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Temperature Distribution Analysis in Double-Arced Concrete Dams under Environmental Reactions- A Case Study of the Dez Hydro-Electrical Dam in Northern Dezful

Siamak.Ahmadi Fard[1] , Amin Bagheban Zade Dezfouli[2]

[1]*Department of Civil Engineering, Sama technical and vocational training school, Islamic Azad University, Dezful Branch, Dezful, Iran. Saf1832@ yahoo.com.*

[2]*Department of Civil Engineering, Islamic Azad University, Dezful Branch, Dezful, Iran*

Abstract
Variations in temperature and their resulting stress and strain on concrete dams is of vital importance because of their effects on sustainability and operational efficiency of these hydraulic structures under arid and semi-arid conditions.
The influence of temperature on dynamic behavior of the double-arced concrete dams for instance, is shown to have a direct impact on the thermo-elasticity characteristics of the mixed concrete and the constituting materials in the concrete. Because of these factors the present paper investigates the effects of variation in air temperature on dynamic behavior of these structures based on the data obtained from the precision tools incorporated in the system.
Results showed a higher temperature at the upper water height than the deeper water bodies and as such, the size of the cracks greater than the lower depth. For this reason, data obtained from the dilatometer tools shown more drainage of water from the cracks at the upper than the lower level. Results further indicated a variation in the dam configuration at upstream due to higher temperature during summer on one hand and further variation at downstream during winter season. Research shown the vital importance of the precision tools in identifying the effects of components such as variations in temperature and seepage rate in the sustainability of these structures on one hand and their operational efficiency aimed at optimum utilization of the renewable water resources on the other.

Keywords: double-arced concrete dams, temperature analysis, temperature conveyance, temperature distribution.

1. Introduction

Reservoir dams of the concrete type are considered as the vital hydraulic structures in and semi-arid regions, by the means of which a considerable volume of the surface run-offs in the water basins which feed them. Because of the importance attached to water abstracted by these structures for allocation to various sectors downstream arid, their systematic operation and maintenance become very crucial. This also necessitates very careful design to enhance the safety factors to prevent failure that might threaten the livelihood of the riparian as well as the expensive structures downstream, which could cause similar destruction to that happened

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recently in Punjab, Pakistan. Based on these considerations, systematic safety inspections coupled with routine analysis on the behavior of the concrete dams could help identify any deficiency that could threaten the stability of these structures and if necessary, take appropriate preemptive measures to enhance their operational safety. The potential hazard of the concrete dams due to their greater risks related to their greater height compared with the earth dams. The following

Inspection procedures are considered[3]:

1-the horizontal and vertical movements
2-various strains
3-strains
4-stresses
5-pisometric observations
6-temperature variations
7-sesmic occurrences
8-water level

2. Matreials and method

Regarding the number of concrete dams, particularly their double – arced type, as well as relatively high water level of this kind of dams and given positioning them in deep valises, study of temperature distribution in them is vital and inevitable. The heat resulting from solar radiation during the year has a very significant effect on reservoir water temperature, there fore, in the present paper, we investigate diagrams obtained from pendulums movements, drains, dilatometers and cracks between rock and concrete, and we derive the results to achieve optimum time for injecting concrete into cracks and to maintain and utilize these structures. We study, for example, the curves obtained from precision tools of the Dez Double – arced Concrete Dam in 2005. [1]

Agreement: If we stand on the dam crown with face towards upstream, our left side is the left support and right side is the right support.

Figure 1 shows tangential pendulums. These pendulums indicate the dam structure movements towards the supports. At level 178m above sea level the minimum movement has been 6.6mm which has occurred in June at reservoir level 352 m.a.s.l and the maximum displacement has

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been 7.7mm which has occurred in March at reservoir level 345.7 m.a.s.l, indicating the strong impact of heat on tangential is exerted on supports, tangential movements range is often less than radial movements and temperature variations cause significant relative changes in supports. By increasing reservoir level and getting close to summer season, the dam structure inclines to the right support and by decreasing reservoir level and approaching to wintertime the structure leans towards the left support.

Figure 2, obtained from radial pendulums, expresses that such tools indicate the structure moves towards upstream and downstream and that the structure is affected by the eater level such that when reservoir level decreases, the dam structure moves towards upstream and when it increases, the dam structure displaces towards downstream. However, it should be noted that the maximum variation in these pendulums configuration occurs in the cold season. Moreover, investigating movements of radial pendulums during the time range from April to July has indicated that regarding temperature increase and relative stability of reservoir level the dam structure moves towards upstream that we know this displacement is caused by temperature increase.

Figure 3 presents changes in reservoir level during different seasons with results obtained from drains of levels 225-292.

Drains of the right hand side of reservoir shows slight seepage rate, however, for the left hand side drains, regarding relative stability of reservoir level we can conclude from the output incremental trend of drains during April to July period that the structure I inclined towards the right support.

Figure 4 shows leakages at level 182 on both right and left sides April to July period, regarding relative stability of reservoir level, incremental trend in the left drains shows that this diagram follows the curve of the Figure 3 and its results.

Figures 5 and 6 display diagrams of movements and opening and closing of cracks occurred in concrete or rock, and measured by dilatometer device. These diagrams particularly depend on environmental temperature. As it can be seen all crack changes are directly influenced by temperature. The effect of temperature on motional process of cracks in rocks located above the exit of deviation tunnel indicates that as temperature increases during April to August, cracks close and as it decreases cracks tends to open. Further – move, for cracks occurred in rock it could be said be said that as temperature increases cracks tend to close because of rock expansion and as temperature decreases cracks open and although this phenomenon doesn't

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introduce a significant effect in short time, it causes cracks increase in depth and length directions in long term due to creation of a kind of mechanical destruction.

3. Results and discussion

The effect of temperature and solar radiation on dam movements is clear. Just like a lining creature, the body of the double – arced dam responds to environmental actions and implements reactions in accordance with them. Regarding the increase of reservoir level during summer season and displacement of the dam structure to upstream, as well as the structure motion to the right support, the reported leakages from the left side of the dam body increase in the case of occurrence of cracks on the left side, given the greatest opening at the maximum reservoir level, the optimum time for injecting is during summer season. The most opening of cracks the been reported during the cold season and at the minimum level of reservoir and it is the best time for injecting concrete into cracks between dam and rock.

Also for cracks occurred on the right side of the dam structure, given the leakage obtained from drains, it should be that in the case of occurrence of these kinds of cracks on the right side of the dam body the optimum time to rehabilitate them is during the cold season and the minimum level of utilization. When utilizing these structures it should be taken into account that there are same conditions in static loading compound of double – arced concrete dam under which such loading is controllable by having temperature and reservoir level measurements. Some of these conditions include [4]:

1. Dam weight + water pressure at the maximum level of reservoir

2. Dam weight + water pressure at the minimum level of reservoir + summertime average temperature.

3. Dam weight + water pressure at the minimum level of reservoir + wintertime average temperature.

The worst conditions of static loading in double – arced dams are:

1. Dam weight + pressure of the maximum level of reservoir water

2. Dam weight + pressure of the minimum level of reservoir water.

Te last conditions lead in the maximum variation of crown configuration that generally occurs for Iranian dams, unless, during successive droughts, maximum temperature occurs when we have minimum level of reservoir water. Then the maximum radial deformation of crown occurs

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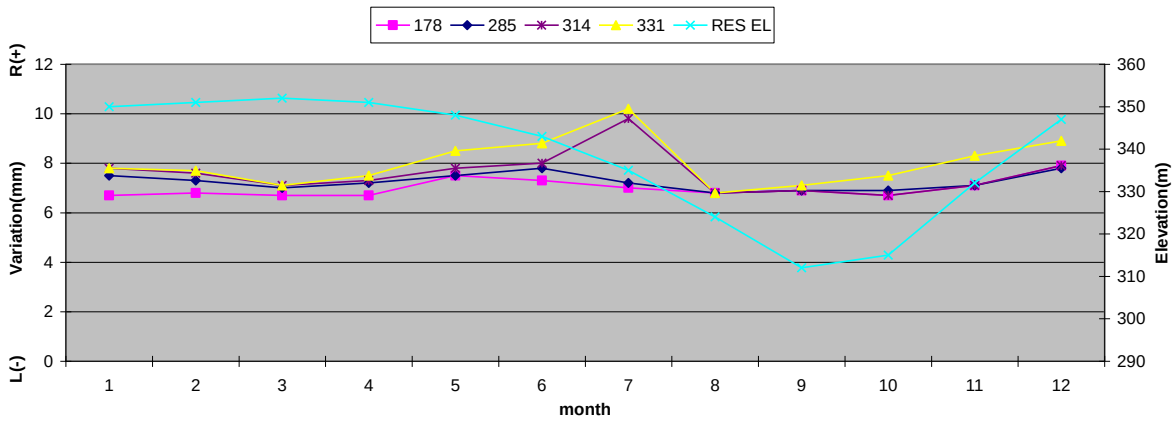
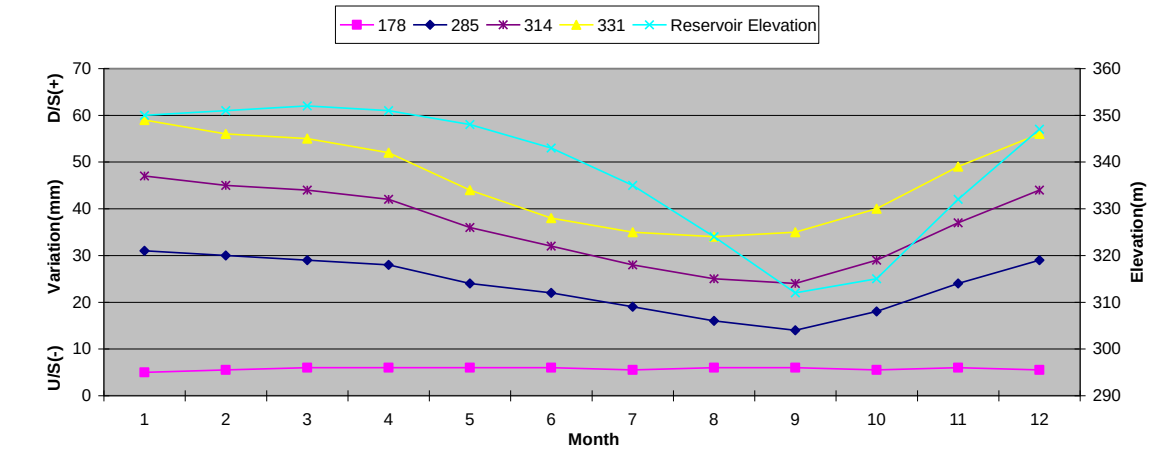
towards upstream that it requires executives and exploiters of water resources act more sensitively and precisely in managing these resources given drought of the past years.



Figure(1) - Dez Dam tengential Pendulum [1]



Figure(2) - Dez Dam Redial Pendulum [1]

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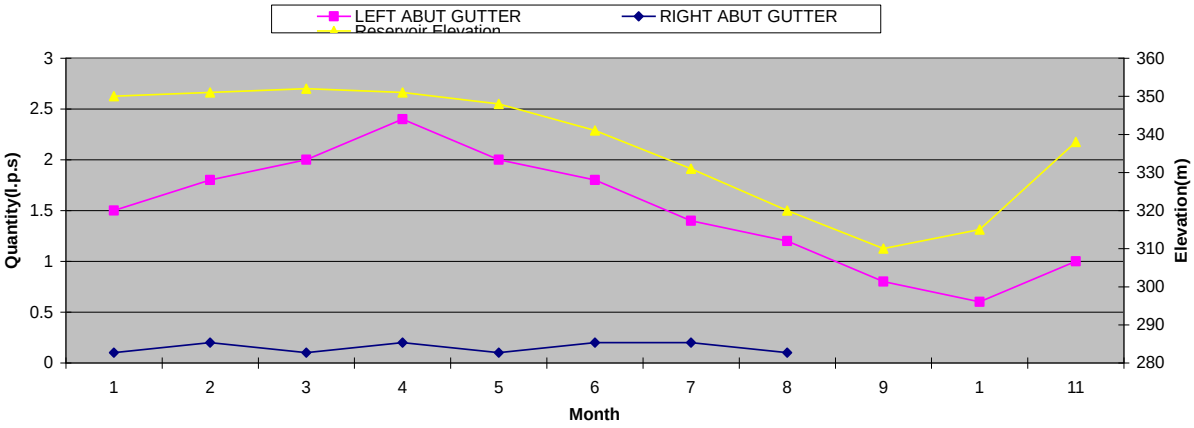
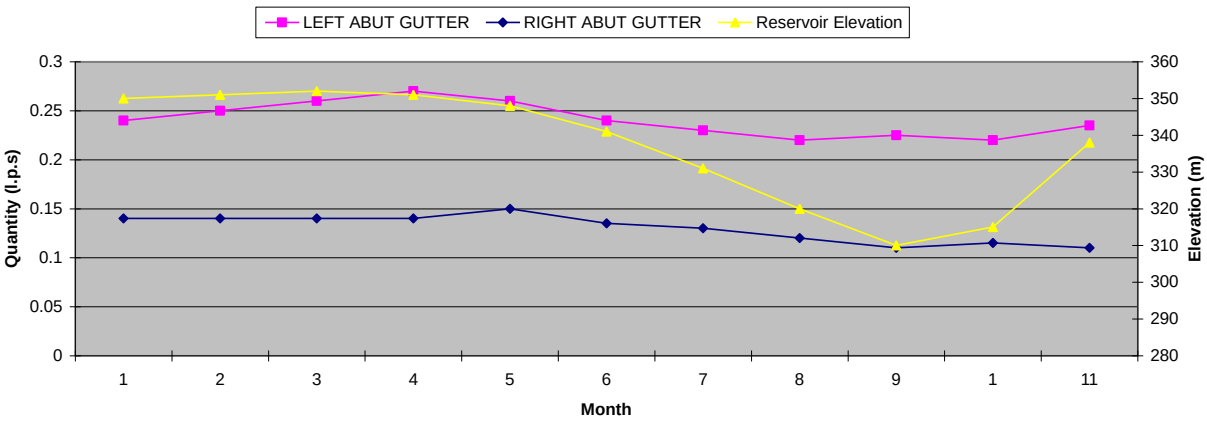


Figure(3) - Dez Dam Seepage El 225-292 [1]



Figure(4) - Dez Dam Seepage El 182 [1]

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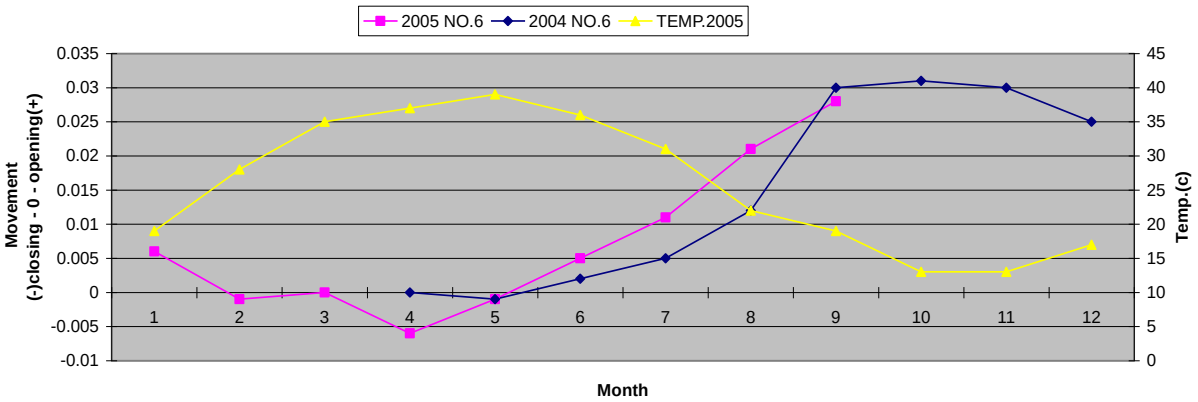
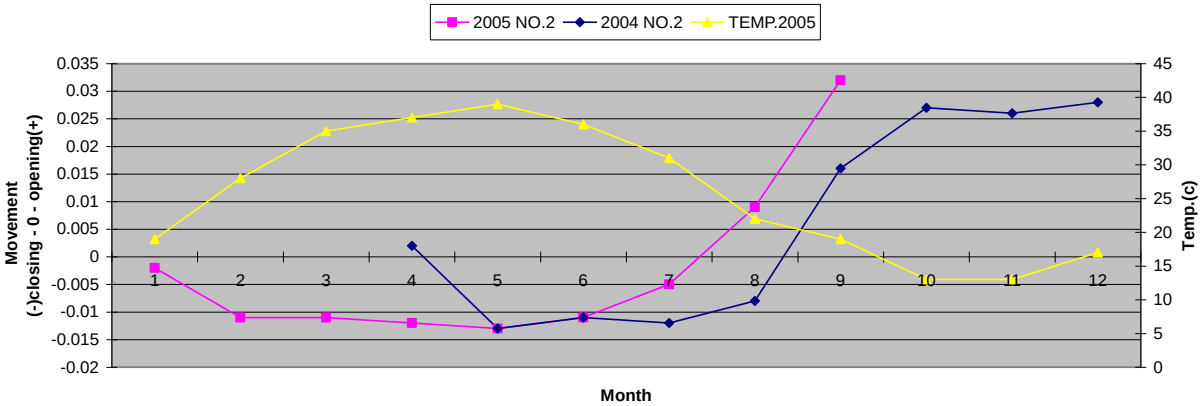


Figure(5) - Rock Movement Up Diversion Tunnel [6]



Figure(6) - Rock Movement Up Diversion Tunnel [6]

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