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Experimental investigation of the flow field around a bridge pier with hooked collar

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2012.08

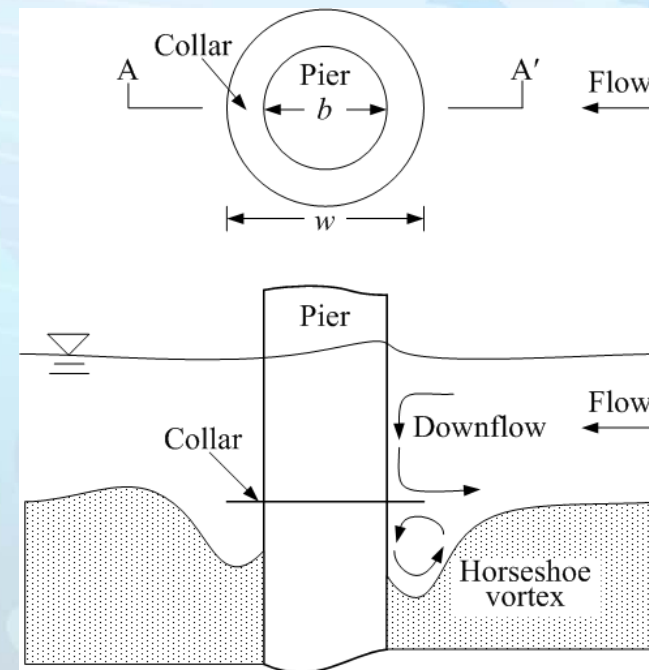
Introduction



- Two methods are used to reduce the scour depth :
 1. To increase streambed resistance to withstand erosion.
 2. To reduce the downflow and thus the formation of the horseshoe vortex.



<http://www.ttvs.cy.edu.tw/kcc/970919fo/fon.htm>



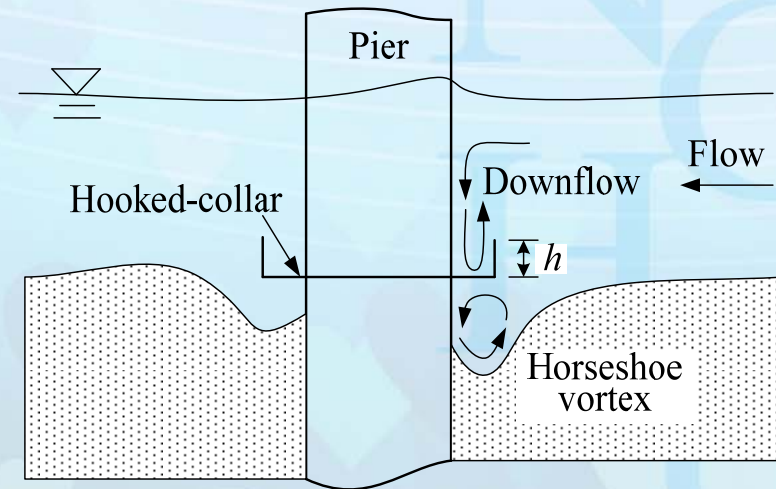
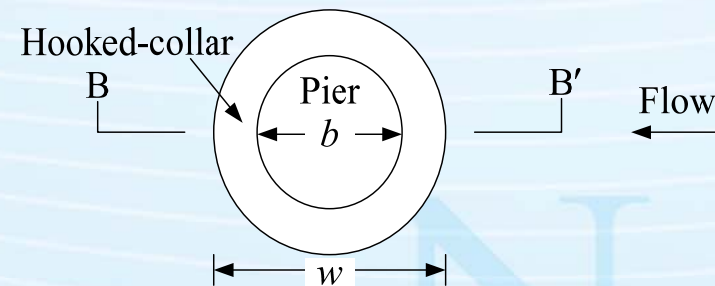
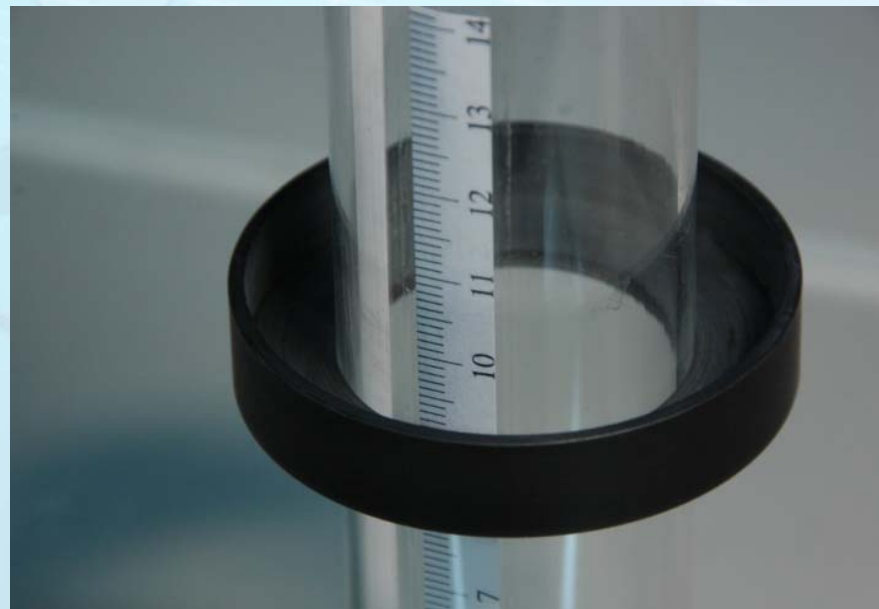


- Efficacy of a collar is a function of its width and its elevation relative to the bed surface.
 1. A collar width of $2b$ placed at $-0.1b$ for circular piers, where b is the pier width (Singh et al., 2001)
 2. A collar $3b$ wide for rectangular piers (Zarrati et al. , 2004)
 3. A collar $4b$ wide (Kumar et al., 1999)
- Collar performance enhances with increasing collar width.
- Installing a large collar may be difficult in practical engineering.

Introduction



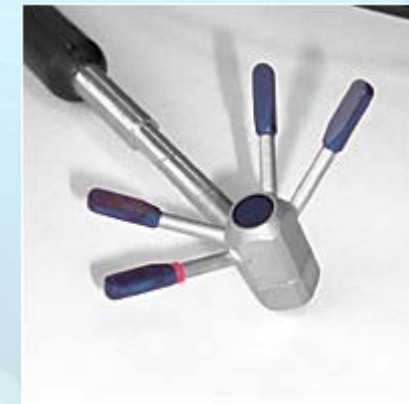
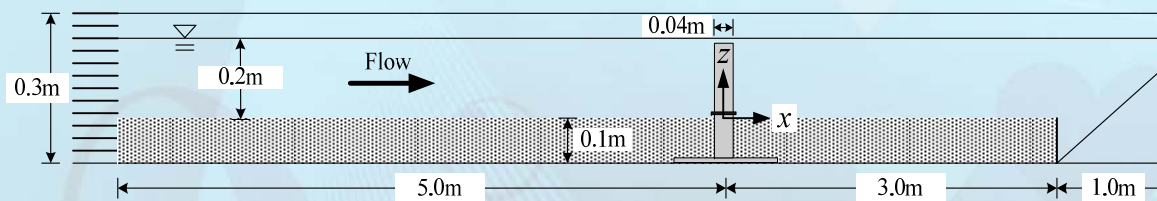
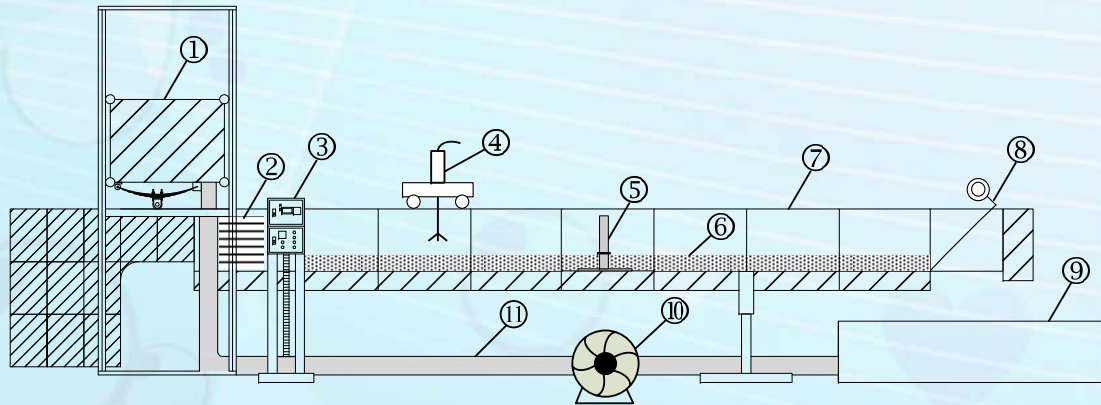
- This study proposes a new type of collar, the hooked-collar.



Experimental setup and procedure



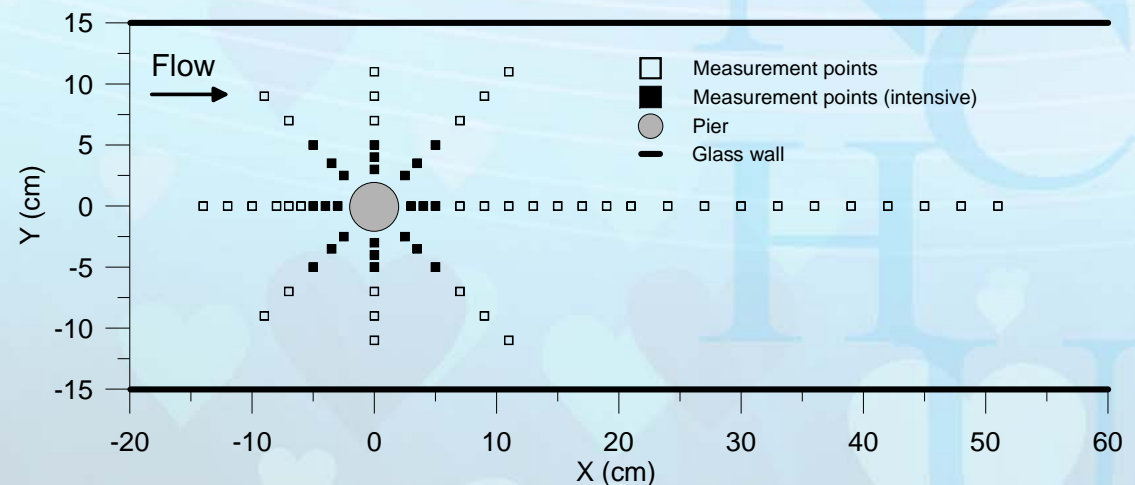
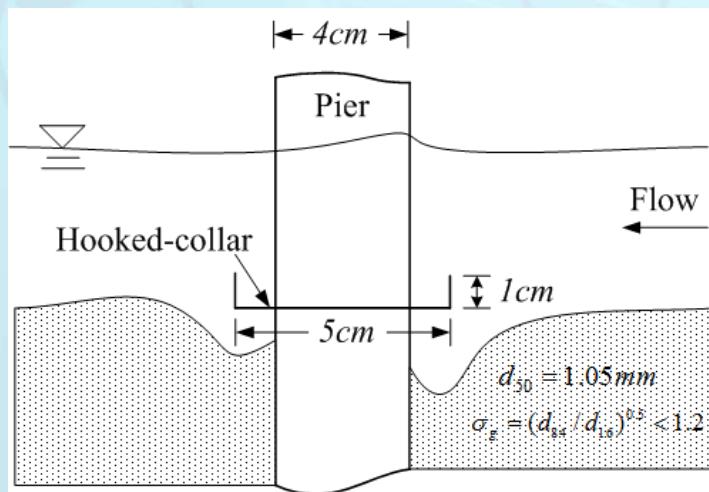
- Experiments were conducted in a recirculating flume.



Experimental setup and procedure



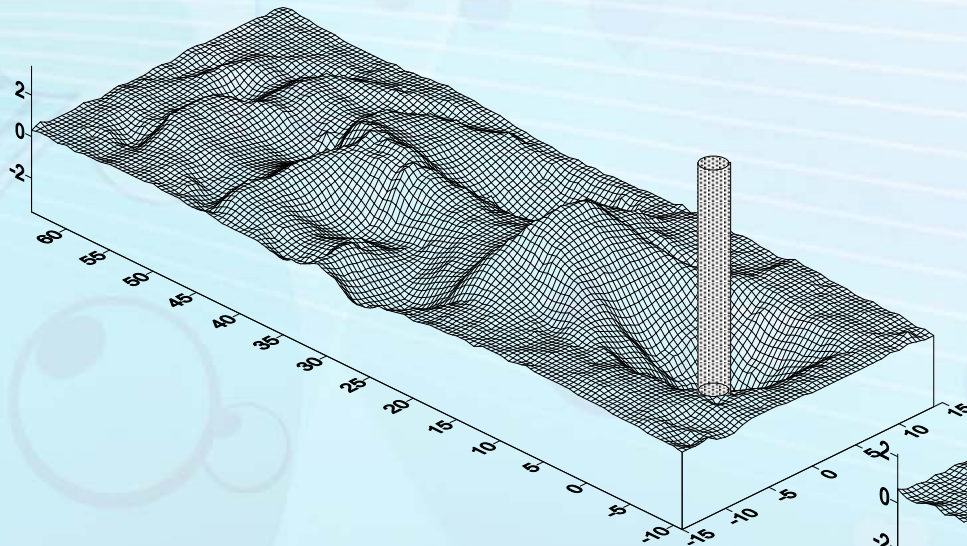
- Circular cylinder: diameter $b=4$ cm
- Hooked-collar: $W=1.25b$ and $h=0.25b$
- $Q=0.011$ m³/s with 0.20 m flow depth.
- Flow measurements: 25 Hz for 5 minutes.



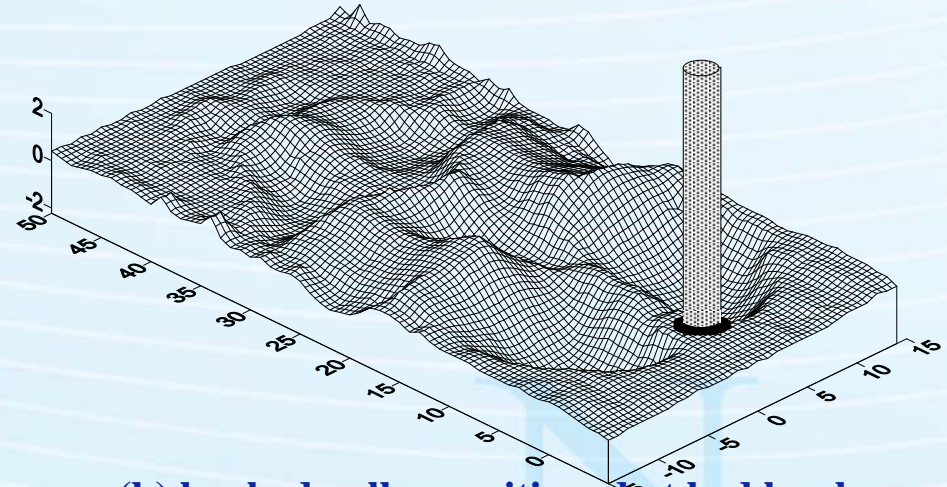
Results and discussions



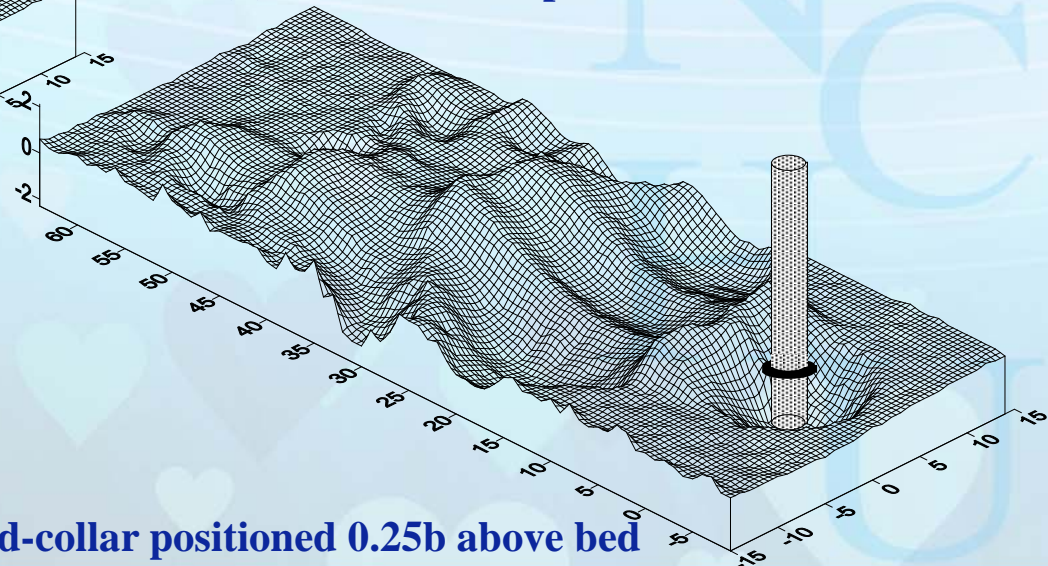
➤ Scour



(a) without the hooked-collar



(b) hooked-collar positioned at bed level



(b) hooked-collar positioned 0.25b above bed



- Hooked-collar positioned $0.25b$ above the bed

Depth of scour hole Reduces about 33%, compared with the pier without a hooked-collar

- Hooked-collar positioned at bed level

Collar performance improved

No scour at the front and sides of the pier

Deepest scour hole is at the collar edge

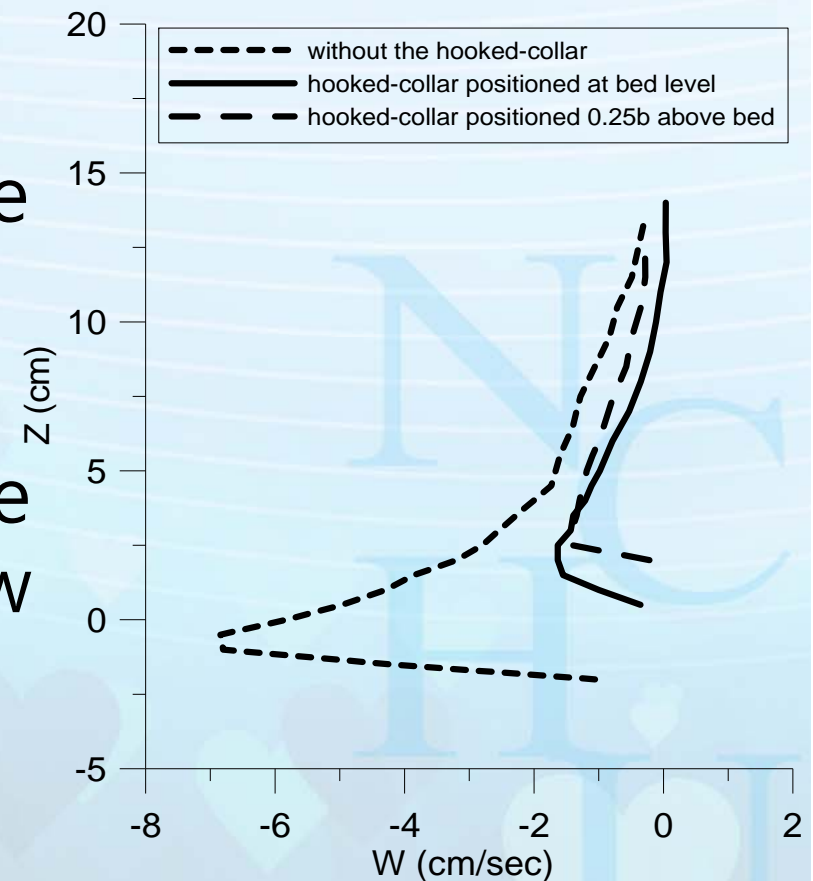
These findings are similar to the results of Kumar et al. (1999).

Results and discussions



Time-averaged vertical velocities at 1 cm upstream of the pier

1. Hooked-collar dissipates the energy of the downflow above the collar.
2. For the experiments with the hooked-collar, the downflow is approximately 25% of the maximal downflow.

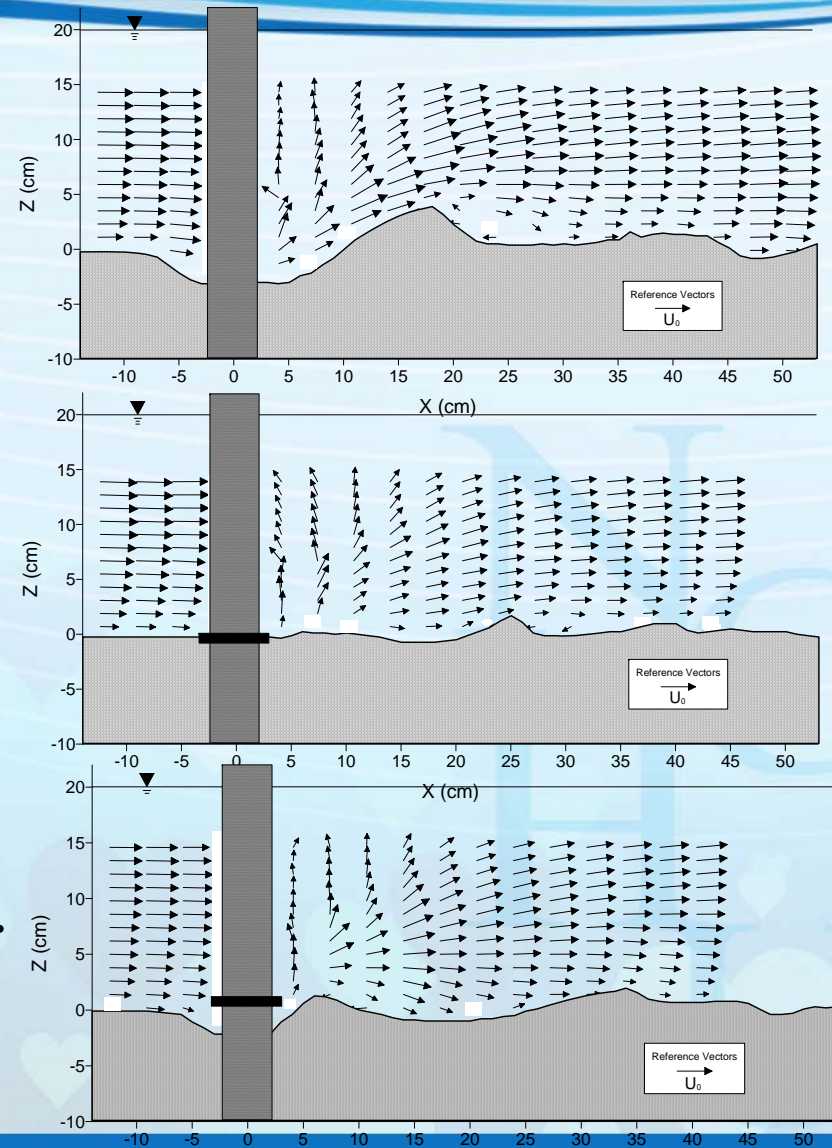


Results and discussions



Time-averaged velocity vectors along the vertical plane of symmetry of the pier

1. The formation of the horseshoe vortex is resulting in the interaction between the downflow and the coming flow.
2. With the hooked-collar, the size of the scour hole reduces with a decrease in horseshoe vortex strength.



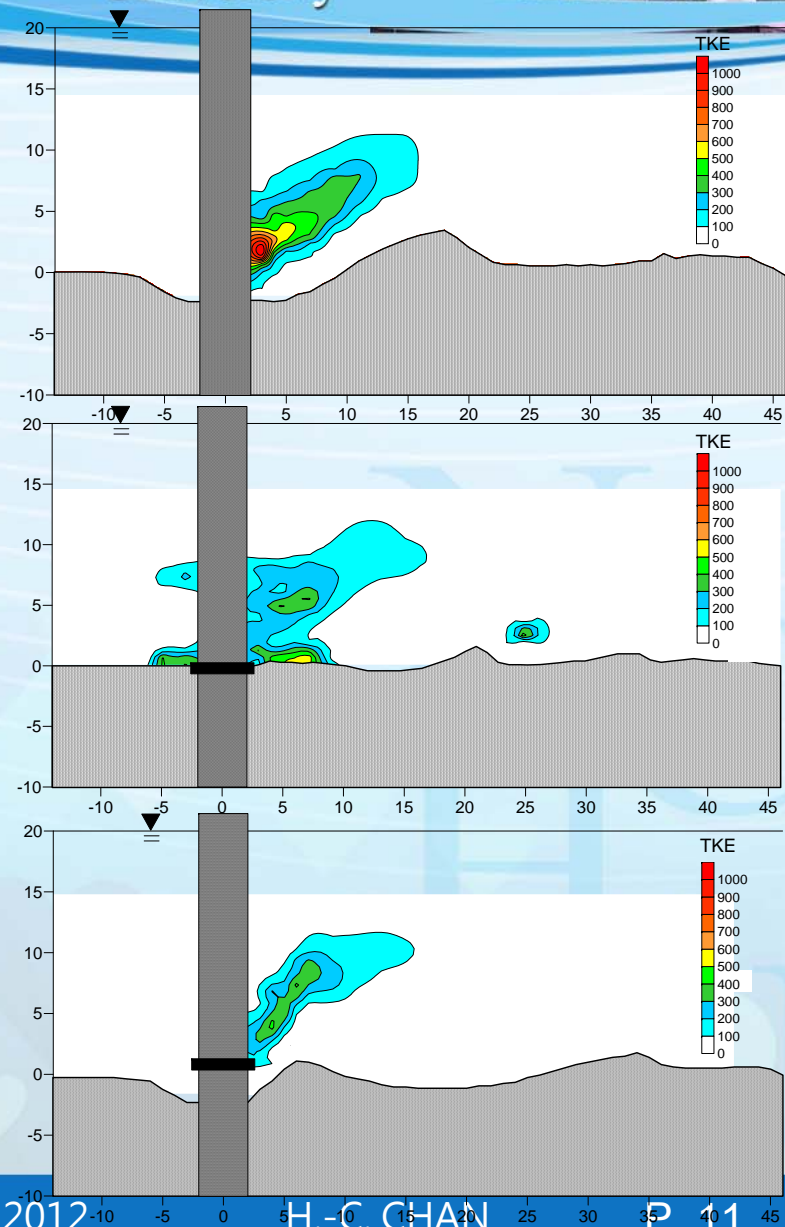
Results and discussions



➤ Normalized turbulent kinetic energy

For the experiment without the hooked-collar,

1. there is a core of high turbulent kinetic energy behind the pier.
2. no significant turbulent kinetic energy can be found near the bed.
3. the energy has been dissipated during the scouring process.



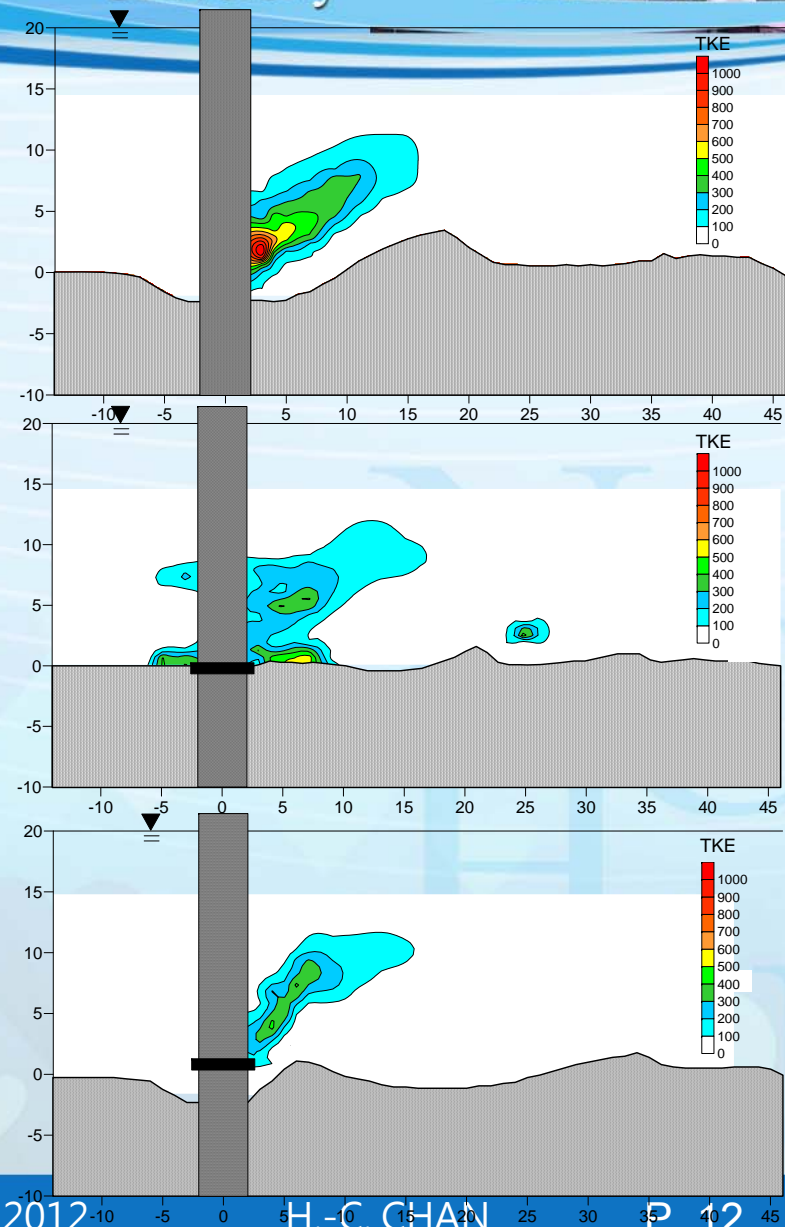
Results and discussions



Normalized turbulent kinetic energy

For the experiments with the hooked-collar,

1. two regions with local higher turbulent kinetic energy.
2. the maximum turbulent kinetic energy decreases by about 60%, compared to that of the experiment without the hooked-collar.



Conclusions



- A new type of collar, the hooked-collar, is proposed.
- With the hooked-collar installed at the bed level, there is no sign of scouring and horseshoe vortex at the upstream face of the pier.
- Further research is needed.



*Thank you for
your attention*

*Please share your
idea with me*