Final Technical Project Status Report

Project Name: Check Dam (Earthen)

Location

Village: Gudhvanwadi  
Block: Karjat

District: Raigad  
State: Maharashtra

Promoted By:  
CTARA, Indian Institute of Technology, Mumbai.

Local Development Organisation:  
Academy of Development Science, Kashele, Karjat, Raigad.

Design and Supervision By:  
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Introduction

Building a check dam at Gudhvanwadi, for providing drinking water to the tribal hamlet, was a unique project of team work and techno-social outlook especially promoted by IIT, Mumbai and the local villagers of Gudhvanwadi. A voluntary organization ‘Academy of Development Science’ (ADS), Kashele, Karjat, Raigad and the technical support professional organization ‘Gangotree Resource Developers Pvt. Ltd.’, Pune. (GRD) joined hands with IIT along with the beneficiaries for the cause.

It all started when the team of CTARA that includes Dr. A. W. Date, Dr. Milind Sohoni, Prof. Computer Science Department, IIT and their colleagues identified the severity of drinking water need in the Karjat district of Maharashtra, to which the team was quite familiar during their treks in the region. They not only identified the need but also proposed a probable solution of building a check dam to create the source of drinking water for the hamlet.

Under Prof. A.W. Date’s leadership and overwhelming enthusiasm of Dr. Milind Sohoni, a full scale project of building a check dam was launched. In the history of IIT Mumbai, it was the first time ever that IIT promoted to build a check dam. After lot of permutations and combinations of sites and villages finally CTARA selected the village Gudhvanwadi near Kashele about 20 to 25 km. from Karjat, for the proposed work.
**Initial work and Inauguration**

Dr. Sohoni along with ADS and Gangotree finalized the site to build the proposed check dam. As per the initial visual survey dam alignment was finalized and preliminary L-section was taken. Villagers were asked to take about 6 to 7 trial pits along the dam alignment. These trial pits were dug manually, about 1 to 1.5 m deep. The strata was observed and based on this data an initial design was prepared to figure out the rough cost of the project. After the clear go ahead, a final detail survey of catchments area and dam alignment was conducted along with advanced surveying instruments like Total Station. A rainfall data of nearest rain gauge station was acquired and was used in the final design. A revised detail surveying has corrected the dam alignment and final center line of dam was marked on the ground.

On December 28, 2005 an Inauguration ceremony was conducted on the site at the hands of local villagers the village water committee, who had contributed their land and other resources for the check dam. IIT alumni members, donors, CTARA members, IIT professors, students and other distinguished guests along with villagers of Gudhvanwadi and the nearby villages were present at the inauguration. This was the grand start of the project.
Technical Details of the Project.

1. Type of Structure = Earthen Structure
2. Length of Embankment = 85.00 m
3. Waste weir Length = 15.00 m
4. Total Length with Waste weir = 100.00 m
5. Lowest Nala Bed Level after S.O.D. Excavation = 92.02 m
6. Full Supply Level (F.S.L.) = 98.7 m
7. Height of Water Storage = 6.68 m
8. FSL Estimated Storage = 17729.00 Cum.
9. FSL Live Storage (after 10 Years) = 17257.00 cum
10. Post Monsoon Temp Storage = 1751.00 Cum
11. Total Estimated Storage = 19480.00 Cum
12. Height of Flood Level (H.F.L.) = 99.7 m
13. Flood Lift Provided = 1.00 m
14. Free Board Provided = 1.50 m
15. Top Bund Level = 101.20 m
16. Maximum Height of Structure = 9.18 m
17. Seat of Dam Excavation = 0.30 m

18. Casing Zone

   Top Width = 3.00 m
   Height = 9.18 m
   U/S Slope = 1: 2.5
   D/S Slope = 1: 2

19. Hearting Zone

   Top Width = 2.50 m
   Height = 7.98 m
   U/S Slope = 1: 1
   D/S Slope = 1: 1

20. Cut of Trench (C.O.T.)

   Bed Width = 2.5 m (min) @10 m max.
   Max Height = >4.8 m at 65 chain age to hit rock
   U/S Slope = 0.5: 1
   D/S Slope = 0.5: 1

21. Rock Toe

   Height = H/6
   U/S Slope = 1: 1
   D/S Slope = 1: 2

22. Pitching Up to T.B.L. Both side

   U/S Slope = 1: 2.5
D/S Slope = 1: 2.0  
On Top of Bund Pitching Length = 80.00 m  
On Topo Bund Pitching Width = 3.00 m

23. Longitudinal Drains (L.D.)

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24. Cross Drains (C.D.)

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25. Toe Drains (T.D.)

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26. Billed Cost of the Project = Rs. 27,175/-

27. Duration of the Project = 7 months (Dec 05- June 06)

**Works:**

**Line out, Alignment & seat of dam excavation:**

Immediately after the Inauguration the line out for scraping the surface soil and dam alignment was done on the ground. The villager’s unskilled labour was employed to clear and clean all the bushes and shrubs, trees and grass which come in the seat of dam lineout. Simultaneously JCB machine along with its dumpers prepared the access roads to the site. After the site cleaning, seat of dam was excavated to @ 0.3 m depth to remove all vegetative growth below the ground to the maximum possible extend.

**Cut of Trench (COT)**
COT excavation was started for the chainage from 0.0 m to 80.0 m with in designed widths for each chainage. The removed material was dumped on the down stream side of the dam at about 25 m away from the toe of the dam. The initial designed CoT was with H/2 criteria, which was already over safe, than the required as per the MI manual of Govt. of Maharashtra, which is H/4, for such structures. During execution it was decided that for better water storage the CoT should reach the rock level at all chainages. The check dam should have positive cut off. Hence the same was implemented. This decision has made depths of excavation more than the designed H/2 depths at some places and also correspondingly top widths were also increased. In COT there were 3 prominent local cracks in the strata running across the alignment. At two ends of the COT stratum, the lowest part was looking softer. As per Gangotree’s experience this was not a critical issue as the cracks were well below the designed COT depths and soft stratum was nothing but weathered rock. But local villagers and ADS were carrying the different opinion. According to them this is serious and water will percolate through it faster. The work was held on site for almost two weeks for the consensus decision on how to treat the cracks and soft stratum.

After the joint inspection of the rock exposed by the COT, Prof. T.N.Singh of IIT Mumbai, Mr. Ganpat Kalekar, ADS representative, Mr. A.D. Gadre Senior consultant Gangotree along with village water committee it was decided to blast the rock in COT further for @ 0.5 m to 1.0 m depth. It was also decided to open up the soft stratum part of COT for further inspection.

Execution of this work resulted in increasing the depth of COT and also the width. More excavation was carried out. The JCB was unable to excavate while standing at the edge of COT. Hence the machines have to get into the excavated COT, push the excavated material out, put it on the edge of COT then again come out and load it into the dumpers to carry it away. This involved double handling of same material and led to cost escalation as well as time overrun of the project. However, as it was a conscious decision by all the involved parties, the item was executed to the satisfaction of the beneficiaries. The time & cost overrun was accepted by CTARA, IIT.

After the increased blasting of the rock and the cleaning away of the debris, the COT was once again inspected by the experts and was found technically satisfied. The cracks found at the bottom of the CoT were suggested to be filled by the cement grouting along with the additives by using the gravity grouting method. Pressure grouting was explored but found to be too costly and unviable. The quotations were received that quoted the costs at Rs. 3 to 4 lacks, using the pressure grouting method. It was rejected. The soft stratum was cleaned to the maximum possible extent. Finally COT’s maximum depth was reached at
4.8 m at 65.0 m chainage and the maximum width was 8.65 m at 25.0 m chainage. The total COT quantity excavated is 1269.0 cum as against designed 519.0 cum. The final executed work of CoT was satisfactory, and the further work of hearting and casing was then commenced.

**Hearting and Casing**

The earthwork part of the check dam is composed of two sections as the hearting and the casing. Hearting is the inner core of the earthen structure and the casing is the outer earthen part that protects the inner hearting core. The COT was filled with the hearting material that was available locally, and that would meet the expected quality. The testing of hearting and casing materials for their suitability was done at IIT labs and also by Gangotree and both the results were found suitable for the use for the dam. Later, along with the members of the water committee, more agricultural fields were identified that could be used as the hearting material. Meetings were conducted with the help of ADS and Village Water committee, with the owners of the fields, and they voluntarily agreed to provide soil for the dam without any cash compensation. It shows the inspiration and the involvement of the villagers for the project.

COT was filled in layers with appropriate watering and rolling. This would help to prevent subsurface seepage.

Drains were dug as designed at the seat of dam, between the hearting toe to down stream part of the casing toe. The drains would carry the water saturated in the hearting and the casing zone after the dam would fill with water. Drains are filled with metal and sand to prepare the filter media and the least resistance path to drain away the accumulated water.

Casing material was available in plenty as compared to the hearting material. As much as possible, the casing material was excavated and used from the submergence of the check dam. This would also increase the storage of the check dam.

**Waste Weir (Spill Way)**
The Waste Weir or Spill Way is another important part of the check dam. Its function is to carry over the surplus water available after the check dam is completely filled. We have designed channel type spillway for the check dam.

The length of the waste weir was calculated based on the catchment and the rainfall data using standard empirical formulae. Here, the length of the waste weir bar is 15.0 meter.

The waste weir bar is built in the channel to control the Full Supply Level (FSL) of the dam. Here, we have built the bar by providing slight slopes on the outer side so as to guide the flood water in the guide trench at the tail channel.

Flank Wall is built at the junction of earth work and the spill way. It is checked for stability in section with earth pressure as well as for its own weight. Flank wall rests on solid foundation. We have built the flank wall with CR masonry up to high flood Level. The thickest section of the flank wall is 3.15 m.

Approach channel is the part of the spill way from where water would advance towards the spill way. It was cleared for water passage by removing obstructions.

The tail channel is the part which carries’s flood water flowing over the spill way, and carried the water safely away from the structure, and into the stream. We have cleared the passage of tail channel and also have provided a guide trench in the tail channel to guide the water flow and prevent it from entering in the adjoining fields on the down stream side of the check dam.

**Rock toe:**
This is the rock filled solid section built at the down stream casing’s toe along the dam length. It is built to give good anchoring to the dam against earth slipping.

**Pitching:**
It is the stone lining done on the surface of the casing to protect the soil erosion from the rains as well as the wave action. In case of our check dam it is done on both faces of the casing as the check dam is located in the high rainfall region of the Maharashtra State. The casing material may get eroded due to the wave action, at the water storage side of the check dam. On the down stream side it would happen due to rains. Both the parts of the casing are properly protected.
Pitching was done by the skilled labour contractor as well as by the villagers too. It was voluminous labour work. Most of the down stream pitching is done by the villagers.

**Time Line of the project along with the important events:**

1. Total Station Survey 01.12.05
2. Training workshop at CTARA 21.12.05
3. Inauguration Ceremony 28.12.05
4. Commencement of Work on the Field 07.01.06
5. Earthwork by Machinery Commenced 10.01.06
6. COT work Held for Decision on Depth 13.02.06
7. Site resumed with further blasting 22.02.06
8. Inspection visit by Dr. T. N. Singh 25.02.06
9. Machines by Ravindra on Site 10.03.06
10. Grouting at COT 22.03.06
11. Filling of COT commenced 25.03.06
12. Hearting and Casing work commenced 06.04.06
13. Soil Testing by Independent Body 13.04.06
14. Machines work by Ashirwad complete 12.05.06
15. Visit by Director, IIT. 16.05.06
16. Second Machine by Ravindra started 25.05.06
17. Closure of the Machine work 01.06.06
18. Upstream Pitching Completed 20.06.06
19. Down Stream Pitching completed 27.06.06
20. Check Dam filled completely with water for the first time 30.06.06
Challenges Faced by Gangotree.

Sourcing of Materials and Machinery: In the project region, Gangotree faced the serious challenge of monopoly of material and machine supplier, for materials like rubble, metal etc. and for earth moving machines because of supplier’s social and political strength. With Gangotree’s experience and support from IIT and ADS, we could handle the suppliers to the extent possible that there was no any major hurdle in the project.

Work Environment: Due to the social tensions in the region, Gangotree engineers were under substantial psychological pressures especially from the life safety point of view.

Labour problem: Villages initially were very hesitant to work and were very much irregular. This caused a severe labour shortage and in turn time overruns in the schedules. Later, with the
interactions with the water committee and ADS, the situation was quite improved and the time overruns were minimized.

Water Scarcity: As the work got delayed due to COT’s features, the nearest river was dried and we had to bring the water from the Pench river which is about 15 km away from the site. This increased the lead time of water tanker and cost of the watering. Also the cycle time of machines i.e. working efficiency got hampered. With good personal relations and with some incentives to the workers, we managed to get the machines work done even in evenings and at night.

Unavailability of hearting soil near the dam site: Hearting soil was not available in near proximity of the dam. Leads were considerable for the soil transport. This also caused the delay in the work.

In spite of all the above mentioned problems and many small local level problems, the work was completed without any major contingency only because of assistance by the water committee and the volunteers of ADS. One can not ignore the encouragement and the inspiration provided by CTARA, IIT with special reference to Dr. A.W. Date, Dr. Milind Sohoni, Dr. T.N.Singh, Mr. Omkar Marathe and Mr. Satyajit Somvanshi. The Gangotree team that includes Mr. A.D. Gadre, Mr. Santosh Gondhalekar, Mr. Prafulla Hande, Mr. Ramesh Gadade and Mr. Sanjay Rachelli enjoyed the work of construction of the check dam at Gudhvanwadi. We are fortunate that we could share our experience in the field of water management for providing drinking water to the remote tribal hamlet.

Social Aspect:

Village Water Committee was formed in the village in order to organize the work on behalf of the village. The proper coordination of CTARA- IIT, Gangotree and ADS and the committee was effectively done.

Names of the Committee Members are;

2. Smt. Changuna Rama Paradhi.
5. Shri. Govind Nama Khandvi
6. Shri Laxman Kanhu Khandvi
7. Shri Mangal Maruti Nirguda
8. Shri Madhav Maruti Khandvi.

This committee took all those required decisions on behalf of the village.

Laxman Khandvi, a natural young leader from the village took the responsibility to fill the water tanker on the “Pench” river. This involved a lot of social and authorities dealing which he managed successfully.

A bore well was dug on the downstream side of the dam some 150 m away. A hand pump is fitted on it. Also the existing bore well was repaired by villagers with the help of IIT and ADS.

In one of the meetings, village women put fourth the problem that even though they wish to come to work, they couldn’t as they have to spend half the time of their day to fetch and carry the water from about 4 to 5 km distance. On the humanitarian ground we decided to provide one tanker per day for the village out of the tanker trips we have hired for watering of the dam. This really made the difference. Later, women members were very much consistent on the work as required.

This has added on some cost to the project. But it also solved the temporary water problem during the working season for the village.

Many times work was hampered as far as labour work is concerned due to marriages in the village and in near by village. Most of the labours attend the social function. This really disturbed the work. But the site engineers and supervisors Sanjay and Ramesh took lot of pain to reorganize the work so as to minimize the time and cost overruns.

With CTARA’s initiatives and ADS’s support a system was designed to contribute Rs 10/- per day per labour to the ‘water fund’ towards the villagers contribution to the dam.

Pending works:
1. As far as the Check dam is concerned, no civil work or earth work is pending. All as desired and designed work was completed on 28th June. Including the down stream side pitching.

2. If required govt. royalty charges should be paid. For this 7/12 format of all those farmers who gave the soil for the check dam should be collected.

**Future works**

1. Spill Way Treatments: While cutting spill way, unfortunately we didn’t hit a hard rock at all. The excavated part is hard murum only. Hence there is a possibility that the tail channel part may get eroded and washed away in the heavy floods. In this case a tail channel treatment of trench finishing, mortar jointed pitching, W.W. Bar protection against down stream side scoring. Clearing of the water path from the obstacles, if any, may be required.

   But this may be explicitly said only after the monsoon 2006 gets over.

2. Catchment Area Treatment:

   There are two activities need to be done;
   a. Building of Gabion Check dams, on the small streams joining the storage water, to minimize the silting in the constructed check dam.
   b. Tree plantation in the catchments for preventing soil erosion and increasing the income opportunities.

3. Temporary increase in the storage:

   The storage may be increased above FSL after the flood and the monsoon is over. It can be done by building gunny bags weir along the Waste Weir Bar for the height of maximum 1.0 m. In no case the height should be increased more than this limit. Villagers will have to build this every year as it would get washed away in the floods. Later, after some years, we can construct the permanent gated weir, on the existing waste weir bar.

For all these pending works any estimation of time and cost can be done only after monsoon 2006 is over.
Maintenance of the Structure and the Storage:

1. If required extra dumping of soil with manual ramming where ever there are any settlement cracks.
2. In the summer season if the dam gets empty, removal of sedimentation in the submergence would provide more storage.
3. Water level records in the check dam and the flood level records in the spill way would help hydrological analysis in the future.
4. In the spill way region, the approach of water in the spill way should not be obstructed. Villagers will have to look for this.
5. Down stream field bund protection, if any.
6. For future studies and analysis at least a rain gauge should be installed near the check dam. It would provide more reliable, accurate and the authentic data.
7. Cleanliness of the stored water should be maintained for drinking water purpose. Animals should not be taken to the storage water for drinking or washing purpose.

CTARA, IIT’s initiative and the support of ADS, Gangotree and Villagers led to the creation of a small earthen check dam with in a span of 7 months of project period. All the organizations were working together for first time. Many a time’s occasions did arrived where there was difference of opinions among them about the course of work. But the true spirit of all of them helped to complete the task. It was great and enjoyable experience of working together.

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