Measurement of Crack Movement of Barrage using 2 & 3 Dimensional Crack Monitors

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Abstract

Barrages are basically meant for diversion of river water through canals for irrigation purposes. There are numerous barrages in India for various purposes. Some old barrages in India are in poor condition and have developed cracks and need regular monitoring for safety of structure. A comprehensive programme of instrumentation and observation can play a major role in evaluating the stability of a structure. Proper guidelines for instrumentation of barrage are basic requirement for monitoring its performance and safety. BIS has framed guidelines for instrumentation of barrages and weirs in its code IS 14248:1995. These BIS standards recommend monitoring of barrage for uplift pressure, stress and strain, water levels, tilt and displacement. This paper discusses about the analysis, results and recommendations based on the monitoring of crack movement.

Keywords: DW: Dividing Wall; DP: Double Pier; S: Step; P: Pier; AFT: Acre Foot

I. INTRODUCTION

Barrage/headwork of the project is located 10 km downstream of Baramulla town on river Jhelum between villages Gantamulla on left Bank and Jehampora on right bank. Main function of head works is to divert water from river into the water conductor system and to provide live pondage of 250 AFT for partly meeting the fluctuations of load.

The project is having total generation capacity of 105 MW (3 units of 35 MW each). Barrage/ headwork has developed several cracks on dividing wall and piers on upstream and downstream sides. CSMRS had installed 27 instruments for crack movement monitoring at different locations on upstream and downstream side of barrage during 2004-05. Since then, data analysis is being done by CSMRS.

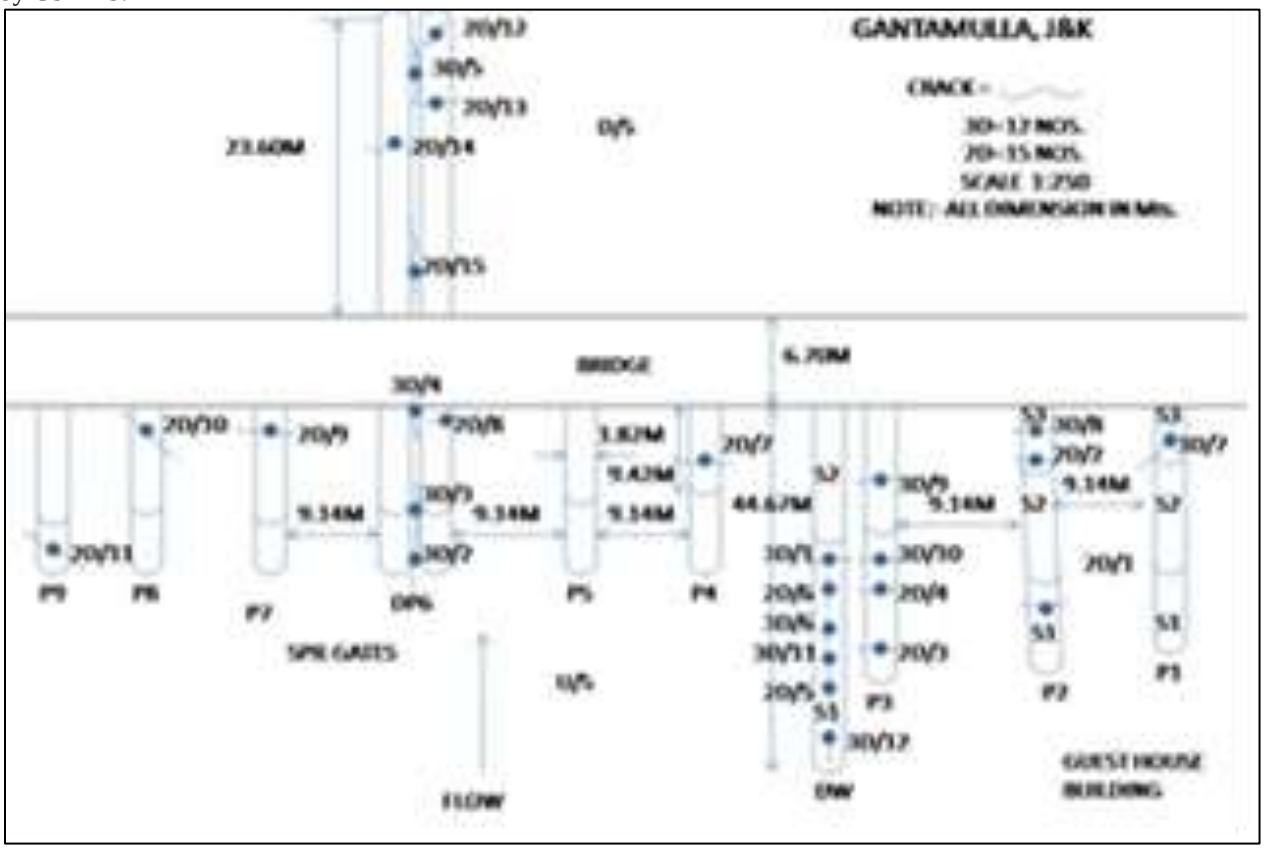

Fig. 1: Location Plan of Instruments

A. Instrumentation

There are multiple superficial cracks on dividing wall and piers on upstream and downstream sides of barrage. Total 27 instruments (2-D crack monitors: 15 nos.; 3-D crack monitors: 12 nos.) have been installed for crack movement monitoring at different locations on upstream and downstream sides of barrage during 2004-05. Locations plan of various instruments installed in barrage are shows in figure 1.

B. Description of Instruments 2-Dimensional Crack Monitor

This instrument is used for monitoring of relative movement of crack in 2 directions viz. along the crack (x-axis) and across the crack (y-axis).

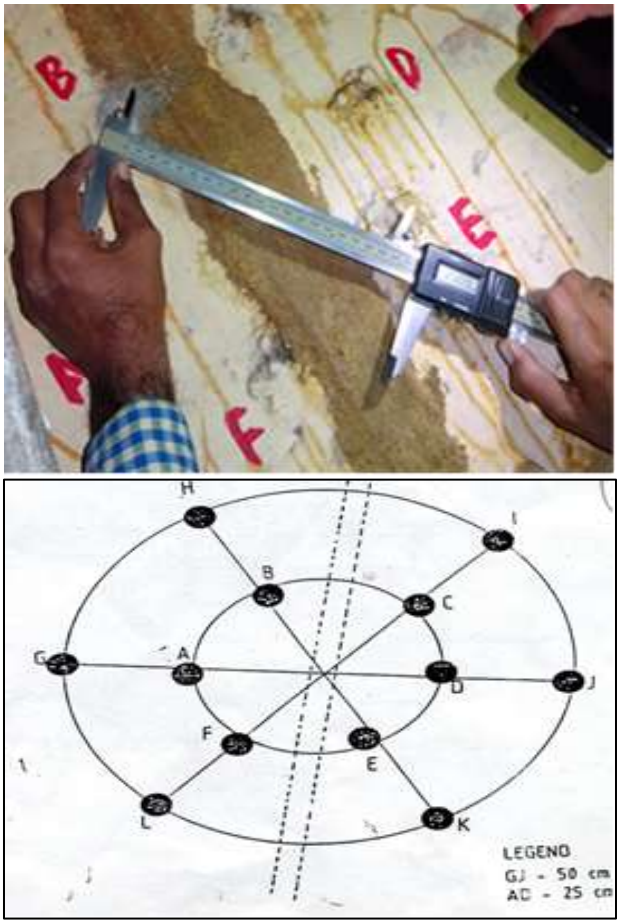

Fig. 2: 2-Dimentional crack monitor with axis orientation for monitoring of crack movement

C. 3-Dimensional Crack Monitor

3D Crack Monitor (Fig. 3), gives relative movement of crack in three directions simultaneously viz. along the crack (x- axis), across the crack (y-axis) and perpendicular to both x and y axes (z axis).

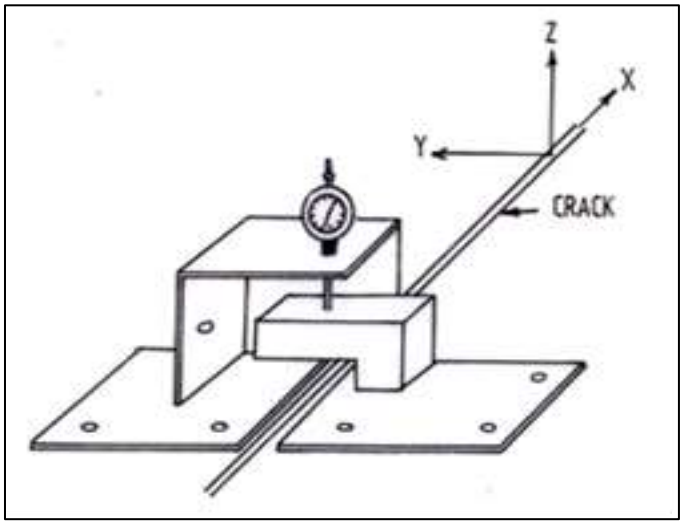

Fig. 3: 3-Dimentional crack monitor with axis orientation for monitoring of crack movement

D. Data Interpretation/ Analysis Up-Stream Side of Barrage

As per data available it has been observed that at most of locations crack movement was as given below:
In X direction i.e. along the crack, movement of crack was ranging from 0.96 mm (at 2D/11 located on pier 9, during monitoring period from April 2005 to June 2013) to -0.05 mm (at 3D/11 located on divide wall, during monitoring period from December 2005 to June 2013).

In Y direction i.e. across the crack, movement of crack was ranging from 3.29 mm (at 3D/6 located on divide wall, during monitoring period from December2005 to June2013) to -0.68 mm (at 2D/2 located on pier 2, during monitoring period from April 2005 to June 2013).

While in Z direction i.e. perpendicular to both directions, movement of crack was ranging from 0.83 mm (at 3D/8, located at pier 2,) to-1.28 mm (at 3D/9, located on pier 3), during monitoring period from December 2005 to June 2013.

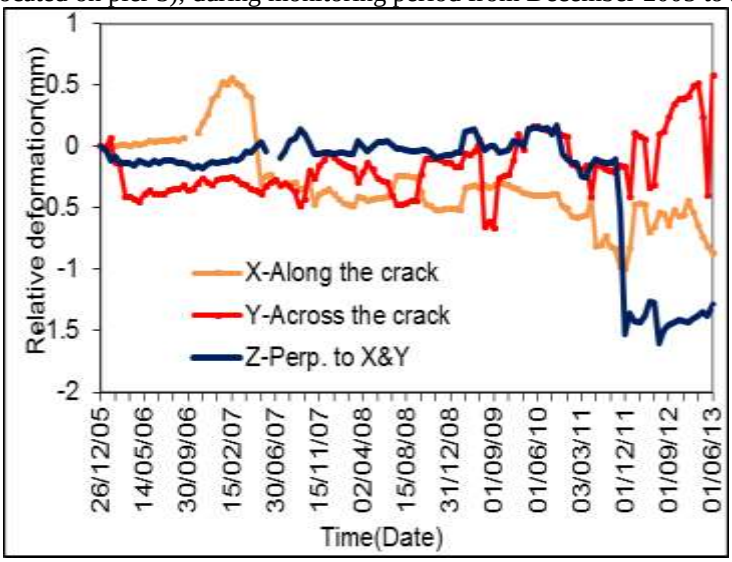

Fig.4: 3-D crack movement 3D/9, P3, S2

E. Down Stream Side

In X direction i.e. along the crack, movement of crack was ranging from 4.54 mm (at 2D/15) to - 0.25 mm (at 2D/13) during monitoring period from April 2005 to June 2013 both located on double pier 7.

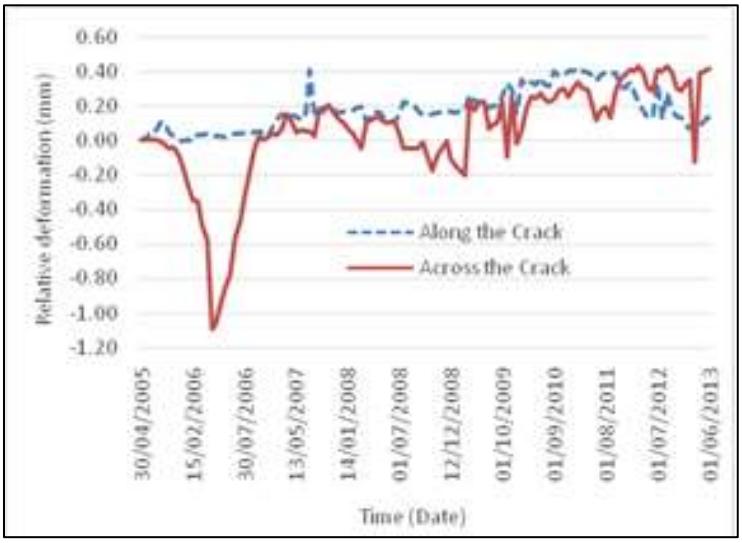

Fig. 5: 2-D crack movement 2D/14, DP7, S1

In Y direction i.e. across the crack, movement of crack was ranging 5.18 mm (at 2D/15) to -0.41 mm (at 2D/14) during monitoring period from April 2005 to June 2013 both located on double pier 7.

II. CONCLUSIONS

The following conclusions have been drawn based on instrumentation work in the barrage of Lower Jhelum H.E. Project:

- The maximum rate of crack movement (in Y direction i.e. across the crack) was observed 0.22 mm during the period 15.10.2008 to 01.06.2013 at location 3D/6 in upstream side of barrage. While that in downstream side was observed 0.64 mm during period 01.10.2009 to 01.06.2013 at location 2D/15.
- Overall there is no significant movement at all instrumented locations.
- Simple mechanical instruments like 2-D and 3-D crack monitors installed for monitoring the cracks are very effective and gives a clear trend of deformation at different locations. This showed the need of instrumentation in multiple crack movement monitoring.

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