INNOVATIVE METHODOLOGY TO CONTROL SEEPAGE OF PATHAZHAKKUNDU EARTHEN DAM IN KERALA, INDIA

by

DR. P.T.SANTHOSH KUMAR

DEPUTY DIRECTOR, CONSTRUCTION MATERIALS DIVISION, KERALA ENGINEERING RESEARCH INSTITUTE, IRRIGATION DEPARTMENT, GOVT. OF KERALA, INDIA

drsanthosh2012@gmail.com

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SALIENT FEATURES OF PATHAZHAKKUNDU DAM

1.	Length of the Reservoir	- 143.00 meter
2.	Height of the Reservoir	- 18.30 meter
3.	River basin	- Puzhakkal river, Thrissur District, Kerala, India.
4.	Volume content of dam	- 1.58 Mm^3
5.	Gross storage capacity	- 1.58Mm^3
6.	Reservoir area	- 1.53sqkm
7.	Spillway capacity	- 4 vents 2.28 x1.525 m
8.	Maximum Water level	- +129.235 meter
9.	Reservoir bottom width	- 84.00 meter
10.	Top level	- +131.06 meter

SALIENT FEATURES OF PATHAZHAKKUNDU DAM…

11.	Bottom level	- +113.00 meter
12.	River sluice (Barrel) level	- +115.00 meter
13.	Sluice Valve Well dia	- 1.20 meter
14.	Sluice well location	- 37.00 M from up toe
15.	Sluice Barrel size	- 0.60x1.5/1.2 meter
16.	Barrel bed	- Concrete
17.	Barell side wall	- Stainless steel casing
18.	Barell top	- Pre-cast RCC slab
19.	Latitude	- 10°37'09.8"N
20.	Longitude	- 76°14'12.1"E

PROBLEM STATEMENT

- Dam was commissioned in 1978 and not functional effectively due to excessive seepage.
- When reservoir is getting full, whirlpools were observed.

STAGE WISE SOLUTION TO THE PROBLEM

- Extension of upstream blankets, curtain wall and scarification of upstream earthen portion and refilling with necessary compaction with ripraps.
- Repair of barrel and well.

REPAIR OF BARREL AND WELL

- As the random rubble masonry barrel is very narrow of the order of 0.9 m wide by 1.5 m deep, it was not possible to enter in to this and repair the barrel 84 m length.
- The sluice is provided with a vertical well with inner dia 1.60m at top and 1.20m at bottom.

REPAIR OF BARREL AND WELL…

- Repair of this sluice with an innovative technology, similar through a push technology of steel barrel in to this RCC barrel with railings at the bottom and grouted the space between the outside of the RR masonry and the outer side the steel casing caused the stoppage of leakage.

REPAIR OF BARREL AND WELL…

- A ring bund was also provided in the upstream side of the barrel to arrest entry of water in to the barrel. PVC pipes of diameter 7.5 cm to inject bentonite and earth slurry in to the dam body near the barrel. Non-shrink free flow grout was proposed to fill in the space between the outside of the SS barrel and inside of existing RR barrel. Apart from this, mechanical parts are scrutinized and corrected.

REPAIR OF BARREL AND WELL…

- A rail was initially laid on the bottom of this barrel and the stainless steel caging of size 0.9 m wide by 1.5 m deep was pushed from the downstream end to the upstream end. Each piece of the single barrel was 6 m long. After inserting the first piece, second piece was welded on the back of the first piece by butt welding. Further, the first and second parts of the barrel were pushed inside the body of the dam. Similarly, pushing was carried on until the barrel reached near the well. Proper connections were then set in for the hydro mechanical parts.

REPAIR OF BARREL AND WELL…

- Bentonite earth grouting on the body of the dam coupled with filling of non-shrink grout on the gap between the steel barrel and the RR outside of existing barrel was carried out to prevent lateral seepage along the outside surface of the steel barrel and the inner side of the RR barrel.

REPAIR OF BARREL AND WELL…

- Structural component- Structural component is checked by modelling in STAADPRO considering it as a free body with the associated forces. For this purpose, the section with maximum overburden was chosen, which is 131.06- (115+1.5) = 14.56 m, with the length of 6 m, which is the length of a unit of the steel barrel.

REPAIR OF BARREL AND WELL…

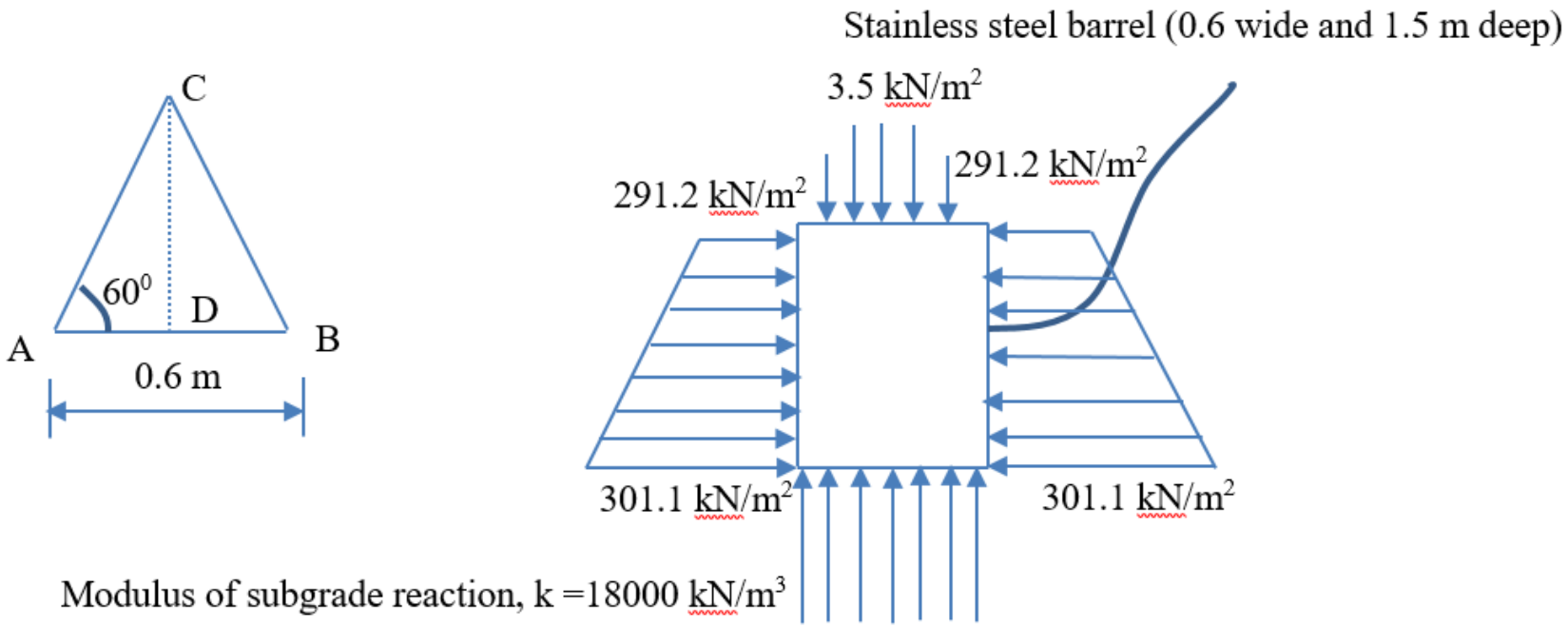

FIG 1- STAINLESS STEEL BARREL WITH FORCES

REPAIR OF BARREL AND WELL…

FIG 2- DETAILS OF WELL CONNECTED TO THE OUTLET

REPAIR OF BARREL AND WELL…

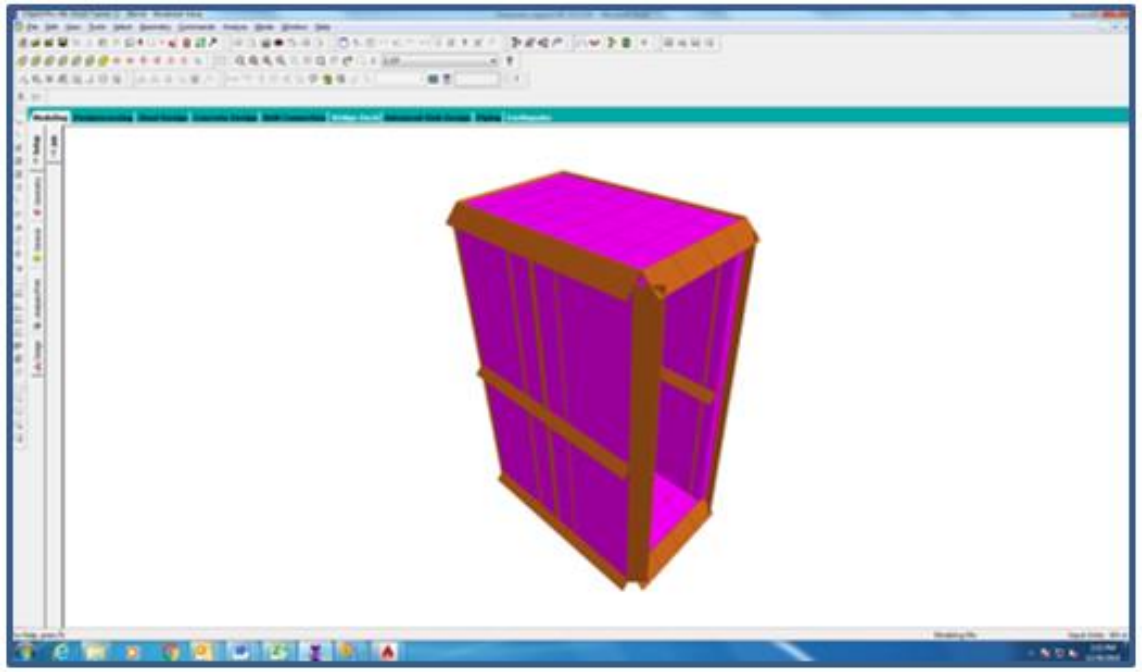

FIG 3- 3D VIEW OF BARREL IN STAADPRO ANALYSIS

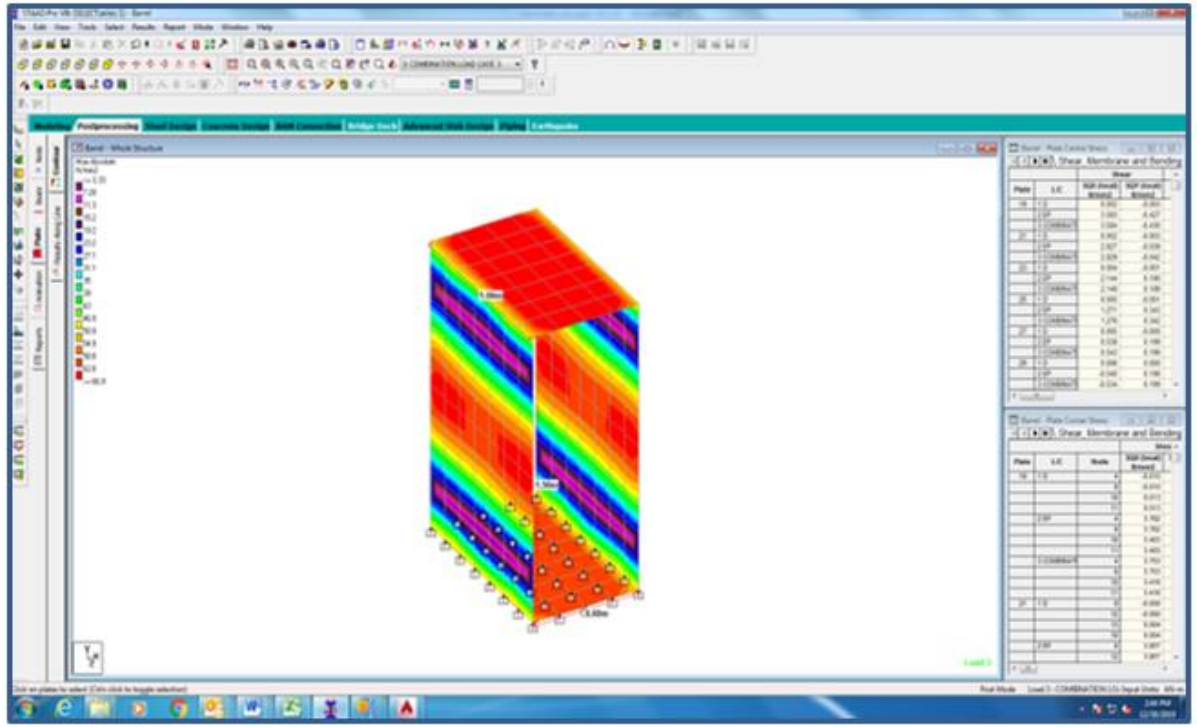

FIG 4- STRESS CONTOUR IN THE MODEL SHOWING WITHING LIMITS

REPAIR OF BARREL AND WELL…

6 CHECK FOR PIPING

Consider Bligh's creep coefficient for soil as 5, as the soil is considered as silt and sandy clay.

$$L = CH$$

Where 'L' is the creep length and 'H' is the head loss.

For a head loss of 14.56 m (at the level of the barrel), creep length required for safely passing out water $= 14.56 \times 5 = 72.8$ m. This is less than reservoir bottom width of 84 m, and hence, there is no threat to piping.

REPAIR OF BARREL AND WELL…

As Bligh's creep theory is related to Darcy's law, limitations of Darcy's law is also applicable here. These limitations are a) The size of soil particles shall not be more than 2 mm and b) Velocity of flow through the porous medium shall be less than 5 mm/s.

REPAIR OF BARREL AND WELL- CHECK FOR DISCHARGE THROUGH BARREL

Ayacut area for the dam is 150.70 Ha. Considering a duty of 60 acres per cusec (857.2 Ha/cu.m) (Department manual), discharge required = 150.7/857.2 = 0.18 m^3/s.

Maximum discharge through the barrel shall be calculated as following.

As per CWC norms on Piped Irrigation Network (PIN), permissible velocity through channel

$$= 1/N \times R^{2/3} \times S^{1/2}$$

N= 0.011

R= Ratio of wetted area to wetted perimeter

$$= 1 \times 0.6/2.6$$

$$= 0.23$$

REPAIR OF BARREL AND WELL- CHECK FOR DISCHARGE THROUGH BARREL

S is the slope, which is 1 in 1000.

$$\text{Hence, velocity, } V = 1/0.011 \times (0.23)^{2/3} \times (1/1000)^{1/2}$$
$$= 1.08 \text{ m/s}$$
$$\text{Discharge, } Q = V \times A$$
$$= 1.08 \times 1 = 1.08 \text{ m}^3/\text{s}$$

This is more than the required velocity of 0.18 m^3/s and hence, the channel is deemed to satisfy the discharge requirements.

CONCLUSIONS

- For the first time since 1980, the dam has been opened on 21st August 2019 at 12.54 M water level (F.R.L.) and the leakage was stopped by following the steps described above.
- This method has replicability scope in similar dams.

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