The cost management of rockfill dam with clay core and concrete face and the economical comparison of these two methods (Case Study: Jere dam of Ramhormoz)

Ezat Allah Mousavi[1], Mohammad Sirous Pakbaz[2], Arash Adib[2]

[1.] MA in civil engineering, Islamic Azad University, Shoushtar, Iran
[2.] Associate professor, civil engineering department, engineering faculty, Shahid Chamran University, Ahvaz, Iran

Abstract: Collection, maintenance and optimized distribution of water is one of the most important and costly projects of water industry in Iran. The selection of the optimized choice among various methods of the construction of the dam body is economical and reduces the construction costs considerably. In recent decades, by the advancement of road construction machineries and earth operation, applying earth dams is developed. To select the best choice, the designer should investigate and compare various choices to reduce the project costs and make the implementation time minimum. In this study, based on the construction of Jere Ramhormoz earth-core rockfill dam (ECRD), this dam was designed for concrete face rockfill dam (CFRD) and was compared with ECRD. To do this, in the first section of the study, we investigate the general reasons of the selection of the type of dam body and recognition of the study area of the construction location of Jere dam. This dam with the height of 107m is constructed on Zard River and in another section by showing the sample sections for both of construction methods, they were compared. This economical comparison shows good saving in the selection of CFRD compared to ECRD**.**
[Ezat Allah Mousavi, Mohammad Sirous Pakbaz, Arash Adib. **The cost management of rockfill dam with clay core and concrete face and the economical comparison of these two methods (Case Study: Jere dam of Ramhormoz)**. *Life Sci J* 2013;10(3s):444-448]. (ISSN: 1097-8135). http://www.lifesciencesite.com. 68

Keywords: Earth dam; Earth-core; Concrete face; Economical comparison

Introduction

The determination of good location for construction of the dam and the selection of the type of dam in accordance with the condition of the first site is the most important state in the design of dam construction projects.

The main criterion of the design of the dam is its economical issues. It means that to construct the dam, the minimum cost should be required. In addition, there should be the minimum cost for the maintenance and secondary costs such as the protection of upstream and downstream slope, drainage and additional structures and mechanical equipments. The earth dams should be safe for all states and operation of same and stable reservoir [3].

The effective factors on dam plans are as:

1- The quality and quantity of available materials
2- The properties of the foundation of the selected site
3- The climate condition of the dam construction region
4- The size and form of valley
5- Topography of the site in terms of the selection of the type and the best site for spillway and water diversion path
6- The seismic condition of the region
7- The performance and application of the dam and its lake [3]

In most of the studies of the design of dam construction projects of earth dam, rockfill dam and concrete dams are investigated in terms of all the criteria and the technical and economical comparisons are made and finally the best choice is selected based on all the parameters.

In terms of implementation, all the choices are implemented but in the studies, the optimum choice is chosen. The optimum choice is selected based on the technical, economical and implementation experience.

In this study, as a case study, the attributes, advantages and disadvantages of ECRD, CFRD choices were investigated in Jere dam site and finally the best choice was selected for the site (Fig. 1).

The selection of the type of dam body

The selection of the type of dam body depends upon the dam height and dam crest length and it is dependent upon the type of existing materials. Also, the type of body of the dam is dependent upon the form of valley, foundation and accessible materials. The technology of dam construction (specialized human resources) is effective factors.

- A narrow valley in V form with strong foundation and walls is the best section for the construction of an arch dam.
- A valley with moderate area and low to moderate top soil can be suitable for gravity or buttress dam. This section is suitable for the construction of an earth dam or rockfill dam.
- A wide valley with the deep top soil leads into the selection of rockfill dam.

- An irregular valley can led into the selection of a dam with mixed section [2].

The selection of batter

The slope of the bottom of the dam depends upon the type of materials, the compression and the type of foundation. Generally, in these dams due to the high internal friction coefficient of the materials and high shear strength of aggregate compression and the lack of fine-grained regions, the upstream and downstream slope of the body of the dam can be increased and it leads into less volume, high speed and less material.

The slope 34 degree to 37 degree is good [5]. For rockfill with high quality, both upstream and downstream slopes 1 to 1.3 and 1 to 1.4 are applied. For aggregate materials with weak quality, high slopes are applied. Also, for the dams with the height of more than 110m, the slopes 1 to 1.5 or 1 to 1.6 are applied for sand materials [1].

The technical properties of Jere Ramhormoz dam

Name of the dam	Jere Ramhormoz
Name of the river	Zardrood
Dam site	35 km of the north of Ramhormoz in Khuzestan
Type of dam	ECRD
Height from foundation	113m
Height from the bottom	107 m
Crest length	735m
Crest width	12m
Crest level	507.5 m from sea level
Minimum operation level	453.3m
Water normal level	497m
Water level in maximum probable flood	503.6
Total volume of reservoir in normal level	180 million m^3
Useful volume of reservoir	156 million m^3
The width of reservoir in water normal leve	6.4 km^2
Reservoir width in maximum elevation	8km2
Reservoir length in normal elevation	24km

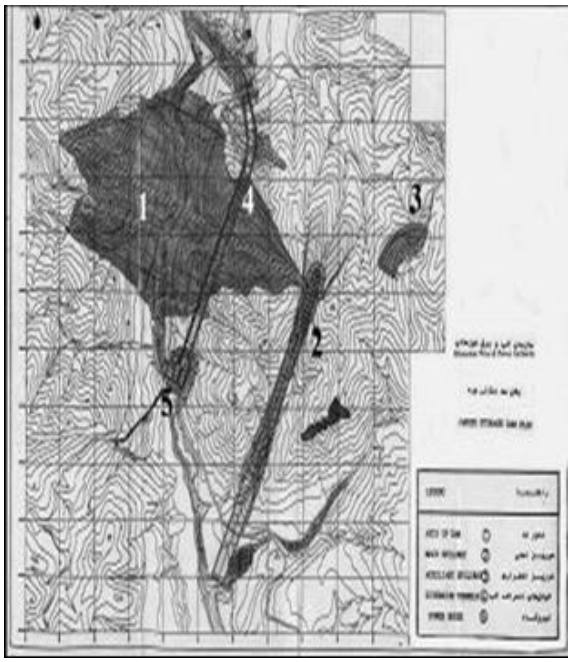


Fig. 1 The plan of layout of Jere dam and the related structures[5].

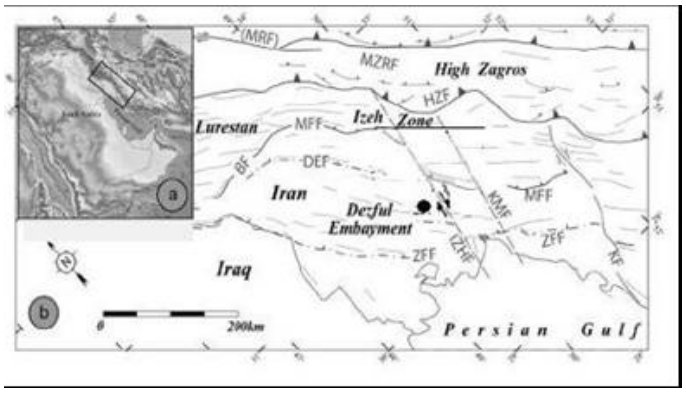


Fig. 2 The location of the construction site of Jere dam of Ramhormoz[5].

Topography and geomorphology

The study area is located beside Zagros folding. The formations located in the study area are including Fars, Gachsaran, Mishan and Aqajari on which Bakhtiary conglomerates are formed. Jere dam is inside Bakhtiary formation and this conglomerate is with mud stone and sand stone. Jere dam site is located in a deep canyon created inside Bakhtiary conglomerate formation and in this site, Rood Zard river by northern-southern trend cross the formation layers. The general form of V-form valley is open. The topography slope of dam support is to the height about 15 m of river bed about 70 degree. In the right bottom of the site, there are two deep water ways

with some sub water ways joining them. Left waterways are shallow and continue as parallel with the center line (Fig. 2).

Hydrology and engineering geology

As the major part of this section of Dam Lake is occupied by Gachsaran formation, the hydro geological attributes followed the two factors due to the tectonic of the region and plastic behavior of Gachsaran formation (Fig. 3). It is obvious that hydro geological properties directly or indirectly affect the local geotechnical parameters [4]. Generally, the erodibility of Gachsaran formation is high based on the high similarity of stratigraphy and lithology but the effect of rupture caused that the crushing, falling and erosion are increased.

Fig. 3 The site of Jere dam in geology map of the region (black arc) As, Gs, Mn, Lb, Aj, Bk show Bakhtiary formation, Aghajari, Mishan, Lahbari, Gachsaran and Asmari, respectively[5].

Materials reference

To prove various materials in the construction of Jere dam, the contractor of the body construction can construction material sources, stone mine or excavation on condition that it is in line with the required technical properties.

The investigations show that all the required materials of dam body construction can be used for two methods of dam construction of the site (Fig. 4).

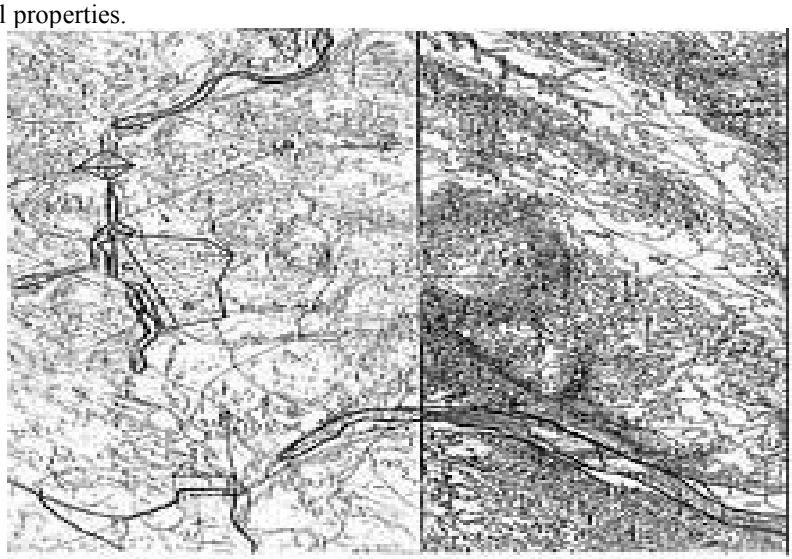
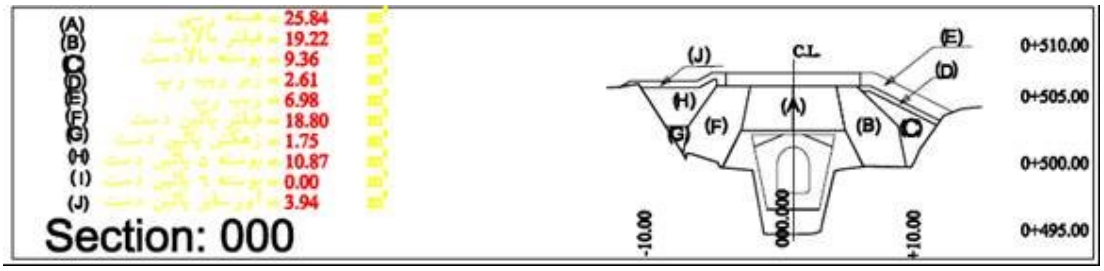
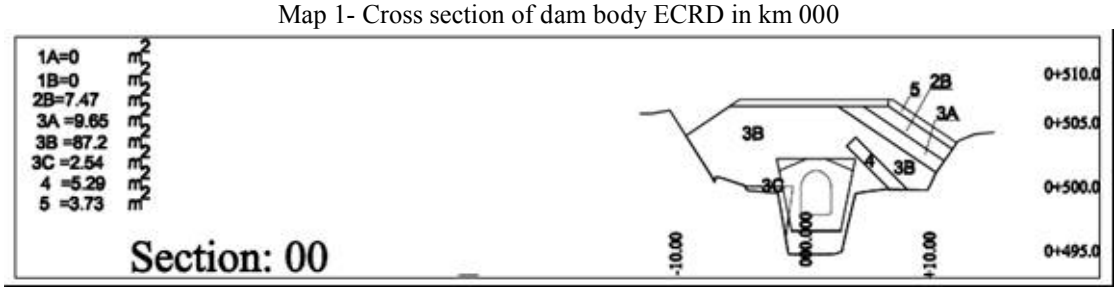


Fig. 4 Layout map of construction material sources around Jere dam

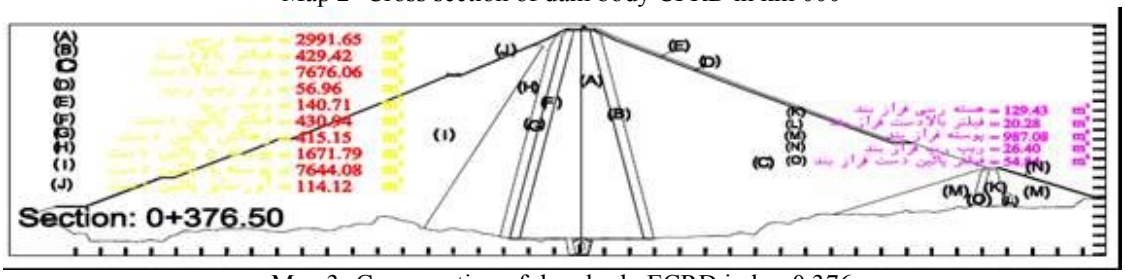
The comparison of Jere dam sections with Jere dam with concrete face. Here, we compare the executional sections of ECRD and CFRD and the comparison shows that is the difference of the dams in implementation for economical comparison of the dams.



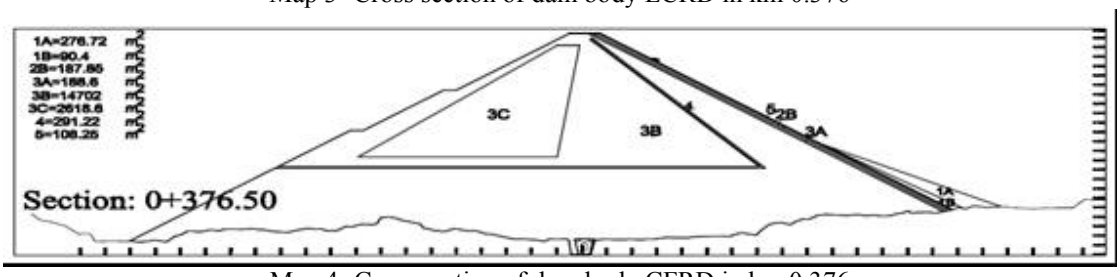
Map 1- Cross section of dam body ECRD in km 000



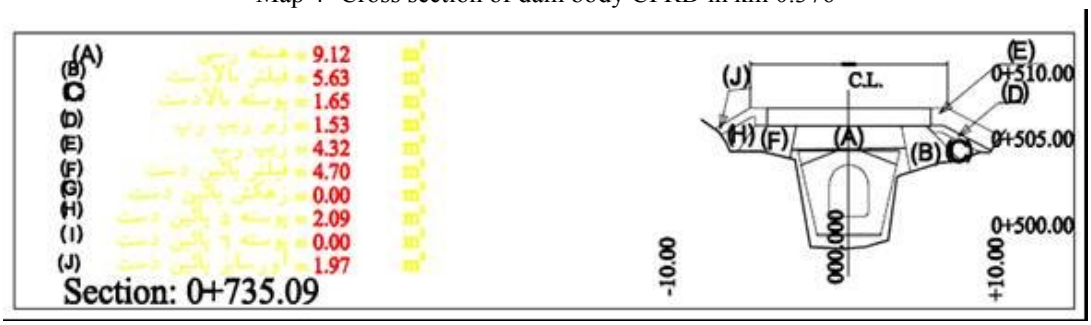
Map 2- Cross section of dam body CFRD in km 000



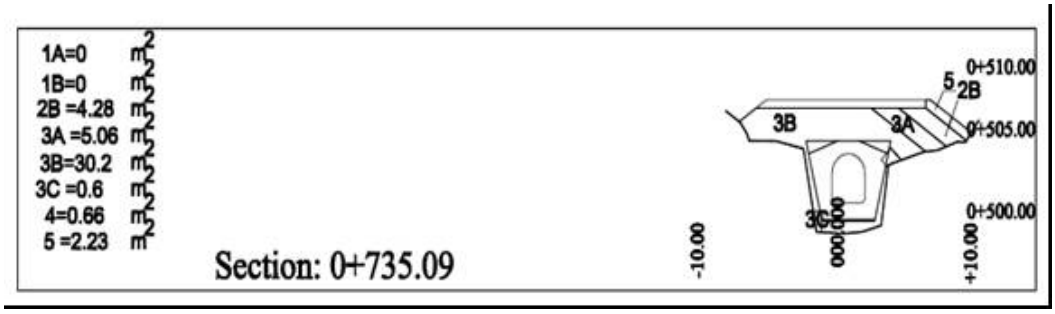
Map 3- Cross section of dam body ECRD in km 0.376



Map 4- Cross section of dam body CFRD in km 0.376



Map 5- Cross section of dam body ECRD in km 0.735



Map 6- Cross section of dam body CFRD in km 0.735

The estimation of the values of materials and price estimation of Jere dam with ECRD, CFRD in Rials.

According to the sections of two dams, the volume of body embankment operation volume is obtained and based on the volume, the Rial estimation of the project was carried out and the superiority of CFRD was proved economically.

Table 1- The summary of the properties of Jere dam for ECRD

The height from the river bottom	107m
The height from foundation	113m
Crest length	735m
Crest width	12 m
Type of core	Vertical clay
Embankment volume estimation	6200000 m^3
Upstream body slope	1:2) horizontal: vertical(
Downstream body slope	1:1.9) horizontal: vertical(

Table 2- The summary of the properties of Jere dam for CFRD choice

The height from the river bottom	107m
The height from foundation	113m
Crest length	735m
Crest width	12 m
Upstream body slope	1:1.5) horizontal: vertical(
Downstream body slope	1:1.5) horizontal: vertical(
Embankment volume estimation	4800000 m^3
Concrete face volume estimation	40000 m^3

The investigations show that in Jere dam site, both ECRD, CFRD are implemented and the main reason of the selection of ECRD is the high execution experience in construction of ECRD dams. After doing this study, the following results are inferred:

1- The necessity of adequate consideration to the initial studies of dam construction and avoiding cliché designs and involvement of non-technical materials in this issue.

2- Reduction of the slope of the body sides of CFRD leads into the reduction of dam base width and the reduction of the length of dam tunnels and it leads into the considerable reduction in earth operation volume.

3- The unit price of rockfill of CFRD is less than ECRD because in the construction of CFRD, there is more freedom for embankment and continuing the operation but in ECRD, the preparation should be done on the core and filters.

4- The most important result of the current study is such that in construction of CFRD, the embankment operation volume is reduced considerably. This reduction is about 1.3 million m^3 of total earth operation leading into the reduction of the execution time of the project and considerable reduction of the cost of the project in Rial. These estimations show the reduction of about 11.4 billion toman in the cost of the execution of CFRD.

References:

1- Stanly, D. Raol, H. M. 2000. Common methods in design and construction of earth dams. Dr. Mohammad Sirus Pakbaz. Translator. Ahvaz. Shahid Chamran University of Ahvaz publication.

2- Rahimi, H. 2004. Earth dams. Tehran. Tehran University publications.

3- Shamsayi, A. 2004. The design and construction of earth and rockfill reservoir dams. Science and Industry University publications.

4- Chau , l . 2004. A study on Concrete Faced Rockfill Dams . university of southern Queensland , chapter 2.3 & 5 .Fitz Patrick , M , Cole , B .A kinstler , F.L. & knoop , B.P .1985. Design of Concrete Faced Rock fill Dams .

5- Arash Barjasteh , Farhad Barghi 1388 investigation of engineering geological parameters of jarreh storage dam as the first earth dam without any water-tightness plan in iran.