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परियोजना का नाम :– जनपद चम्पावत के लोहाघाट के समीप कोलीढेक में बहुउद्देशीय कृत्रिम जलाशय (झील) का निर्माण।

भू–वैज्ञानिक की आख्या का प्रमाण–पत्र

उपरोक्त परियोजना के निर्माण से सम्बन्धित भू–वैज्ञानिक की आख्या संलग्न है।

जिलेदार
सिंचाई उपखण्ड चम्पावत

सहायक अभियन्ता प्रथम
सिंचाई उप खण्ड लोहाघाट
जनपद- चम्पावत

अधिशासी अभियन्ता
प्रयोक्ता सिंचाई एवं जल
लोहाघाट

CHAPTER – 2

PRELIMINARY GEOLOGICAL INVESTIGATIONS

2.1 INTRODUCTION

The project envisages creation of an artificial Lake by constructing a concrete/ gravity dam of 15 m high and 65 m in length across the river Lohawati near village Kolidhek in District Champavat in Uttarakhand State, to promote tourism, minor irrigation and drinking water supply to town and its vicinity. The project site is located about 2 km from Lohaghat Town on Lohaghat-Devidhura road. The area of investigation falls in survey of India toposheet No. 63 C/3. The project area falls under seismic zone-V of seismic zoning map of India.

The detailed geological mapping of the project site was carried out during the period between 30th May and 4th June 2005 in pursuance of GSI field season programme 2004-05 where in the item of investigation was included as an additional item. An inspection visit was also paid to the project site at the request of the District Magistrate, Champavat and the Executive Engineer Irrigation Construction Division, Lohaghat, on 24th Feb 2005.

The area experiences tropical climate with seasonal variation. Rains are common throughout the year; however, regular monsoon starts from June and continue upto October. The area is generally covered by thick forest but at places, few barren hills also seen. The main flora consists of Chirr, Deodar, Nashpaati and Chameli. The area around dam site and reservoir area are covered with thick forest of Deodar trees.

This report deals with the geological investigations carried out at dam sites and part of reservoir area of Kolidhek Artificial Lake Project in the year 2004-05. The investigation taken includes detailed geological mapping of dam sites and part of reservoir area to delineate different lithological units, structural units, overburden rock contact, assess general rock mass conditions and to finalise the dam axis.

2.2 GENERAL GEOLOGY OF THE PROJECT AREA

In the area alternating sequences of Sandstone, Siltstone and Shale, of the Siwalik Group are exposed upto Sukhidong. The Bhimtal Formation sandwitched between Main Boundary Fault (MBF) in the south and Ramgarh thrust in the North comprises purple to pale green quartzite with phyllite and chlorite schist and metavolcanics. The formation close to the thrust is sheared and pulverized, at places.

Ramgarh Group of rocks, bounded by South Almora Thrust (SAT) in the North and Ramgarh thrust in the South, consists of phyllite, gneiss, porphyries, quartzite and chlorite schist. Further north, these are followed by the Almora Crystalline Group, comprising garneti ferous mica schist carbonaceous phyllite, slates, augengneiss, granite and granodiorite. Near Chat the Crystalline Group of rocks separated by shale, phyllites, limestone and dolomite of Garhwal Group are exposed. Quanternary deposits occur in the form of river terraces, flood pain and riverbed deposits, debris/ talus deposits and reworked debris in the area.

2.3 GEOLOGY OF DAM SITE AND PART OF RESERVOIR AREA

The detailed geological mapping (Fig. 1.2) on 1:1000 scale, using total station, was carried out at the proposed dam site area and its reservoir area (upto chainage 700 m). An area of 1,25,000 m^2 was covered. Geological mapping in the current season was taken up with the aim to delineate different lithological units, structural units, overburden, rock contacts, assess general rockmass conditions and to finalise the dam axis.

At the proposed dam axis 'A' and 'B', grayish coloured, hard and massive phyllites are exposed. On the right bank, insitu rocks are exposed with in vegetation upto an elevation ± 1718 m from the riverbed, (± 1694). The rock are also exposed in the riverbed section on the both sites. The width of river at these sites ranges from 10 to 15 m (Fig. 1.2).

On the left bank, along the dam axis 'B' the rocks are exposed upto an EL. ± 1706 m from the riverbed. Beyond this, the area is occupied with overburden material/ soil cover upto a considerable distance. The river section at this site is covered with massive phyllite rocks, which are very hard and compact in nature.

On the left bank, along the dam axes 'A', the rocks are exposed between riverbed level (±1699) and EL. ±1700m. At this site the area between EL. ±1700 and ±1710 is covered with soil/overburden materials. Beyond EL. ±1710 the scanty outcrop of insitu rocks area seen exposed with in cover of overburden material and soil.

The foliation of rocks at these sites, in general, trends N 60° – 70° W – S 60° – 70° E direction with 30° and 60° dip in north easterly direction. The following sets of joint have been observed. The foliation joints are the prominent joints in the area.

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सिंचाई उप खण्ड लोहाघाट
जनपद- चम्पावत

सहायक अभियन्ता प्रथम
सिंचाई उप खण्ड लोहाघाट
जनपद- चम्पावत

S. No.	Strike	Dip/amount and direction	Description
1	N60°W-S60°E	30°NE	Spacing 2 to 5 cm tight, moderate smooth.
2	N65°-70°W-S65°-70°E	60°NE	Smooth and tight, iron stained
3	N-S to N 10°W-S10°E	50°-60°W to S 80°W	Smooth, tight, spacing 5 cm to 20 cm
4	N 55°E-S55°W	75°NW	Smooth, tight
5	N70°E-S70°W	15°SE	Smooth, tight
6	N40°W-S40°E	27°SW	Spacing 2 cm to 5 cm, rough, tight, iron stained.

In absence of any subsurface data, it is not possible at this stage to comment on the depth of acceptable foundation rock on the left bank for both the alternative sites. However, on the basis of available surface data and the tentative geological section drawn along dam axis it is anticipated that the overburden material would be upto a depth of 2 to 6 m. But this needs confirmation by putting few drill holes down to fresh rock level in consultation with geologists.

The reservoir area, which will have a 1.6 km^2 spread, is located mainly on grayish coloured hard and compact phyllites of Manila Formation. The rocks in the reservoir area generally strike N 40° to 60°W – S 40° to 60° E and dip 30° to 70° in northeasterly direction. Variation in attitude of rocks have also been observed at places. The following joint sets are observed in the area. The foliation joint are the prominent joints in the area.

i.	N-S/55°E°	Tight, rough, spacing 2 to 5 cm, 0.5 continuity
ii.	E-W/Vertical .	Spacing 5 to 10 cm, tight, rough 0.5 m continuity
iii.	N 60° E-S40° W/60°SE	Spacing 2 to 10 cm tight rough iron stained, 0.5 cm continuity
iv.	N 40° E – S 40°W/50°NW	Rough, stained, spacing 5 to 25 cm, continuity 20 cm
v.	N 70° E – S 70° W/60° NW	Tight, rough.
vi.	N 450 ° W – S 450 ° E/150 ° SW	Spacing 5 to 20 cm, moderately smooth, continuity 0.5 m.
vii.	N 40 ° W – S40 ° E/50 ° SW	On 5 to 0.5 m spacing, stained, tight, rough

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सहायक अभियन्ता (प्रथम)
सिंचाई उप खण्ड लोहाघाट
जनपद- चम्पावत

सहायक अभियन्ता प्रथम
सिंचाई उप खण्ड लोहाघाट
जनपद- चम्पावत

The entire area of reservoir is devoid of any overburden materials except at certain location where few rolled blocks of quartz vein associated with host rocks and RBM are seen in the river bed section. The exposures of rocks are observed in riverbed section on proposed reservoir area upto a height of 3 to 10 m on the either bank. Scanty outcrops are also seen exposed on left bank of reservoir area.

The slopes on the right and left banks of the proposed reservoir area are largely terraced, gentle and occupied by barren agriculture lands. The hill slopes on both the banks of the proposed reservoir area, are stable except at few locations where the vertical slope with thick vegetation exist and dips towards the valley. The Dam is located in known seismically sensitive Himalayan Region and it would be necessary to adopt a suitable seismic factor in the design of the dam.

2.4 CONCLUSIONS AND RECOMMENDATIONS

2.4.1 Detailed geological mapping on 1:1000 scale at dam site area was completed in this field season and contacts of different rock types and of rock and overburden mass were delineated. In the area mainly phyllites of Manila Formation are present. As the thickness of overburden/soil material is tentative, it is recommended to explore the left bank area of the proposed dam sites by fiver drill holes (location is given in the plate-I) to know the subsurface geological condition and decide about acceptable foundation medium and dam axis. Water percolation tests may also be conducted as per BIS codes is the holes. These holes should be drilled for a depth 25 m each (at least 5 m in bed rock).

2.4.2 The rock types present in and around dam site and reservoir area are phyllites (Manila Formation) of Kumaon Super Group. Regionally, these rocks are intruded by grandiorities of Champavat, dipping 30° to 60° in northeasterly direction. The left bank area of dam sites is covered with overburden materials and bedrock is expected to be at the depth of 2 to 6 m. This need to be confirmed by subsurface exploration by mean of drilljng at suitable locations.

2.4.3 The left bank area of dam site 'A' and 'B' should also be explored by drilling followed by water percolation tests with a view to decipher the subsurface geological condi...

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सिंचाई उप खण्ड लोहाघाट
जनपद-चम्पावत

and acceptable foundation medium; albeit both the sites, prima facie, appear to be feasible.

2.4.4 On the basis of the desired subsurface data, final decision would be taken up as regard to the choice of dam axis and height of the dam and also to comment on the acceptable foundation level.

2.4.5 Geomechanical properties like compressive strength, modules of elasticity, shear parameters and other laboratory/insitu tests should be conducted, for evaluation of rock mass parameters.

2.4.6 The Dam is located in a known seismic region and it would be necessary to adopt a suitable seismic factor in the design of the dam.

2.4.7 Project authorities are also advised to workout the layout of dam and other appurtenant structures in consultation with designers for taking up further engineering geological investigations.

2.5 EXPLORATORY DRILL HOLES

As per the recommendations of the geologist above, the investigations of the subsurface strata were carried out by GSI through drill holes suggested by GIS and design engineers. The exploratory drill holes drilled on the left abutment on the two axis A and B and one hole in the river bed along axis A were geologically logged. The locations of these drill holes are shown in Fig. 1.2. The detailed observations of geological logging as recorded during drilling are given in Appendix-2.1. The summarized account of the geological logging is as under:

Drill hole no. DH-1 was drilled for 27 m depth, on the left abutment of the river at the lower most portions along the proposed barrage axis. The hole revealed the presence of 5.0 meter thick overburden material comprising yellowish brown silty soil with clayey matter in the upper three meter and another two meter depth comprises boulder of hard phyllitic rock. The bed rock comprises hard and compact massive phyllites. This rock is slightly weathered upto 9 meter depth below which the rock is fresh and contains thick quartz vein the upper portion of the fresh rock. The dips of foliation / bedding planes are between 40° and 50°. The core recovery ranges from 20% to 78%.

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सहायक अभियन्ता प्रथम
सिंचाई उप खण्ड लोहाघाट
जनपद- चम्पावत

Drill hole no. DH-2 was drilled for 28 m depth, on the left abutment of the river at the middle portion along the proposed barrage axis. The hole revealed the presence of 5.0 meter thick overburden material comprising yellowish brown silty soil with clayey matter in the upper three meter and another two meter depth comprises boulder of hard phyllitic rock. The bed rock comprises hard and compact massive phyllites. This rock is slightly weathered upto 7 meter depth below which the rock is fresh. The dip of foliation / bedding planes varies from 50° to 60° core recovery ranges from 33 to 75%.

Drill hole no. DH-3 was drilled for 26 m, on the left abutment of the river at the upper middle portion along the proposed barrage axis. The hole revealed the presence of 4.0 meter thick overburden material comprising yellowish brown silty soil with clayey matter. The bed rock comprising hard and compact, jointed, phyllities. This rock is slightly weathered upto 6 meter depth below which the rock is fresh. The dip of foliation/bedding planes varies from 50° to 60° core recovery ranges from 30% to 60%.

Drill hole no. DH-4 was drilled for 27 m, on the left abutment at BB axis in the lower middle portion along the proposed barrage axis. The hole revealed the presence of 3.0 meter thick overburden material comprising yellowish brown silty soil with clayey matter. The bed rock comprises grey hard and compact, jointed, phyllites. This rock is moderately to slightly weathered upto 7 meter depth below which the rock is fresh. The dip of foliation/bedding planes varies from 50° to 60° core recovery ranges from 30% to 45%. A shear zone was interpreted between 21 m and 24 m depth on the basis of fine grey sludge.

Drill hole no. DH-5 was drilled for 27 m, on the left abutment at BB axis in the upper middle portion along the proposed barrage axis. The hole revealed the presence of 8.0 meter thick overburden material comprising yellowish brown silty soil with clayey matter. The bed rock comprises grey hard and compact, jointed, phyllites. Thick rock is moderately to slightly weathered from 8 meter to 16 meter depth below which the rock is fresh. The dip of foliation/bedding planes varies from 50° and 60° core recovery ranges from 16% to 28%. A shear zone was interpreted between 21.5 and 23 m depth on the basis of fin grey sludge.

Drill hole no. DH-6 was drilled for 15 m depth in the river bed portion on the A axis. The bed rock comprising grey, hard and compact, massive phyllites were met in the entire drilled depth. The dips of the bedding plane vary from 40° to 60°. The core recovery ranges from 18% to 48%.

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सहायक अभियन्ता प्रथम
सिंचाई उप खण्ड लोहाघाट
जनपद- चम्पावत

Drill hole no. DH-7 This hole was drilled on the extreme end on the left side of the dam axis. The hole was drilled for 26 meters and indicated 9 m thick overburden comprising reddish brown colored clayey silt with fine sand. Further from 9 m to 26 m bluish grey to grey, hard and compact phyllites were encountered. The initial 30 cm depth of Phyllite is moderately to slightly weathered thereafter the rock is fresh. The rock is moderately to closely jointed. The prominent joint plane is foliation joint dipping at 60°. The core recovery varies from 40% to 70% and RQD values are between. 9% and 40%.

Drill hole no. DH-8 This hole was drilled along the dam axis on the right bank. The hole was drilled for 26 m and indicated 2 m thick overburden comprising reddish brown silt/clayey silt. The bed rock comprises bluish grey to grey hard and compact phyllite. The Rock is rich in mica content and moderately to slightly weathered from 2 m to 11 m. The rock contains staining and coating of silt/soil along joint planes in the upper zone. The rock below 11 m depth is hard, compact and fresh. The rock is moderately to closely jointed. Foliation joints are the prominent joint planes. These foliation joints dip at 70° to 75° up to 17 m depth and below 17 m depth foliation joints dip ranges from 50°-60°. The core splits along the foliation joins. The other steep joint dips at 80° and is rough planer, was recorded between 20 m and 23 m depth. The core recovery is below 15% up to 17 m and beyond 17 m it is up to 35%. The RQD is between 5% and 25% only.

Drill hole no.DH-9 This hole was drilled in top portion along the proposed spillway alignment. The hole was drilled for 26 m depth and has indicated Bluish grey to grey, hard and compact phyllites. The rock is moderately weathered up to 15 m depth and slightly weathered from 15 m to 18 m depth, beyond 18 m the rock is fresh. Brownish colour in weathered rock zone and ferruginous coating along joint planes in fresh rock was also observed. The rock is closely jointed. The foliation dips varied 60° to 70°. The core at many places splits along foliation joint. The core recovery up to 15 m is below 20% and beyond this depth it is up to 38%. The RQD values ranges from 5% to 19% only.

Drill hole no. DH-10 This hole was drilled in the middle portion along the proposed spillway alignment. The hole was drilled for 26 m depth and indicated 2 m thick overburden comprising clayey silt with fine sand. Bluish grey to grey, hard and compact, phyllites were encountered in the entire depth. The rock is slightly weathered up to 18 m depth and contains high degree of ferruginous staining/coating. Fresh rock with fine grained and at times slat...

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सहायक अभियन्ता प्रथम
सिंचाई उप खण्ड लोहाघाट
जनपद - चम्पावत

nature was encountered from 18 m depth onwards. The core recovery is below 20% up to 24 m depth and in the last two meter zone it was 49%. The RQD values were below 15% only.

Drill hole no. DH-11 This hole was suggested by the design engineers. The hole was drilled for 2 m depth only. The hole has indicated 5 m deep overburden comprising reddish, brown clayey silt with fine sand. The bed rock was encountered below 5 m depth. In the top one meter zone the rock is hard, compact, flaggy quartzitic phyllites, below this grey to bluish grey, hard and compact phyllites with quartz vein up to 2 cm thick were encountered, The rock is slightly weathered up to 8 m depth below this rock is fresh distortion of the foliation planes due to intrusion of quartz veins was noted in the cores. Pyrite specks were also observed in some core pieces. The foliation joints dipping around 70° are prominent one. The core recovery varies from 18% to 45% and RQD values were below 20%.

2.6 CONCLUSIONS

The preliminary analysis of the drilling data indicate that the overburden thickness ranges from 4 to 5 meters and 2 to 4 meter weathered rock zone above the fresh bed rock along A axis on the left abutment. The overburden thickness on the left abutment along B axis varies from 3 meter to 8 meters and 4 meter to 8 meter weathered rock zone lies on the fresh bed rock and a shear zone was also interpreted between 21 meter and 24 meter depth. In the river bed section around axis-A, hard fresh bed rock was encountered from the start of the hole.

On the basis of the present subsurface data axis-A appears to be more suitable for weir as the fresh bed rock on the left abutment will be available at 7 to 9 meter depth in comparison to axis-B where it will be available between 7 to 16 meter depth. From engineering point of view the civil design engineers should also evaluate the site after physical inspection. If found suitable from engineering side also if further required exploring over burden and weathered rock thickness on the left abutment extreme end portion by one drill hole. Right abutment and spillway structure on the right side also required to be explored by three drill holes. The location of the holes have been shown to the project engineers at site as well as also marked on the contour plan.

सहायक अभियन्ता प्रथम
सिंचाई उप खण्ड लोहाघाट
जनपद- चम्पावत

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सहायक अभियन्ता प्रथम
सिंचाई उप खण्ड लोहाघाट
जनपद- चम्पावत

अधिशासी अभियन्ता
सिंचाई खण्ड लोहाघाट