VOL. 9, NO. 10, OCTOBER 2014 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

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LOCAL SCOUR ANALYSIS STUDY TO HEXAGONAL PILLAR BY USING SHAPE CURTAIN RECTANGULAR WITH WEDGE SHAPE CURVE (RWWSC)

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ABSTRACT

Threats to safety beneath the bridge structure often come on stream dynamics, especially the dynamics of the river bed around the foundation and pillar of the bridge. The degradation riverbed and local scour around bridge pillar foundations often a major factor structural failure under the bridge. The purpose of this study, provide a solution in the form of scouring around the zone damper models pillars of innovative technology and evaluate this further, analyzing the characteristics of the flow and scour around the pillars by using models as well as the influence of the placement of scour silencer silencer models to scour scour depth and distance that occur around pillars. This study uses tract of land with a cross section of the trapezium shape, observations made around the curtain is the flow velocity, depth of scour around the pillar, and deformation of the base around the pillars and curtains. This research is part of a dissertation by the title Scour Reducer Modeling By Using Shape Curtain Rectangular With Wedge Shape Curve (RWWSC) The Pillar Zone and expected results is an overview and analysis of the pattern of flow and scour around a pillar, especially with regard to agradasi and degradation.

Keywords: flow patterns, scours, pillar, curtains.

INTRODUCTION

Sediment transport is a natural phenomenon that is common in a wide variety of open channels, a phenomenon that occurs in channel sediment or rivers is a very complex event, because it is influenced by fluctuations in the turbulent flow continuously along the channel. Thus the river bed material is very heterogeneous from one place to another, causing a change of sediment transport. In places where the diameter of the small grains of sediment transport capability is high, while the location where the grain diameter base and a relatively large river rock will cause the sediment transport capabilities of small. [5]

The collapse of a bridge largely caused by the failure of bridge pillar stability in function to transfer the load. A problem encountered in bridge cross the river under the bridge is a structure failure (foundation, pillars, base / abutment) to support the bridge. In some cases, this failure led to the collapse of the bridge. Threats to safety beneath the bridge structure often come on stream dynamics, especially the dynamics of the river bed around the foundation and pillar of the bridge. As mentioned in [2] decrease or river bed degradation and local scour around bridge pillar foundations often a major factor structural failure under the bridge.

As mentioned in [3] scour that occurs is closely related to the phenomenon of the flow behavior of the river, which river flow hydraulics in its interaction with the river geometry, geometry and layout of the pillars of the bridge, as well as basic characteristics of the soil in which the pillars are built. Scour occurs due to the flow velocity, flow rate, flow depth, shear stress and shear rate at the surface of the river bed, the dimensions of the pillars and the pillars of the tilt angle between the directions of flow.

Pillars are part of the most important bridge because it serves to hold its own weight and the weight of Cargo Bridge that crossed it. Therefore, Pillar Bridge built on the river flow and the stability of the local scour due to the influence of river water flow need to be considered.

Local scour around bridge pillars caused by changes in flow patterns. These changes are the result of the entrained flow section of the pillars, so that the flow in the downstream direction and will turn aside. If this becomes a strong increase in pressure, the horse shoe vortex will be formed on the base of the pillar itself. Then this whirlpool will reach downstream towards the bridge pillar, thus it greatly affects local scour process. In this condition, erosion and sediment transport will be high [4].

As mentioned in [1] there are several factors that determine the size of the local scour occurs in the riverbed around the pillars, those factors that form the pillars of geometry, flow characteristics and sediment types. Scours are also a function of sediment size, flow characteristics, channel geometry, time and space. The maximum depth of scour will reach equilibrium during certain conditions.

Erosion and sedimentation process is a complex problem, which is strongly influenced by the flow conditions, and the condition of the river sediment material itself. In order to overcome these phenomena needs for laboratory studies on local scour around bridge pillars is happening in the presence of sediment transport conditions (live-bed scour). Scour processes that occur need to be studied to determine the parameters that affect the flow of local scour around bridge pillars, so it can be searched further control efforts and prevention of scours

VOL. 9, NO. 10, OCTOBER 2014 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

on pillars so that damage can be avoided and construction collapse.

For that would be assessed the use of the model by using the damper scours the front side curtain curved square shape, with the consideration that the placement of the building after the curtain with the type of the pillars of the building will be able to reduce scour around bridge pillars.

Based on the above key issues, then this research is to help overcome the scours that occur around the pillar due to the decline in construction and due to the water flow. The purpose of this study generally provides a solution in the form of scouring around the zone damper models and evaluating the pillars of this technological innovation further.

METHODS

The method used in this study is an experimental study. This type of testing that is done is the basic material testing and flow testing to determine the type of flow and discharge, using the model of scour silencer.

PREPARATION OF EQUIPMENT CHANNEL MODEL

The channel used is channel sand, soil material overlaid with trapezium cross-section shape. The geometric shape of the channel is a straight line with a permanent wall, base channel width of 0.50 m, height 0.20 m and a channel length of 15 m channel experiments.

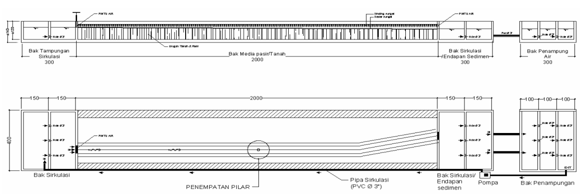

Figure-1. Models open channels with trapezoid cross- Section.

PILLAR MODEL

Pillar model used in this study is made of concrete blocks formed by model. This study uses a model of hexagonal pillars with a height of 40 cm and a width of 5 cm pillar. Models pillars placed in the middle of the channel model at a distance of 15 m from the upstream

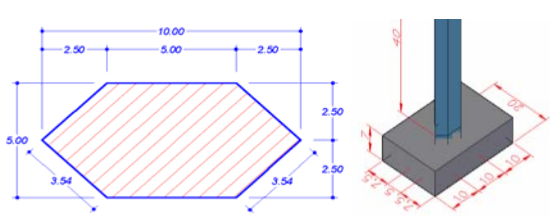

Figure-2. Models hexagonal pillar.

CURTAIN MODEL

Curtain models used in this study are made of beams formed by model. This study uses a square shape with side curtain front curved (rectanguler with wedge shape curve) with a height of 40 cm and a width of 5 cm pillar. The model is placed in front of the curtain pillar models with variations in the distance between the bridge pillars and curtains.

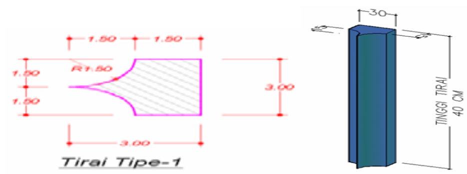

Figure-3. Shape Curtain Rectanguler with Wedge Shape Curve (Rwwsc).

IMPLEMENTATION RESEARCH

In the implementation of the planned research using the model of hexagonal pillars and silencer scours the variation model of the front side curtain curved square shape (rectangular with wedge shape curve) with various types of formations.

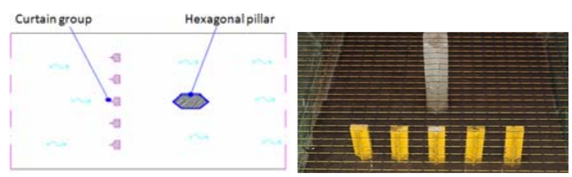

Figure-4. The placement curtain models and bridge pillars.

RESEARCH IMPLEMENTATION STEPS:

Pillars model placed in the middle of the ground line with a distance of 6.0 m from the upstream, then arranged the placement of models in the dampers and the front piers of sand material is spread in a flat state.

Water is supplied from a small discharge to discharge specified so as to achieve a constant.

The observations made: The flow velocities (v), water level (h) do any experiments.

Observations scour depth, each experiment carried out through observation and by noting the depth of the initial running with time t: 15 minutes, t: 40 minutes, and t: 100 minutes.

Data collection scour contour around the zone was measured after running pillar finished, by minimizing the flow slowly in order to scour around the pillars are not bothered by the change in discharge. This is done so that the data obtained represent the contours of the scours. Elevations measured scour the area at the top of several parts, namely the direction parallel to the direction of flow and transverse flow.

Taking scour around the zone length is measured after running the pillars finished.

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After the measurement of three-dimensional, flattened sand back for further running with other variations.

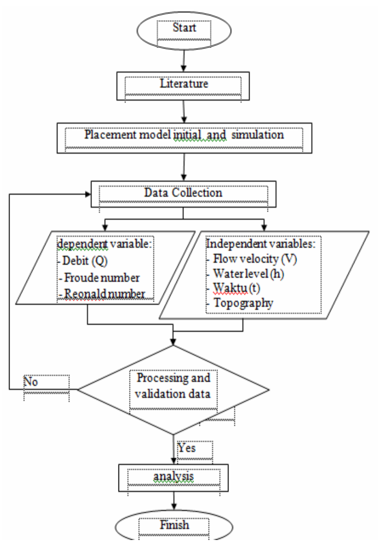

Figure-5. Flow chart of research.

ANALYSIS

This study uses hexagonal pillars with curtains, square shape with a curved front side drainage time is t: 15 min, 40 min and t: 100 minutes. The data obtained is velocity, (v), water level (h), discharge (Q) and the basic topography that occurs around the curtain and pillars.

FLOW VELOCITY

The data were presented as the channel flow velocity in Table-1 below.

Table-1. Data flow velocity.

Observation point	Model eksperiments	Velocity (m/s) h= 0.0216 Time (t) 10	40	100
1	Pillar	0.40	0.40	0.50
2		0.30	0.30	0.50
3		0.40	0.40	0.40
4		0.40	0.40	0.40
5		0.30	0.40	0.40
6		0.30	0.40	0.40
7		0.30	0.30	0.40
8		0.20	0.30	0.40
1	Pillar with curtain	0.20	0.30	0.20
2		0.30	0.40	0.30
3		0.30	0.30	0.40
4		0.30	0.40	0.40
5		0.30	0.30	0.40
6		0.22	0.40	0.30
7		0.20	0.20	0.20
8		0.24	0.20	0.20

EFFECT OF DEPTH SCOURS (ds) ON VELOCITY (V)

From the observations obtained an increase in the depth of scour due to increasing velocity, increasing speed also resulted in increasing shear strees velocity, which can generally be seen in Table-1.

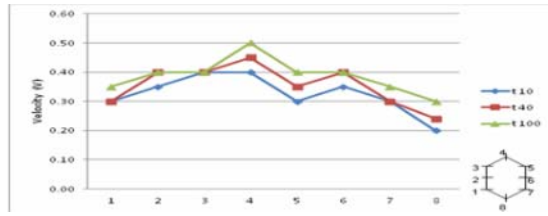

Figure-6. Graph, flow velocity versus time relationship on the pillars without a curtain.

In Figure-6, the depth of scour that occurred around the pillar without curtains increased scour depths that vary in front (upstream) pillar, right and left side pillar and rear pillar portion downstream.

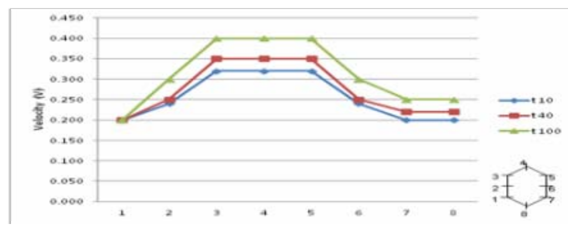

Figure-7. Graph, flow velocity versus time relationship on the pillar by using curtains.

From the graph above, we can see that the velocity is going on around the pillars that use screen to increase the velocity on the right side and the left pillar and rear pillar,

DEPTH EFFECT SCOURS ON FLOW TIME

The depth of scour that occurred around the pillar without the use of curtains and curtain pillar increased depth of scour at the upstream front pillar, the pillar and the right and left rear (downstream) pillar, which was originally larger then the longer the addition of depth scours has narrowed to the final reaches a certain equilibrium (equilibrium scour depth).

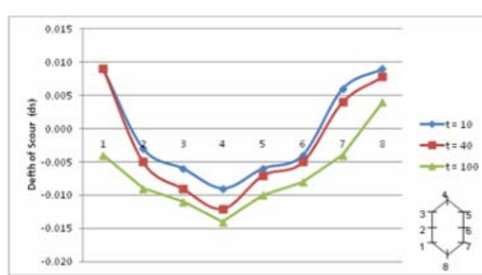

Figure-8. Graph relationship charts scour depth (ds) with time (t) on the pillar without using curtains.

The depth of scour at the pillar without using curtains, at least at the upper right side of the pillar (1) at

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t_{10} = - 0.100 m and the highest at the upstream piers (4) t_{100} = - 2.100 m. The precipitate that occurs on the pillars without the use of curtains is the lowest in the downstream piers (8) on the t_{100} = 0.000 m and the highest at the downstream side of the pillar (8) t_{10} = 0.700 m. Scour and deposition occurs around the pier.

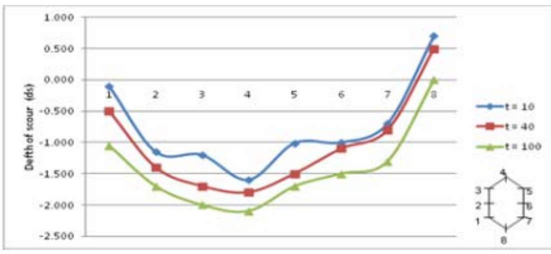

Figure-9. Graph relationship charts scour depth (ds) with time (t) on the pillars by using curtains.

The depth of scour at the pillar using a curtain, which is the lowest on the left side of the pillar (2) on the t_{100} = - 0002 m and the highest at the upstream pillars (4) t_{100} = - 0.014 m. The precipitate that occurs on the piers using screens, the lowest on the right side of the downstream pillar (7) at t_{40} = 0.004 m and the highest at the rear side pillars (1 and 8) t_{40} = 0.009 m. Scour and deposition occurs around the pillar and change the pattern of scour.

SCOURS VOLUME

The volume of scour and deposition are calculated based on changes in the channel cross-sectional area of the form prior to jetting throughout the observation area. The following scours the volume of data presented to a variety of simulated conditions.

Table-2. Recapitulation scours volumes for a variety of simulation studies.

No	Flow velocity	Debit flow	Time	Simulation	scour volume	volume reduction of scour	Percentage Reduction scours
	V (cm/s)	Q (cm3/s)	(minutes)		Vg (cm3)	Vg (cm3)	(%)
1	0.8	0.0090	t 10	pillar without curtain	414		
2				pillar by using curtain	162	251	60.80
3			t 40	pillar without curtain	444		
4				pillar by using curtain	280	164	36.86
5			t 100	pillar without curtain	453		
6				pillar by using curtain	317	137	30.16

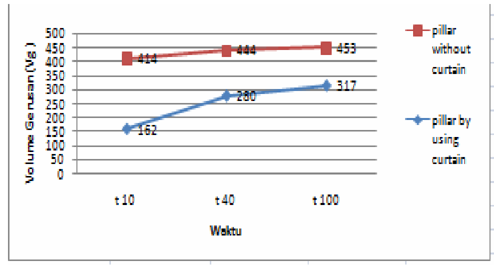

Figure-10. Graph relationship scour volume based the time (t).

EFFECT OF CURTAINS INSTALLATION SCOURING PILLAR

Installation of curtain upstream of the pillars is intended to curb the flow velocity and steer or deflect the flow direction. As the real effect of the installation of the curtain that observed in the laboratory, is the reduction in flow velocity that occurs behind the curtain. With these conditions, it is expected that the volume of scour that occurs also experienced a reduction.

On the interaction of surface water flow moving towards the pillar, the flow of water around the structure will change and vertical velocity gradient (vertical gradient) of the flow will turn into a pressure gradient (pressure gradient) at the surface of the structure. Pressure gradient (pressure gradient) is the result of the flow under the bed height. On the basis of the following flow structure to form a vortex that eventually swept the round and the bottom of the structure to meet the entire flow.

There is a difference in the pattern of scour around bridge pillars using a screen with pillars without a curtain. Scour around the pillar without curtains starting from the front (upstream) pillar with a depth of scour -2.100 cm -1.500 cm towards the right side, left side and rear pillars -1.700 cm (downstream) pillar,

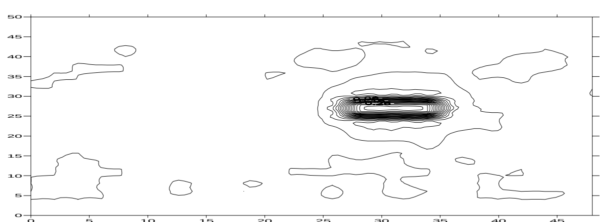

Figure-11. Topography scours around the pillar without curtain (t_{100}).

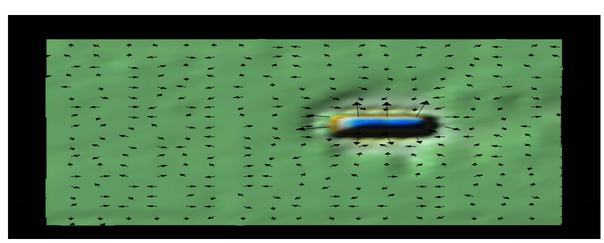

Figure-12. Shape of the flow pattern and the basic deformation without curtains

While the pillars are using curtains, flow velocity moving toward the curtain will be blocked, so that the flow will be distributed side-curtain and the flow will be spinning in between the curtains is caused by the shape of the arch on the front side curtain scouring that occurred around the pillar. Starting from the front pillar toward the left side and right side of the pillar, so that the flow rate will be reduced to the pillars that lead to the more shallow scours behind (downstream) pillar. On the right side and the left side of the pillar depth of scour widened due to scours (local scouring) caused by the installation of the curtain which causes the flow to become concentrated.

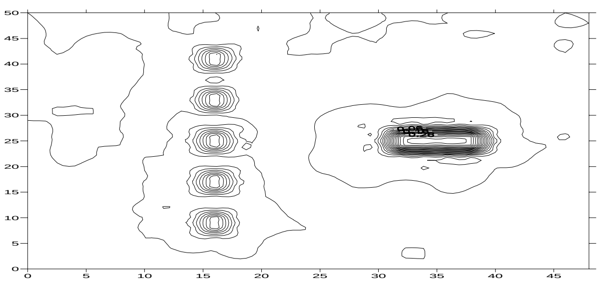

Figure-13. Topography scours around the pillar using curtain (t_{100}).

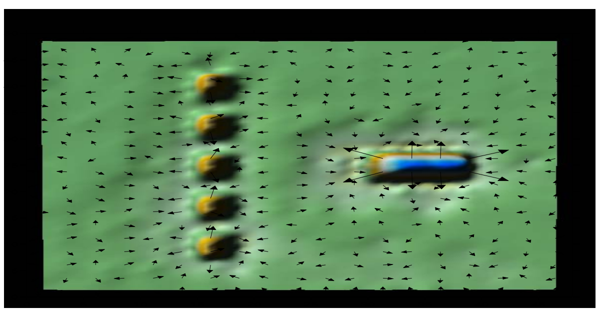

Figure-14. The shape of the flow pattern and the basic deformation using curtains.

Structure screen serves to reduce the pressure gradient (pressure gradient) so that the flow is touching the bed in front (upstream) pillar is reduced. In addition influenced by the pressure gradient is also caused by the pull of the mainstream (main flow).

CONCLUSIONS

At the pillar without using a curtain formed horseshoe vortex, is caused by the flow velocity is large enough so happens scour hole that formed towards the sides of pillars with different depths.

Installation of the curtain on the pillars streaming with discharge (q) = 0.0090 cm^3 /sec for 10 minutes resulted in a reduction of 251 cm^3 scour or 60.80%, Jetting for 40 minutes resulted in a reduction of 164 cm^3 scour or 36.86%, Jetting for 100 minutes resulted in a reduction of scour 137 cm3 or 30.16%. So that the volume of scour that occur around the pillar decreases after using the model of the curtain.

REFERENCES

[1] Barbhuiya Karim A. and Subhasish. 2003. Vortex Flow Field in a Scour Hole around Abutments International Journal of Sediment Research. 18(4): 310-325.

[2] Istiarto. 2011. Problematika Jembatan di Sungai. Error! Hyperlink reference not valid.

[3] Khwairakpam P, Mazumdar A. 2009. Local Scour around Hydraulic Structures International Journal of Recent Trends in Engineering. 1(6).

[4] Richardson JR and Richardson E.V. 1993. Discussion of Local Scour at Bridge Abutments. Journal Hydraulic Engineering, ASCE. 119(9): 1067 -1071.

[5] Yang C.T. 1996. Sediment Transport Theory and Practice. The McGraw-Hill Companies, lnc, Singapura.