SAARC ENERGY CENTRE
Energy for Peace & Prosperity

Online training of SAARC Professionals on Small, Mini and Micro Hydro Power Generation (Sept 13 - 17, 2021)

Construction of SMMHP Plants

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Contents

- about different pre construction activities
- Various step in carrying out the construction
- General problems in construction
- Challenges in construction

Leaning Objective

To learn about the process of construction of SHP projects

Stages of SMMHP Development

Normally there are three stages for SMMHP Development

- Clearance stage
- Construction stage
- Post construction stage.
- We shall be discussing here construction stage

Pre-construction Activity

- **Signing of IA (implementation agreement)**
- **Financial Tie-Up (continuous process from clearance stage)**
- Establishment of Site office.
- Establishment of Labour Huts.
- Providing of drinking water, electricity and sanitation to labour & staff.
- Construction of road up-to Power House.
- Availability of construction power if not new line has to be laid.

Pre-construction Activity

- Survey of nearest market/supplier for construction material such as cement, sand, aggregate & steel.
- Planning of construction activities as per Bar Chart.
- Appointment/Engagement of staff and labour according to Bar Chart.

Pre-construction Activity

Setting up of Quality Control Labs for testing of

- Sieve Analysis of coarse and fine aggregate.
- Soundness test.
- Specific gravity & water absorption test.
- Initial & Final setting time test.
- Fineness of cement test.
- Slump test
- Compressive strength test
- Ultrasound &Hydrostatic test of weld joints. Test pressure for hydrostatic test should be 150% of maximum allowable pressure

Construction Schedule

Sr. No.	Description	Year 22-23														
		1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30
		Jan-Feb	Mar-Apr	May-June	Jul-Aug	Sept-Oct	Nov-Dec	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sept-Oct	Nov-Dec	Jan-Feb	Mar-Apr	May-Jun
	Construction Activities															
a.	Diversion Weir & Intake-I															
b.	WCS's in the form of Approach pipe and Pressurized pipe in D-Shaped tunnel															
c.	De-silting Tank & Intake-II															
d.	Surge shaft															
e.	Penstock															
f.	Power House & Switchyard															
g.	Tail Race															
h.	E&M & Transmission works															
i	Erection Testing & Commissioning															

Steps Involved in Construction of SHP

Diversion Site

- Construction of diversion site possible in lean season i.e during winters.
- As less water is there in stream hence could be constructed without diverting the water through temporary diversion tunnels.
- Due to winters setting time for cement concrete is very less so quick setting liquids are used, however, it increases cost of the weir.

Steps Involved in Construction of SHP

- Working hours during winters are very less, so cost of weir increase as extra man-days will be required to complete as per schedule and before summers/rainy season.
- In order to make these projects environment friendly no road is constructed up-to weir site so all the material is shifted through ropeways. It also increases the cost of the project.

Diversion Weir & Intake Tank

Steps Involved in Construction of SHP

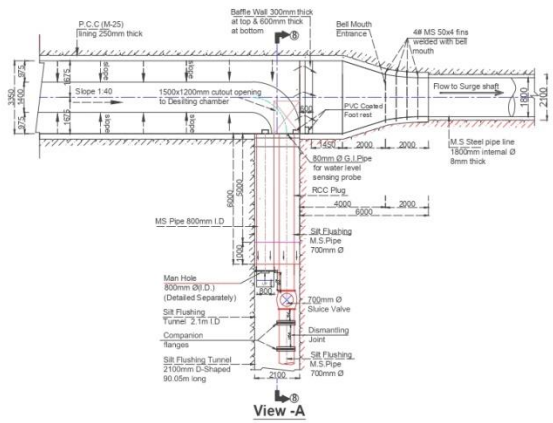
Intake and Gravel Trapper

- Shifting of Gates up-to weir site is again a tiresome job. Since road is not available and ropeways up-to weir site is not capable to take big loads therefore it shall be planned to carry the gates through tunnel.
- Gravel Trapper gates shall also be carried through tunnel.

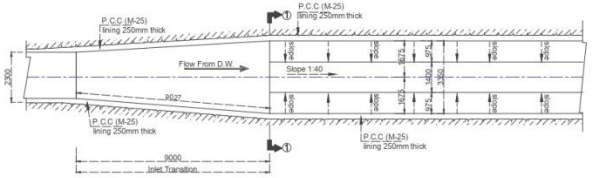
Desilting Tank

In hills adequate space is not available for construction of open de-silting tank, so u/g de-silting tank is preferred. All material is shifted through Ropeway.

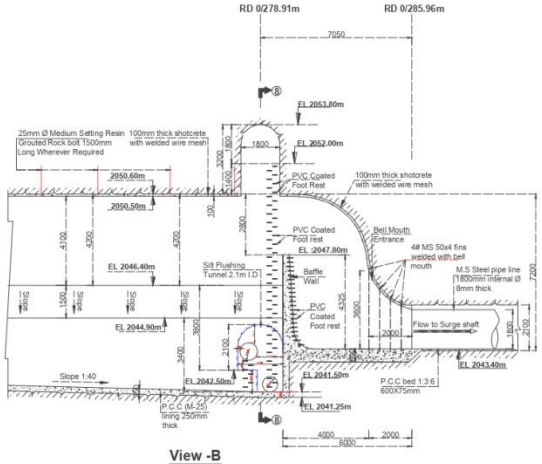
Desilting Tank



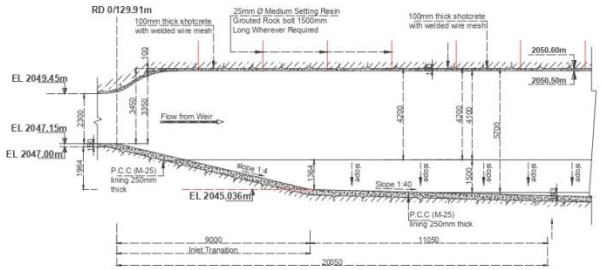
View -A



View -C



View -B



View -D

General Notes

1. All dimensions are in millimeters unless otherwise specified.
2. All dimensions are to be read and not measured.
3. Sequence of excavation:-
a. Marking Profile.
b. Setting up and drilling.
c. Loading explosives and blasting.
d. Removing the foul gases.
e. Checking misfires.
f. Scaling.
g. Mucking and
h. Erecting support or rock bolting and lining if and when necessary.
4. All over excavation shall be back filled with M:10 concrete / beyond minimum excavation line wherever and as specified .
5. Prior to rock excavation, all overburden material along the slopes falling within the limits or rock excavation or which may become prone to sliding consequent upon rock excavation shall be properly removed to the satisfaction of Engineer-in-Charge.
6. All excavation shall be done to the dimensions, line,levels and slopes indicated on the drawings. However,where during the progress of the work it is felt necessary to change the slope which could cause slides and where the height of the excavation is excessive, suitable protective measures shall be taken in consultation with Geologist/Engineer-in-Charge.
7. In general the bedding shear containing gouty and slacken sided material which is laying beyond excavation outline having considerable thickness shall be remove during consolation with Geologist Engineer-in-Charge.
8. No steps, ledges and overhangs greater than 150 mm shall be allowed and those falling within the permissible limits shall be suitably rounded off.
9. Any abrupt changes in the rock excavation outline shall be carried out by local smooth round off.
10. All blasting and re-handling of explosives shall be done in the rock excavation, outline shall be carried out by local smooth rounding's.
11. Blasting wherever carried out,shall be carefully controlled to avoid fracturing of the rock mass beyond the min. lines of excavation.
12. The drilling should be such as to ensure minimum over break and le amount of explosive per unit volume of exaavation.
13. Rock bolt shall be inserted perpendicular to the bedding plane.
14. Placing of concrete and sequence of lining :-
a. Placing of concrete shall be done through placer pump.
b. The maximum size of stone shall not exceed 40mm for this the minimum size of the placer pipe shall be kept 200mm.
c. To ensure quality the minimum size of slump shall not exceed 100mm and cement content shall be kept 400kg/cum to ensure adequate workability and strength
d. For D-Shaped tunnel the kerb shall be concreted first to serve as base for erection of formwork.After constructing the kerb from work is erected for lining the sides and arch is done simultaneously.Finaly, after the removal of formwork the invert concreting is done.
e. In tunnel through weak strata or squeezing and swelling rock, it is necessary to concrete the kerb sides and Arch simultaneously.
f. The concrete shall be thoroughly vibrated after placing by means of vibrating needles, flexible shaft immersion type vibrators. In addition, the concrete must also be vibrated by means external form vibrators to avoid segregation of concrete.
g. The Various type of form used in tunnel lining shall be rib and plate type, rib and lagging type.
h. The inside surface of the form shall be coated with oil to prevent the concrete from sticking to it.
i. The form shall be removed after 16 to 24 hrs and the tunnel surface is cured by keeping it constantly wet for at least 21 days.
15. Surface before concrete placement shall be free from vegetation and other foreign elements that can cause harm to structure. The excavated surface shall be well compacted to form firm base. Manual compaction shall be P.P.C. to achieve requisite firm base.
16. Portland Pozzolan cement, Comply With is1489 shall be used.
17. Aggregate (fine & coarse) to be used in concrete work shall conform to IS: 383. Maximum size of aggregate shall be 20 mm, unless specified otherwise at particular locations.
18. Aggregate shall not have an absorption greater than 2 percent, as measured in accordance with Clause-2 of IS:2386 (Part-III)
19. Water for mixing and curing shall be clean and free from injurious amounts of oil, acids, alkalis, salts or other substances that may be deleterious to concrete or steel.
20. The grade of concrete shall be M: 25, unless specified otherwise .25days characteristic compressive strength for M 25 conc. shall NOT be less than 25 N/mm2.
21. Min. cement content for M: 25 conc. shall be as specified in IS: 456 additives, if used shall conform to IS:9103 and shall not be substitute for cement content.
22. Concrete shall be placed at or near its final position to avoid re-handling.
23. Cold joints shall be avoided during concreting in subsequent layers. Normally the placement of concrete shall continue without interruption until the concreting is completed upto the specified stage elevation.
24. Concrete shall be thoroughly compacted and fully vibrated around the reinforcement and into the corners of the form work.
25. Proper curing of concrete shall be ensured by use of gunny bag or water sprinkling.
26. Plum concrete M-20 with 30% plum of size 150mm-300 mm shall be used .
27. For any discrepancy in drawings & site required changes may kindly be clarified from **Design cell , Sai Engineering Foundation** before execution of same at site.

Sr. No.	Revision	Date	Remarks
4).	Rev-03	15-09-2017	Change in Silt flushing Gate Arrangement (Valve Instead of Gate)
3).	Rev-02	14-04-2017	Change in Height of D-tank
2).	Rev-01	26-12-2016	Change in size of D-tank
1).	Rev-0	04-06-2016	-

DEVELOPER:-	M/s Jagdambey Hydro projects VPO Bhamsoi, Teh. Nadaun, Distt. Hamirpur Himachal Pradesh
EXECUTION By:	SAI ENGINEERING FOUNDATION SAI BHAWAN, NEW SHIMLA SECTOR-4 (H.P)
PROJECT :-	Kawarsi-II Hydel Power Project
Drawn By:-	Heerawati
Designed By:-	Er. Hitender Shandil
Checked By:-	Er.Munish Sharma
Title:-	Desilting Tank Detailing — sheet 2 of 5
Date:- 15/09/2017	Dwg No:- SEF/Kawarsi-II/Desilting Tank/Detailing/17/02 — Rev.03

Steps Involved in Construction of SHP

Water Conductor System

- All the hilly terrain have C or U type of Hills, U/g WCS preferred instead of open WCS to reduce the length instead of open WCS. Underground tunneling is good where strata of the rock is firm. It is very difficult to make the tunnels in loose strata as installation of ribs is very costly.

Steps Involved in Construction of SHP

- In hilly terrain c/o tunnel is preferred and steel liners are provided instead of concrete lining. Although it is costly but save lot of time and reliability is very high. Tunneling increase the cost of the project but is very safe and environment friendly.
- All the water conductor pipes are also shifted on ropeways

Steps Involved in Construction of SHP

Forebay Tank & Surge Shaft

- Although fore bay tank is advised in SHP but now a days Surge shaft is preferred over Fore bay tank as its does not involve spillway system. Capital cost of surge shaft is more but it reduces maintenance and cost of spill way. Overall head increases by providing surge shaft.
- In most of the cases road is not available up-to surge shaft so all the material shifting up-to surge shaft is done with ropeways. There is lot of wastage of material hence shifting up-to surge shaft through ropeways increases construction cost.

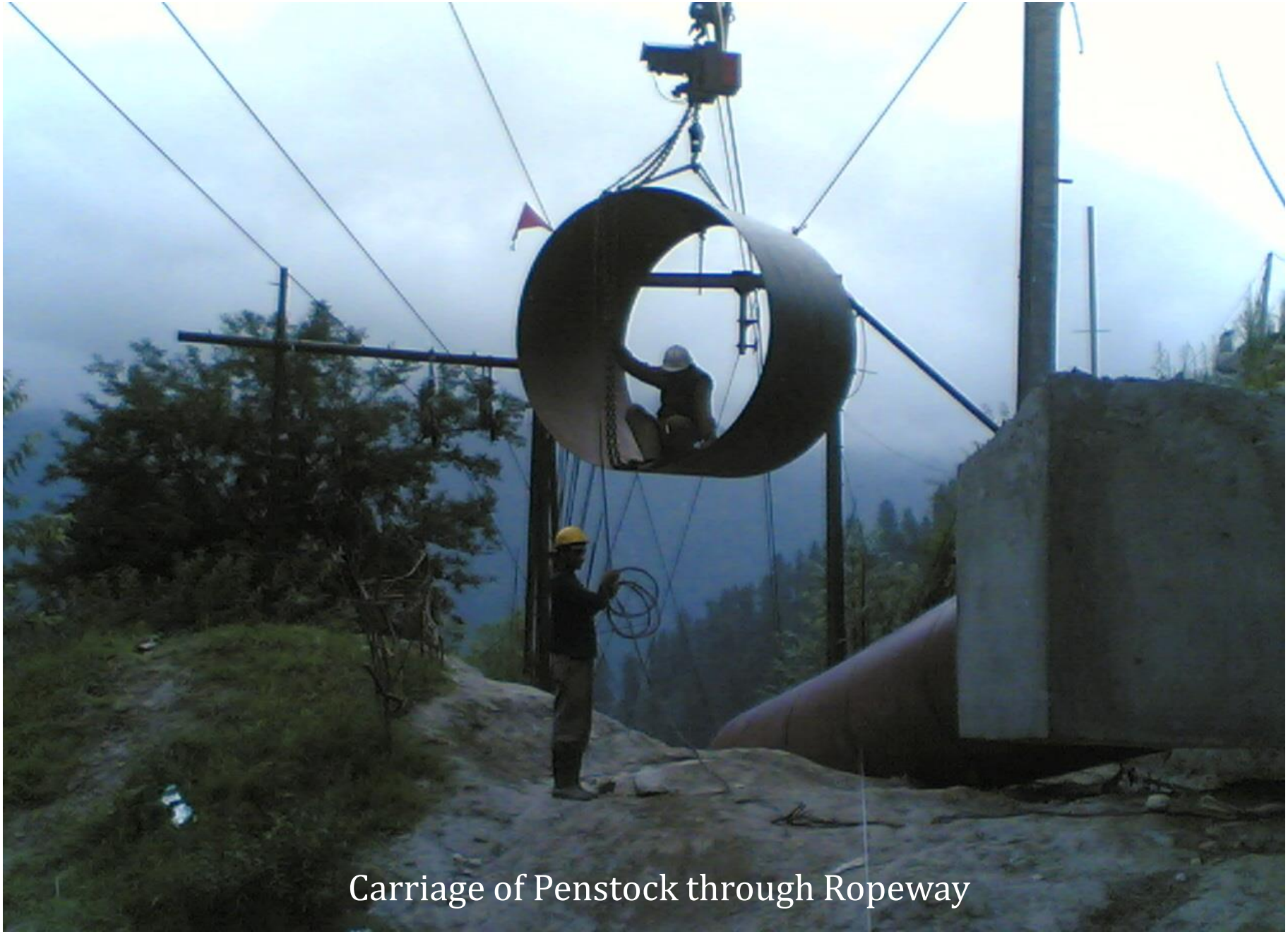

Surgeshaft

Steps Involved in Construction of SHP

Penstock

- Laying of penstock in SHP is most difficult task as it has to be laid according to hill profile. Anchor and saddle block have to constructed at different locations so shifting of material to each and every saddle and anchor block is very difficult.
- Curing of each and every saddle has to be done.
- Ultrasonic and DPT Testing of weld joint along the hill slope is again a very difficult task. Material shifted through ropeway increases cost of the project but there is no other option.


Laying of Penstock on the ridge



Carriage of Penstock through Ropeway

Steps Involved in Construction of SHP

Power House

- Generally, there is no road available for power House, therefore first step to start the project is construction of road up-to powerhouse.
- If space is available surface powerhouse may be constructed. Adequate space for switchyard construction shall also be available near to the powerhouse so that minimum length of cable is required.
- Its easy for operation and maintenance if switch yard is adjoining to powerhouse.

Steps Involved in Construction of SHP

- If space is not available, underground powerhouse for projects above 5 MW may be constructed as it will be safe, easy for operation and maintenance. Muck dumping can be utilized for switchyard.
- Evacuation of power is another problem in SHP , so before construction is started it should be ensured that Evacuation is available nearby. Many Projects have become unviable due to non-availability of evacuation facility. available in nearby area increase the cost of the project.

Underground Power House


Switchyard

General Problem in Construction of SHP

- **Unreasonable demands by local bodies**
- Demand for Construction of roads/Bridges/Play Grounds Mahila mandal Bhawan, Temple reconstruction etc by local bodies is a major problem which is not inbuilt in the project cost.
- In some cases cash is demanded by Devta Committee.
- Old age pension, Unemployment allowance demand by local Panchayat.
- Extortion on account of false damages to built houses near to projects.
- Demand for appointment of teachers and paramedical staff on project expense is also a common practice.

General Problem in Construction of SHP

Construction Power Issues

- In hilly areas reliability of grid electricity is not very good. So power backup for construction of project is required. For construction of SHP 200KW power is enough. Therefore at least half of the power required shall have the power backup.
- For power backup diesel generator minimum of 125KVA shall be kept.
- The storage and carriage of diesel for construction power is also another problem.
- Capacity of diesel generator for construction power shall be selected in such a way that could be utilized later on for back power of power house auxiliaries.

General Problem in Construction of SHP

Non availability of Construction Material near to project site

- As SHP sites are in far flung areas, availability of aggregate and sand shall be explored prior to start of work.
- In present practice, project authorities plan to produce aggregate and sand with installation of small stone crusher units at weir site and at surge-shaft /Muck dumping sites. This not only mitigate the problems of construction material but also help in reclamation of muck.

General Problem in Construction of SHP

- Due to low temperature in hilly regions welding & concreting requires special attention therefore this work has to be scheduled as per climatic conditions.
- Working season in the hills are very limited, prolonged rainy season may attribute to less working season.
- Project management shall plan the construction activities in such a way that during rainy season labour and staff may not remaining idle. Therefore during rainy and winter season underground works such as tunneling, underground powerhouse, underground de-silting tank may be carried out. Such planning will adhere the construction schedule prepared for the project.

General Problem in Construction of SHP

- Supply order for Plant & machinery shall be placed atleast 15 months prior to completion schedule. It should be ensure that adequate space for storage for machinery near to powerhouse is created before arrival of 1st consignment.

General Problem in Construction of SHP

- For loading and unloading of heavy equipment's such as generator, turbine and butterfly/spherical valve installation of crane inside the powerhouse shall be erected before its arrival.
- 1st stage concreting of machine foundation shall be casted before arrival of heavy equipment's. Some times the delivery of E&M equipment's and construction of power house does not match. In those cases heavy IDC makes the project unviable as storage of E&M has to be done out side the project periphery. Loading, unloading, storage of E&M equipment's outside project periphery cost heavily. The project management must ensure the supply of E&M equipment’s, and construction of powerhouse in such a way that loading and unloading is ensured inside the powerhouse with the crane installed.

General Problem in Construction of SHP

Transmission Line

- Evacuation arrangement shall be ensured before commissioning of project.
- It should also be ensured that transmission line beyond interconnection point should have adequate capacity to carry the total installed capacity of the plant+20%COL.
- All agreements such as power purchase agreement, interconnection agreement, test certificates from different agency like chief electrical inspector, M&T(meter and testing department), P&T(Protection and testing department) and safety cell of Nodal agency, clearance shall be obtained before COD(Commercial operation date) fixed for the project.

Challenges during Construction of SHP Plants

- Laws & rules for transfer of land are not simplified
- Delay in the clearances like forest clearance.
- Delay in according Techno-Economic Clearance.
- Delay in obtaining NOCs from Gram Sabha, Fisheries, I&PH, PWD,PCB
- Non- availability of reliable data
- Poor infrastructure facilities
- Complicated procedures for financing of SHPs
- High capital investment
- Interfacing problems
- Frequent changes in the policy

Challenges……Contd.

- High risk factor on account of flash flood, cloudbursts, earthquakes, land slides etc.
- Geological & Hydrological Uncertainties
- Abnormal increase in the cost of construction material & labour cost
- Fixed energy price, no provision of escalation
- Very high price of electro-mechanical equipment
- Unskilled manpower & non availability of experienced professionals
- Non serious developers
- Problems associated with SHP are similar to mega projects.

LAND SLIDES

AFTER FLASH FLOOD

BEFORE FLASH FLOOD

DAMAGE DUE TO FLASH FLOOD

POOR GEOLOGICAL FORMATION

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Thank you