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Geoscientific Instrumentation in River Valley Projects

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ABSTRACT
Present day development of the engineering projects, especially river valley development, underground storage chamber and metro rail projects require lot of instrumentation work, many of hydroelectric projects are located in the Himalayan region. Instruments are required in different stages of the project, especially during excavation and in the areas of poor to very poor rock mass. Monitoring of slope in hilly areas and for civil engineering purpose is essential, because of the various regions.

Geotechnical instruments are tools for evaluating performance of the structures during construction as well as later stages. Various types of instruments are used in dam, tunnel, power house and slope. The main objective of the instrumentation program is to measure the reaction of the surrounding rock mass to the excavation process and the installed support system, thereby ensuring the adequacy of the design of the excavation and support system. This can be achieved by measuring various parameters. Based on the data, interpretation of different kinds of instruments are done, further decisions can be made for safety and long life of the structure.

This paper describes purpose & various types of instruments used in river valley projects and how the data indicates the failure of rock mass. In brief case of Parbati hydroelectric project, for the slope failure of surface power house and underground power house data of Malana hydroelectric project are discussed.

INTRODUCTION

Now a day's rapid growth in the infrastructure and river valley development projects requires lot of instrumentation work, to monitor the behavior of ground, installed support etc. at different stages of project development i.e. before, during and after construction stage. The basic aim of the instrument programme is to decide the type of instrument, purpose, installation, monitoring, data analysis and finally based on the data analysis action plan to be taken. In this paper instruments required in the river valley projects are listed and studies from two hydroelectric projects for few instruments are discussed. These mainly include multipoint bore hole extensometer (MPBX) installed at surface power house slope of approximately 132 m height of Parbati hydroelectric project and underground power house of Malana project.

PURPOSE AND CHOICE OF INSTRUMENTATION

The purpose of instrumentation programme includes site investigation, design verification, construction monitoring, and safety of structures, legal protection and finally the performance of the structure. Choice of instruments depends mainly on the various parameters, ground conditions, environmental conditions, life of instrument, data acquisition, cost, available resources at site, range, resolution and finally accuracy of instruments are deciding factor for choice. All are very important for success of instrumentation program and a dedicated team working only on instrumentation of the project provides benefits to the project.

TYPES OF INSTRUMENTS

Different types of instruments are used in underground, surface work and for dam structure of the river valley projects. The sensor in the instrument can be of vibrating wire type, potentiometer/resistance and strain gauge type. Some of the instruments are as follows:

- Load Cells
- Convergence Meter
- Crack Meter
- Joint Meter
- Borehole Extensometer
- Strain Gauge
- Pressure Cell
- Stress Meter
- Rebar Stress meter
- Inclinometer
- Settlement Gauge
- Portable Tilt Meter
- Stand Pipe Piezometer
- Tape Extensometer
- Water Level Meter etc.

AREA OF APPLICATIONS

Instruments can be recognized broadly in to two types i.e. for in-situ determination of rock or soil properties, required during designing stage of project. Other Category of instruments are used for monitoring performance, such type of instrumentation is required during pre- and- post construction or operation phase of a project. Wide ranges of area of application are applicable for the instrumentation work. Instruments are used for scientific study, in slopes, along the roads, mine, and for underground rail projects etc.For river valley projects instrumentation program focused in underground, surface work and dam structure.

INSTRUMENTATION AT PARBATI H.E.PROJECT STAGE -II

Parbati Hydroelectric project stage – II, is located in Kullu district Himachal Pradesh is under construction for generation of 800 MW power. Geologically this area lies in the Lesser Himalayan zone. The main rock types were observed during power house excavation are Metavolcanics and Metavolcanics with Chlorite Schist bands. From D/S of section + 22 clay bands, open joints of varying thickness are observed. This slope (Fig.1 Layout of power house slope) has experience failure at many times, on 17-04-2004 from section + 9 (U/S), first failure was taken place. Initially cracks were observed in this area and finally slope failed suddenly. After first slope failure, cracks were observed in the D/S of section +22.On 26-06-2006 a major portion of slope again failed, in the D/S side and finally slope again failed on 20-02-2007 when treatment of slope was progressing. After first failure of slope MPBX was planned at various locations, total number of instruments are planned at that time are listed in Table.1.

Table 1. Total Number of Instruments

Sl.No.	Type of Instruments	Location	Quantity (No's)
1	SPBX	Surface	05
2	MPBX	Surface	17
3	Load Cell	PH Drift	04

After installation of instruments at slope at various locations, data were taken regularly and analysed.This data indicated initial indication about displacement (Table 2).This was also confirmed by crack development in slope. Maximum rate of displacement at various locations are given in the table no.-3. Last failure of slope is shown in the Fig.2 and typical graphs before failure of slope on 26-06-2007 are shown in Fig. 3.

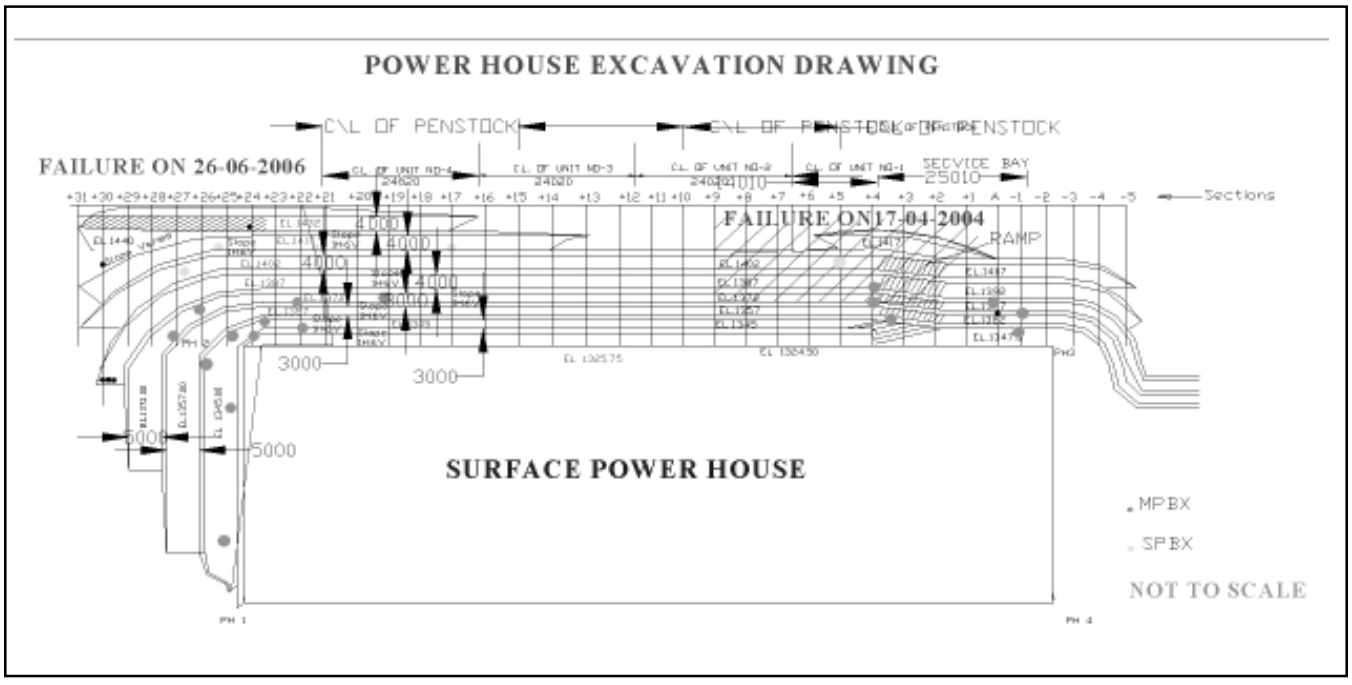


Figure 1. Layout of Power House Slope Parbati H.E. Project Stage – II.

After failure of slope, on 26-06-2007 more instruments were planned in power house slope. Data taken before slope failure clearly indicates the displacement of rock mass and this was resulted in failure .After failure of slope modification in supporting system was decided for future safety of structure by design team. It is observed during surface conditions of slope and data analysis, it is better if load cells and inclinometer are installed in the slope provide more understanding about slope.

Table 2. Displacements at Various Locations

Sl. No.	Type of Instruments	Displacement (mm) Min.	Max.	Location	Depth (m)
1	SPBX	3.52	18.12	EL. 1418 Section +25(+1.5)	6
2	MPBX	16.99	50.85	EL. 1373 Section +26(+2.3)	12
3	MPBX	1.82	10.56	EL. 1364.1 Section +27	12
4	MPBX	-1.08	-13.77	EL. 1347 Section +24(+4)	12
5	MPBX	-1.69	89.12	EL. 1346.5 Section +25(+6.5)	12
6	MPBX	5.38	59.27	EL. 1338 Section +24(+20)	15
7	MPBX	-15.88	-18.10	EL. 1338 Section +22	15

Figure 2. Parbati H.E. Project Stage-II, Surface Power House Slope.

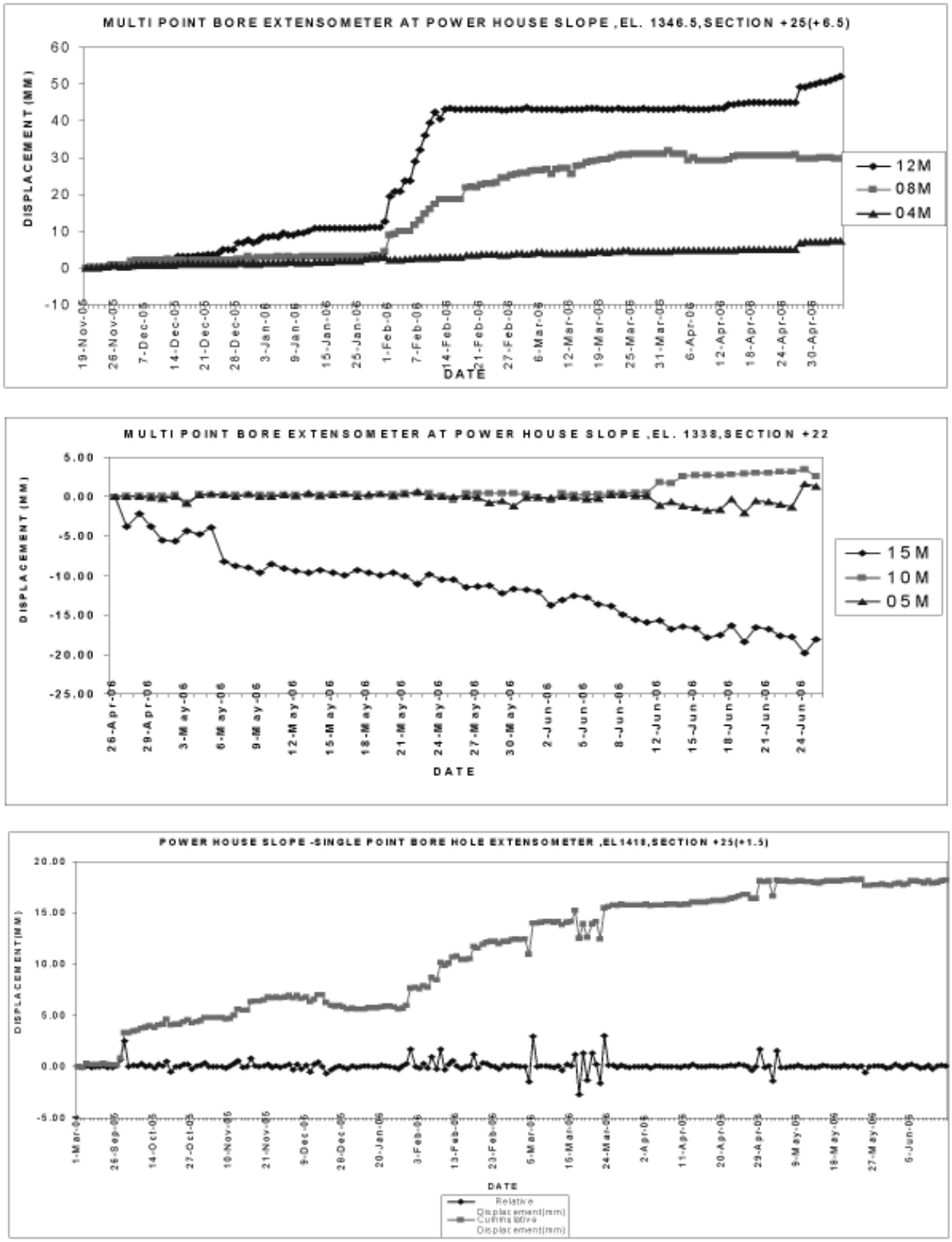


Figure 3. Displacements at Various Locations.

INSTRUMENTATION AT MALANA H.E.PROJECT STAGE II

Malana-II hydroelectric project is under construction for the generation of 100 MW power in Kullu District of Himachal Pradesh. Three main type of rocks are exposed in the area are Quartzite's of Manikaran formation, Carbonaceous Phyllite and Biotite Schist with bands of Quartzite. General layout plan of power house area is shown in Fig.4. Instruments are planned at various locations, only power house data are considered here. Central gullet of power house is excavated and excavation of left and right side is under progress. At three locations multipoint borehole extensometers are installed i.e. at RD11, 36 and 60 m. Data are taken on the regular basis and results are shown in Fig.5 .Result indicates displacement has not occurred in the rock mass.

Table 3, Maximum Rate of Displacement

Sl.No.	Location	Rate of Displacement (mm/day)	Depth (m)
1	EL. 1346.5, Section +25(+6.5)	0.41 0.33 0.10	12 8 4
2	EL. 1338, Section +22	-0.30	15
3	EL. 1338, Section +24(+20)	0.99 0.68 0.98	15 10 5
4	El. 1338, Section +24	0.25 0.29	10 5

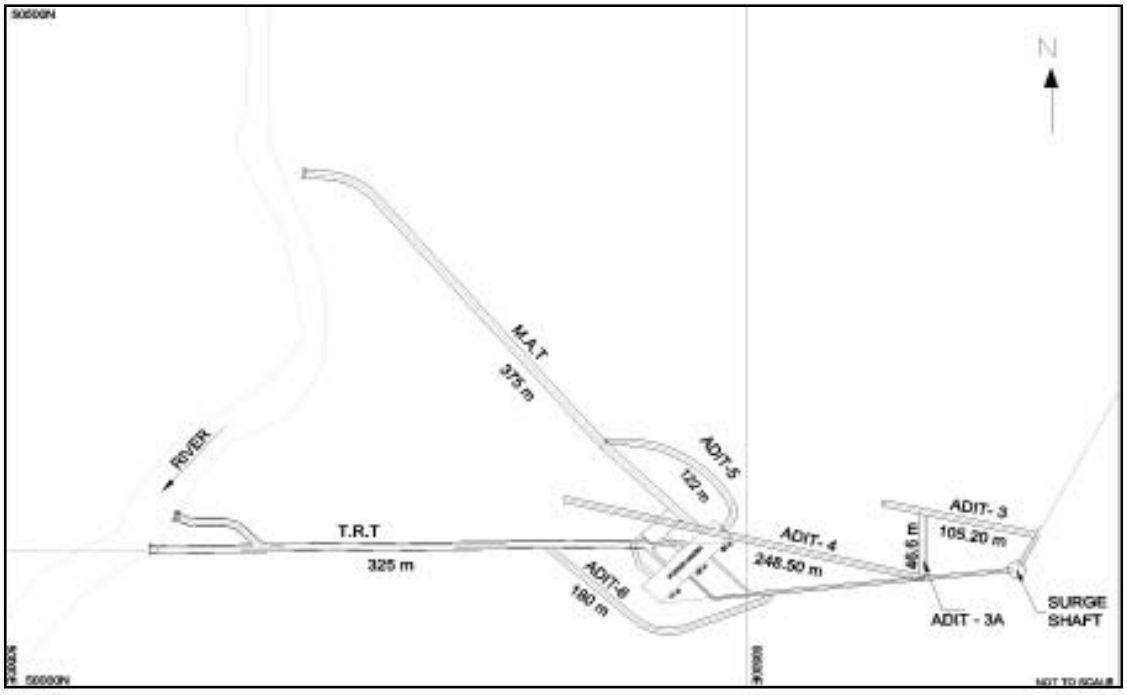
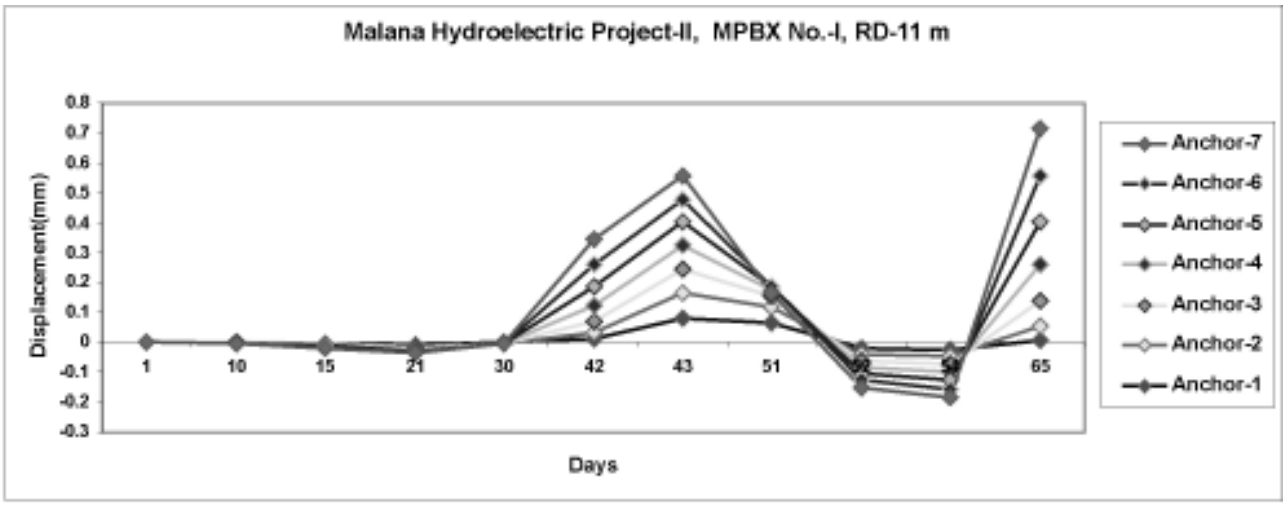
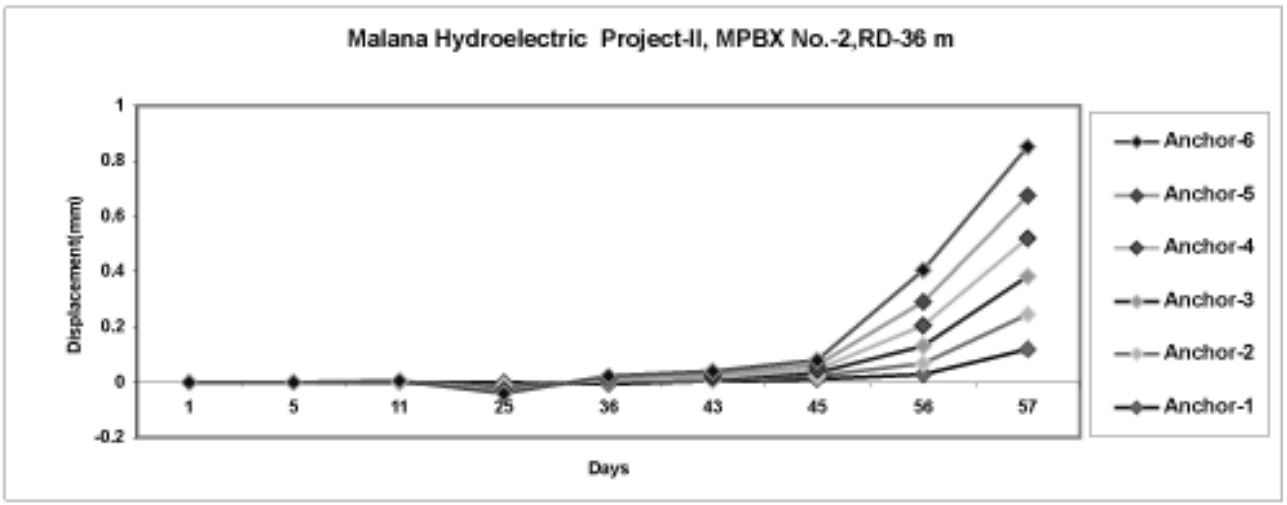


Figure 4. Layout Plan of Power House Malana Hydroelectric Project.





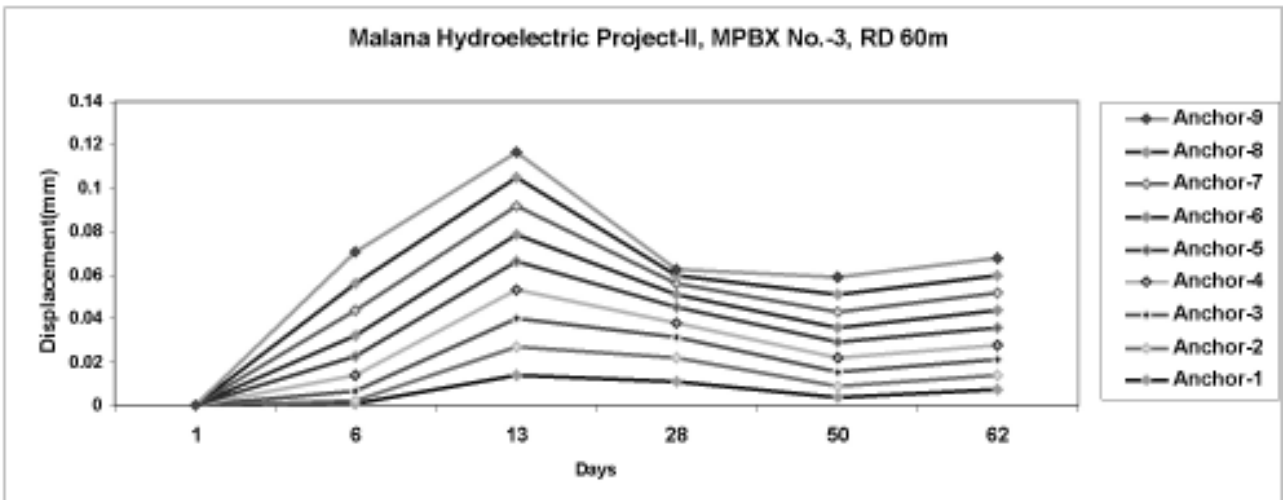


Figure 5. Displacements at Various Locations.

CONCLUSIONS

Instrumentation for the river valley projects includes selection, installation, monitoring & maintenance, data collection, interpretation, analysis and report preparation. Based on reports further decisions are taken for the stability of various structures. In case of the surface power house slope of the Parbati hydroelectric project which was finally resulted in failure indicated by instrument data and surface conditions. Underground power house excavation of Malana – II project is in under progress; available data indicates no displacement has occurred in the rock mass, also it is important here instruments are installed without arising any instability in rock mass. It was also observed whenever required a combination of instruments can also used, when more information is required. It is always better in case of river valley projects, when the instruments are installed before arising instability of the structure. This type of approach can provides better result, thus the science of shallow depth i.e. Geoscientific instrumentation are very important tool for safety of the civil engineering projects.

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REFERENCES

Geotechnical Instrumentation, Manual of Progressive Machine Tools Pvt. Ltd, Jaunpur, U.P., India.

Dhawan, A.K.,2007. Emerging Trends in Geotechnical Investigations, Standard India –Vol.21, No.-2, 12/12, New Delhi, Bureau of Indian Standards.

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