A Modern Approach in Preparation of Detailed Project Report

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Abstract

Detailed Project Report (DPR) is a statutory requirement for construction of any hydro electric project. The Survey and Investigation are the critical activities for the preparation of DPR. This paper analyses what is the structure of the detailed project report and how it is to be prepared. The extent and amount of geological investigations to be taken up and method of geological data collection and its limitations are also discussed broadly. This paper tries to address the grey areas and various constraints faced by the agencies entrusted for preparation of DPR. At this stage, dependable DPR is converted into Bankable DPR, which in other words gives tacit assurance to the investor of the project being completed within stipulated time and estimated cost without affecting environment. The paper summarizes the need for a dependable and bankable DPR. The author synthesizes the experience obtained in preparing DPR's in NHPC and confidence gained in comparing the anticipated and encountered geological conditions in terms of rock classes for those projects.

1. Introduction:

Detailed Project Report is a statutory requirement of construction of any hydro electric project. It is a key in decision making process for the developers and financiers. It provides a cursory view of business module, methodology and finance. Techno-economic feasibility of the project is evaluated by the central governmental agencies that are practicing and implementing the regulations on technical, economical, social and environmental aspects. Truthful representation, reproduction of details/ information in DPR is need of the hour. If DPR is prepared faithfully and details are recorded religiously the question of dependability does not arise. The survey and investigation are the critical activity for the preparation of detailed project report. The paper discusses preparation of the detailed project report and how this can be made dependable in turn bankable.

2. DPR- Concept:

Detailed project report is the compilation of all data / information about the terrain, seismic history, construction planning, methodology, ecology, environment and cost of a project (hydroelectric scheme). DPR is the realistic assessment / estimation of these details to the nearest possible accuracy.
The DPR of hydro electric schemes are required to be submitted to the Authority (CEA) for concurrence in compliance with the requirement of section 8 of the Electricity Act

2003, shall be formulated by generating company/project developer as per the guidelines laid down by the Authority considering the following:

The hydroelectric scheme aims at best ultimate development of the river basin.
The scheme is designed for optimum benefits and does not adversely affect the operation of the u/s and d/s hydro schemes and takes into consideration the impact of the future u/s and d/s development in the river basin identified at the state and central levels.
The hydro electric scheme is consistent with water requirement for drinking water, irrigation, navigation, flood control or other public purposes.
The hydro electric scheme takes into account the progressive development of consumptive use of water and new water resources development schemes in the river basin due to which the water availability may undergo change over the period.
The hydro electric scheme meets the norms regarding dam design and dam safety.
The hydro electric scheme meets the requirement of optimum location of dams and other river works.
The hydro electric scheme is either included in National Electricity Plan drawn by the Authority under Section 3 (4) of the Act or results in generation of power at reasonable tariff.
The DPR is prepared after essential site surveys and investigations are completed.

3. Format of DPR:

The CEA has formulated different chapters to be included in the Detailed Project Reports. However, the details of survey and investigation and civil engineering aspects of the chapters are to be referred with the CWC guidelines for preparation of DPR of Irrigation and multipurpose project. DPR prepared by the generating company shall be structured in the format as follows:

Chapter I	Introduction
Chapter II	Justification of project from power supply angle
Chapter III	Basin development
Chapter IV	Inter state/ International aspects
Chapter V	Survey & Investigation
Chapter VI	Hydrology
Chapter VII	Reservoir
Chapter VIII	Power potential & installed capacity
Chapter IX	Design of civil structures
Chapter X	Electrical and mechanical designs
Chapter XI	Transmission of power and communication facilities
Chapter XII	Construction programme & plant planning
Chapter XIII	Project organization
Chapter XIV	Infrastructural facilities
Chapter XV	Environmental & ecological aspects.
Chapter XVI	Cost Estimates

Chapter XVII	Allocation of cost
Chapter XVIII	Economic Evaluation
Chapter XIX	Future utilization of buildings.
Chapter XX	Recommendations
Chapter XXI	Clearances/Inputs

For the convenience of the agencies entrusted for preparing the DPR, these chapters are classified and amalgamated into different volumes depending upon the area of specialization. Depending upon the area of interest NHPC makes five volumes of detailed project reports. They are:

Volume I	Engineering
Volume II	Cost Estimates & Project Planning
Volume III	Hydrology
Volume IV	Site investigation & Geology
Volume V	Construction material

In addition to the above, sixth volume- Executive summary is also prepared encompassing the gist of all the volumes for quick look analysis. In this paper, the author restricts to his observations, comments, explanations and experiences only to Site investigations & Geology volume of the DPR. The various information to be included in Geology volume of the DPR has been broadly outlined by CEA. They are

Mineral surveys in the catchment area.
Geology and geotechnical features
Seismicity
Foundation investigations of different structures /components of the project indicating borehole details soil & rock strata.
Construction material investigation.

4. Bankable DPR:

Since independence hydro schemes are being conceived and developed by state and central government agencies because of huge initial investment of capital cost and also due to other administrative environmental constraints. In the last decade, with advent of hydro policy, private developers have shown keen interest in taking up these hydro electric projects. Past records show that barring few projects many of the hydro schemes are running into time and cost overrun. There is a huge financial burden on the private developer due to delay in completion of the project in turn escalation of generation cost. A detailed project report is deemed to be dependable and bankable if all activities and factors involved in completion of the project are estimated and assessed well to the nearest possible limits. The concept of Bankable DPR gets into prominence due to these delays. At this stage dependable DPR gets converted into bankable DPR. BIS code suggests that bankable DPR should be prepared only after completing the detailed investigation/explorations and no scope of further investigation should be left and the project layout must be taken as final. The government agencies like CWC, CEA, GSI, and NHPC have formulated guidelines /standards for surface and subsurface investigation

explorations for various structures of the project for preparation of the DPR. Some of the explorations given in certain guideline are broadly outlined. In some other guideline these same standards are discussed in detail. NHPC has issued guideline for geological & geotechnical explorations of hydroelectric projects in Jan 2007 exclusively for internal circulation only. CWC under Ministry of Water Resources has published guidelines for preparation of detailed project report of Irrigation & multipurpose projects in 2010. CEA has given the guidelines for formulation of detailed project reports for hydroelectric schemes, their acceptance and examination for concurrence in Jan 2011 (Revision 2.0). Engineering project evaluation division of GSI has issued guidelines for investigations and explorations required at detailed project report (DPR) stage of proposed hydroelectric projects; in Himalayan terrain. BIS has published 28 nos. of standard for geological investigation and sub surface explorations for river valley projects. The scope of these above standards includes standardization of criteria for choice of methods, investigations and testing of sub surface strata and recommendations for collection and presentation of data. These standards are code of practices for preparation of maps, drilling, drifting and permeability testing mainly for dam power house and reservoir area for river valley projects. Only last year, with the increasing geological problems and uncertainties experienced in river valley projects, BIS was compelled to draft a code of practice for exploration of tunnels. Even in these standards and guidelines there are gaps and anomalies. There is no uniformity in these guidelines issued by these agencies. It is advisable to follow standards issued by BIS wherein the procedures for different tests, methods and investigations have almost discussed adequately. However wherever necessary for detailed geological investigation /exploration the GSI guideline may also be referred. There is an urgent need to standardize these procedures and all the agencies should follow the same for preparation of DPR. DPR becomes dependable and bankable once the same guidelines are followed and adopted by all the developing agencies in preparing the DPR. This in turn will also be reasonably acceptable to financial institutes/banks too. Bankable DPR should instill confidence to the developers as well as financial institutes that the adequate surface and sub surface data have been incorporated to arrive at a design where there is little scope for any uncertainty and variability. In order to make the DPR bankable, all the regulating agencies to draft a uniform investigation / exploration programmes removing all grey areas. To avoid and minimize any surprises during construction, suitable provisions to be provided in the design and construction methodology. Bankable DPR in other words gives tacit assurance to the investor of the project being completed within stipulated time and estimated cost without affecting environment.

5. Constraints in Subsurface Investigations:

Any detailed project report is considered to be redundant if time and cost are exceeding than the estimated assessment level. Unforeseen geological conditions only cannot be blamed for all those cost and time overruns. The important role played by the geological and geotechnical studies are seldom given due attention and realized. In most of the cases the survey and investigation have been hurriedly done in some other cases the budgetary allocation of these investigations has been diverted to other facilities. In turn, the survey and investigation suffers with paucity of funds and within the available resources the

entire gamut of investigation need to be carried out. Even less than 1% of the total cost of the project has been spent on survey and investigations. Ideal and reasonable cost of the investigation should be at least 3% of the total project cost. Considering the CEA benchmark of 10 years for completion of projects, some of the projects were running behind the schedule data of commercial operation by 20 months to 115 months as per CAG report No 10. Of 2012-13 on Capacity expansion in hydro power sector by CPSE's. In the same report, it is stated that the cost overrun was in the range of 53 to 148 percent in some of the projects.

The subsurface investigations pose great challenge to geologists and engineers as a whole. Almost all types of geodata collection require some degree of extrapolation with projection from the known to the unknown (Piteau, 1973). The geological information / interpretation involve certain amount of extrapolation. The output of these explorations depends upon the geological complexity and experience of the geologist associated with the assignment. There is no guarantee that any given geological studies will provide sufficient information for subsurface geological condition. Simple and uniform geology will require less investigation and complex geology with complex layout may warrant extensive exploration. Along the tunnel alignment, it is not economical to drill sufficient no of boreholes or execute sufficient no of explorations. Even in the simplest tunneling job, geological unpredictability will not be ruled out. In view of the restricted amount of investigation usually practicable along tunnel alignment the occurrence of unforeseen difficulties is not uncommon. Uncertainty is an inherent feature of Nature. Therefore understanding and appropriate handling of uncertainties should be part of all future geological investigations. Judicial planning for subsurface exploration programme is to be done to avoid any uncertainties. The main constraints in sub surface investigations / explorations are accessibility, availability of experienced manpower, absence of realistic exploration programmes, time allotted for explorations, budgetary provision.

6. Geological Data Collection:

The geological map is an artistic expression of geologic features, rock types, and geological structures on topographical plan. The geological map uses different lines, symbols for different formations and structures. These geological details needed for engineers are to be converted for engineering application. There is no acceptable substitute of the field mapping and core logging carried out by experienced engineering geologist (Hoek, 1986). The geo data collection is based on observation either on sporadic outcrops on the tunnel surfaces or drill cores. For various reasons, the simple observation made on the surface provides the most reliable data of rock mass parameters (Bieniawski, 1984). When the visible parts of joint traces are limited, detailed and complete observation will be difficult. Joints at a distance from the exposed rock surfaces cannot be directly observed. Visual observation has some limited accuracy. Error from the geological variability can never be avoided it can however be reduced by the use of well experienced geologists with extensive knowledge of the geology of the region, and also by directing specific appropriate investigation towards possible key geologic structures that may occur (A. Palmstrom). If geologists do not provide relevant guidance on geologically sensitive formations, the engineers will be forced to treat geology as a

completely random or unnecessary variable and rely on quantitative field and laboratory test results as an alternative for geology. Hence it is important to record and document any features which may be of geological interest and same should be shared with design engineers. No one is able to see the unseen sub surface geology unless explored extensively and religiously. The geological data collection starts with faithful geological mapping from available outcrops, intelligent interpretation of the drill cores correlated with events associated with drilling activity and painstaking recording of geologically sensitive data from the drifts / adits. Evolving a geological model from the collected information is the culmination of geologist's pursuit of data collection.

7. DPR-Preparation:

In recent years, with the influx of private developers in this industry, preparation of DPR becomes a formality. It is observed that the few developers for various reasons entrust the job of preparation of DPR to other agency. The agency preparing the DPR is found to have a geologist who has having little experience in making these geological and geotechnical reports. Incomplete and inaccurate geotechnical site characterization can lead to selection of incorrect geological model, geotechnical properties and design values. Before preparation of the DPR the following need to be kept in mind:

Geological setting of the project site
The geologist should understand the philosophy of the project layout,
Engineering consideration of the selection of the project,
The language of the engineers should be understood by the geologists
Conceiving a geological model
Within the geological model sources of uncertainty should be identified.DPR preparation involves three stages. The DPR with reference to geology is discussed in the following paragraphs.
Reconnaissance.
Preliminary investigation.
Detailed investigation.

Reconnaissance is the collection of basic data such as published reports, maps, satellite imageries, regional geological, geomorphological studies with tectonic settings. (Hydrometerological data, land and submergence data are also collected in this stage) These studies are followed by preparation of topographical contour plan, traverses and identifying probable alternative sites for preliminary investigations and explorations.

Preliminary investigation comprises of surface and sub surface explorations on the probable and prospective sites identified in the reconnaissance stage. The geological and geotechnical mapping are required to be carried out. These maps should illustrate the locations of sub surface explorations pits, trenches, drilling and drifting. Seismic evaluation studies should be initiated in this stage.

Detailed investigation is a confirmatory investigation where the preferred site is being investigated and explored further with preparation of interpreted geological and geotechnical maps (The details of overburden properties and its disposition are to be elaborated. The different lithological units and its strength characteristics are to be derived from lab and insitu rock mechanic and soil mechanic tests). Drill holes and drifts at different levels and locations are to be carried out for confirmatory investigations. Geophysical studies such as seismic and resistivity etc are also to be conducted at locations where drill hole data is insufficient. Geological model should be evolved by combining all these results. In this stage interaction of design engineers is a must for firming up of layout and identifying the grey areas for further explorations.

8. Experience of NHPC:

In NHPC, with experiences of preparing 50 nos of DPRs so far, the information given in the geology volume is considered to be more informative and exhaustive. Though there are no standard cook book solutions to the amount of investigations and explorations that should be carried out the different government agencies have drafted few guidelines in surface and subsurface investigation programmes. NHPC, initial three decades of its existence and association with oversees expertise in some of the projects, has practiced international standards and guidelines in investigation and exploration techniques in addition to BIS codes of practices. In Jan 2007, NHPC felt the need to formulate its own standards and guidelines. NHPC was one of the pioneer government agencies which has issued guidelines for geological and geotechnical investigations/explorations for river valley projects. This standard was issued exclusively for internal circulation. The confidence level of NHPC has increased to that standard where there is no or negligible variation exist between predicted and encountered geological conditions of the projects for which DPRs have been prepared by NHPC. NHPC is practicing and implementing CSIR, RMR rock mass classification system wherein five rock classes in percentages are identified. Few examples of the completed DPRs of NHPC are cited below, where the anticipated rock classes are comparable with the encountered rock classes (Table 1).

Table 1
Comparison rock classes from predicted and encountered

S No.	Project	Predicted rock class %					Encountered rock class %				
		I	II	III	IV	V	I	II	III	IV	V
1	Sewa II	0	21	71	8	0	0.2	54	38	7.8	0
2.	Parbati III	0	24	47	24.3	4.7	0	12.1	64.8	21	2.1
3.	Dhauliganga	5	55	20	15	5	0.85	73.87	25.28	0	0
4.	Uri II	0	15	50	25	10	0	30	66	4	0
5.	Chamera III	0	61	20	9.5	9.5	0	52	47	0.007	0.3
6.	Chutak	0	40	40	15	5	0.3	77.9	20.2	1.6	0
7.	Teesta V		74.28		25.72			76.77		23.23	

In this table, poor to very poor rock mass condition representing the rock class IV & V are found to be less than the predicted or remain more or less same. The good and fair rock mass condition corresponding to rock class II & III observed to be interchanging thereby appreciating better geotechnical conditions. The above illustration is a testimony to NHPC's credential as a pioneer in this field of activity.

9. Conclusion:

The author attempts to outline broadly the geo data collection and constraints in subsurface investigations. Preparation of detailed project report is critical activity in any hydro electric project because the results of the report have direct impact on the time and cost of the project. Hence the inputs of the report need to be religiously recorded and documented. The output of the report makes any project viable or unviable. Tiny fraction of the details regarding geological data collection and preparation of DPR has been attempted by the author for holistic view of the subject. However, the detailed project report can be made dependable and bankable if the following factors are taken into account faithfully.

Employ a senior experienced engineering geologist to optimize the testing programme.
Full disclosure/ transparent policy to be adopted.
Sources of uncertainty to be discussed.
Adequate fund for sub surface explorations.
Allocate sufficient time to complete the investigations.
Motivation and justification in conducting investigations.

References:

1. CWC guidelines for preparation of detailed project report of Irrigation & multipurpose projects in 2010.
2. CEA guidelines for formulation of Detailed Project Reports for hydroelectric schemes, their acceptance and examination for concurrence in Jan'2011 (Revision 2.0).
3. GSI's guidelines for investigations and explorations required at detailed project report (DPR) stage of proposed hydroelectric projects, in Himalayan terrain.
4. Various codes related to surface and sub surface explorations in river valley projects - Bureau of Indian Standard Codes.
5. NHPC's guidelines for geological & geotechnical explorations of hydroelectric projects in Jan'2007.
6. Palmstrom, A. Collection of Geo-data- Limitations and uncertainties.
7. Baynes, F.J. Sources of Geotechnical risks.
8. Hoek & Palmerie, Geotechnical risks in large civil engineering projects.
9. Rawlings, G. E. The role of the Engineering Geologist during construction.
10. Keaton, Jeffrey R. Engineering geology: Fundamental Input or Random Variable?
11. Hoek, Evert. Putting numbers to geology – An Engineer's view point.