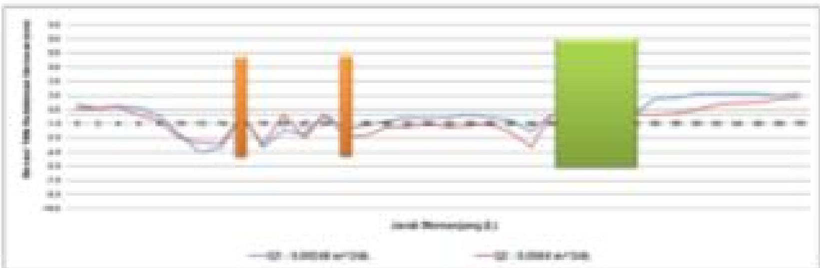

Fig.10. The basic changes a longitudinal direction after placement curtain models

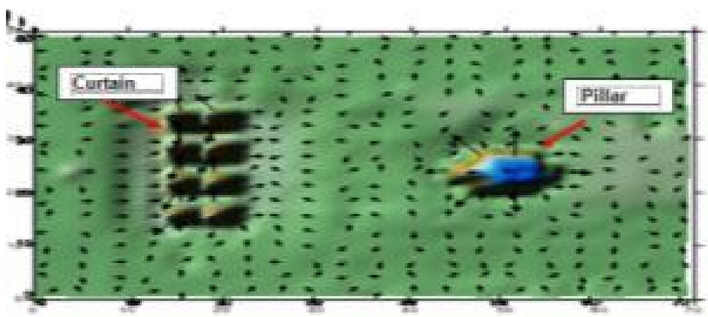

Fig.11. Vector directions and contour basic changes

The discharge *(Q_1)* avarage of flow velocity distribution before the placement of curtain models is 0.400 m / sec. with longitudinal distance (L): 0.01 m until 0.40 m. For discharge *(Q_2)*: 0.0044 m / sec. the distribution of the average flow velocity 0500 m / sec. at a distance cross section 0.01 m, 0.20 m and 0.60 m. Flow velocity distribution after placement of models curtain to discharge *(Q_1)* an average of 0.20 m / sec. the longitudinal distance (L): 0.44 m and the flow velocity tendency to be uniform. For discharge *(Q_2)*: 0.0044 m3 / sec. flow rate tend to be uniform at a distance extending 0.40 m to 0.70 m is 0.300 m / sec.

Effect of cross section canal distance (B) on the flow velocity (V) before and after the placement of curtains models for Q_1 and Q_2, can be shown in Fig. 7.

Distribution of flow velocity before placement of the curtain model towards discharge *(Q_1)* for Vmax: 0.400 m / sec. with cross section distance (B): 0.25 m up to 0.32 m. For discharge (*Q_2)* the avarage of flow velocity distribution (V) is 0.500 m / sec. at the cross sectional distance of (B): 0:19 m and 0.38 m. The flow velocity distribution after placement of curtain models for debit (Q_1) was 0.300 m / sec. with longitudinal distance 0.06 m . Flow velocity around the pillar was more likely to decline at the cross sectional distance of 0.25 am with flow velocity (V): 0.100 m / sec. For discharge *(Q_2)*: 0.0044 m / sec. distribution of flow velocity (V) maximum was 0:20 m / sec. The flow velocity around the pillar tended to decrease at the cross sectional distance of 0.25 m. The changes in canal bed in transverse direction before and after implementation of the curtain model can be shown in Fig. 8.

Canal bed alteration before the placement of curtain models around the pillar demonstrated a fairly large scouring process i.e observed in the cross sectional distance of 0.26 m up to 12.42 m with the scouring depth elevation ranges about (ds) 3.5 cm – 5.00 cm. The changes in canal bed around the pillar reflects that the pillar scouring process tends to decrease after placement of the curtain model. The greatest scouring observed at the cross sectional distance of 0.30 m and depth elevation scouring (ds) of : 1.0 cm. The deposition process at the cross sectional distance of 0.36 am with a high deposition (da) is 1.1 cm.

The changes of canal bed in longitudinal direction before and after implementation of the curtain model can be shown in Fig 9 and Fig. 10

The basic changes before the placement of curtain models around the pillar shows that scouring process begun from upstream up to the downstream of curtain pillar with the elevation scouirng depth elevation ranges from 0.40 cm - 0.60 cm. The basic changes after the placement of the curtain model demontrated a decrease in scouring process around the pillars. The maximum scour depth at longitudinal distances varies from 0.44 m up to 1.00 wtih scour depth elevation is 2.5 cm. Selecting the contour coordinates for the X direction are perpendicular the direction of flow (horizontal), Y and Z direction of flow perpendicular to the direction of flow (vertical). Scour depth (Z direction) was measured at intervals for the direction of X by 2 cm and for the Y direction by 2 cm. Subsequently the data and the measurement result were processed to obtain a contour map.

Vector directions and scouring contour pattern around the pillars showed the highest level at the distance of 0.46 am in front of the pillar, precipitation around the pillar was found to be fairly moderate due to decrese in flow velocity after passing through the curtain. Scour depth contour around the pillar and scour pattern are parallell towards the flow direction. Scour elevation around the pillars experienced further reduction of the more backward the depth of scour. From Fig. 11, it can be stated that with the placement of curtain models in front of the pillar along with observing the water flow movement patterns, these potentially reduce or minimize pillar scouring that tends to precipitates at the distances of 30 and 50 of the pillar layout axis.

Conclusion

The flow velocity around the pillar zone showed a tendency to decrease from 0:50 m / sec. and the average water flow velocity was 0.20 m/sec. After passing the curtain model. Changes in the depth of scour (ds) around the pillar zone demonstrated a tendency to decline from 5.0 cm and after passing through the curtain models the scour depth was 1.0 cm - 2.5 cm. The patterns of flow movement creating scouring tendency obeserved at the distance of 0.46 m, while deposition staring to occur at the axial distances of 30 and 50 from the pillar.

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