QUALITY IMPROVEMET IN TECHNICAL EDUCATION FOR SUSTAINABLE HYDRO-POWER DEVELOPMENT IN INDIA

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INTRODUCTION

India is endowed with an enormous hydro-power potential of 84,000 MW at 60% load factor. With addition of pumped storage schemes, an additional potential of 60,000 MW is going to be added. Development of hydro-power is needed for our energy security. It is a renewable, economic and non-polluting source of energy. Because of high flexibility of operation, it has been universally accepted that the share of hydro-power in the total power supply through energy grids should be about 40%. Unfortunately, the percentage share of hydro-power has gradually reduced over the years to about 26% only at the end of 10^{th} five year plan when hydro-power developed in our country was only 36,654 MW out of total power supply of 1, 32,330 MW which includes thermal, nuclear, hydro and other renewable sources of energy like wind, tidal, solar, hydrogen, geo-thermal etc. (CBIP, 2010).
The objective of writing this paper is to focus on the different challenges in hydro-power development and stress on the need for quality improvement of technical education to meet those challenges for sustainable hydro-power development in India.

TYPES OF HYDO-POWER DEVELOPMENT

Based on Head and Discharge

In all hydro – power projects, input is water which is equivalent to fuel in thermal or nuclear plants. Power (P) in kw may be expressed in terms of flow rate (Q in cumec) and head (H in meter) as

$$\mathbf{P = 9.83\eta_o}\ QH$$

where η_o is the overall efficiency of turbines installed for generation of hydro-power. It is apparent that the power is proportional to both flow rate (Q) and head (H) of the plant. Based on the availability of flow and head, the hydro-electric developments may be classified as under :

a) **High flow and high head development:** in big rivers with storage dams-usually with Pelton type or Francis type turbines
b) **High flow low head development:** in barrages & weirs on big rivers-with Kaplan/Bulb type turbines
c) **Low flow high head development**: in small and medium streams in mountainous regions with remote installations/diversion schemes-with Pelton/Francis type turbines depending on head.
d) **Low flow low head development:** as in canal drop development with bulb and tubular type turbines.

Run-off the river type development: where the storage is insignificant mostly with low.head weirs/barrages for flow diversion in power canals/conduits.
Storage plants: where storage is built by constructing a dam on the river like Bhakra Dam.
Remote installations: where water is conveyed/diverted through canals/tunnels at a down stream point for utilizing the fall in the bed level of the stream as in case of Naptha – Jhakri project.

Underground Installations: hydro-electric plant and all other units lie fully underground so that the plant is safe from enemy's attack during any warfare like Chibro Hydel scheme.
Pumped-Storage Schemes: during night when demand is low, water stored in between an upstream dam and a downstream barrage/dam is pumped back in to the upstream reservoir by means of pump-turbines (working in pump mode during night) to fill in the storage which is released during peak demand through the pump-turbines (working in turbine mode during peak demand period).

CHALLENGES IN HYDRO-POWER DEVELOPMENT

Most of the hydro-power sources lie in the hilly and mountainous terrains which are highly inaccessible. Gestation period for hydro-electric development is very high due to enormous time required (5-10 years or more) for building infrastructures for accessibility to the site ad also due to slow rate of tunneling. Uncertainty in water yield of the catchment due to uncertainties in precipitation (both rainfall and snow) poses difficult problem and complexity in making water potential study needed for making economic analysis. Complex geological formations in the Himalayan region, where most of the hydro-potential source exists in our country, pose serious challenges in construction due to the nature of geology and geological surprises. The other challenges are due to (i) land acquisition (ii) relief and rehabilitation of project affected people (iii) impact on environment and forest (iv) impact on fish and other aquatic life (v) availability of skilled manpower (vi) contractual problems during project execution in difficult and hostile terrain etc.

PLANNING, DESIGN AND CONSTRUCTION PROBLEMS

For proper planning, design and construction of hydro-power projects, extensive site investigations are to be carried out and a large volume of data are to be collected from site for preparing feasibility and project reports. Where stream flow and sediment data are not available at the project site for at least 15 to 20 consecutive years, data available from adjoining hydro-meteorologically similar basins (if available) are to be utilized for predicting dependable flow and spillway capacity, flow diversion etc. Unlike other conventional projects, hydro-power projects are interdisciplinary and highly specialized in nature requiring expert inputs from qualified and experienced persons in the areas of

(i) **Civil engineering**: with specialization in subjects e.g. surveying, hydrology, hydraulics, river mechanics and sediment transport, structures, geo-technical engineering and rock mechanics, construction technology etc
(ii) **Mechanical engineering**: with specialization in subjects e.g. fluid mechanics and hydraulic machines, valves, gates and control instruments like governors, welding, drilling and blasting etc.
(iii) **Electrical engineering**: with specialization in generators, transformers, transmission, control systems etc.
(iv) **Environmental engineering**: with specialization in impact assessment, ecology etc
(v) **Geology and geo-physics**: with knowledge in tunneling, foundations and materials etc.

Deep knowledge and expertise are needed in the above disciplines in engineering and technology for proper planning, design, construction, operation and maintenance of different units of any hydro-power project e.g.

(a)**Dams/barrages/cofferdams:** for Storage and flow diversion
(b)**Headrace/Tailrace channels/tunnels:** for transporting water
(c)**Desilting and sediment flushing units:** for removal of sediments
(d)**Spillway/Energy Dissipation:** for disposal of floods
(e)**Penstocks/surge tanks:** water conductor/ control of water hammer and flow as per demand
(f)**Powerhouse/turbines/draft tubes:** for housing generators/ prime mover/ flow diffusion
(g) **Generators/transformers:** for power generation/ voltage step up or step down
(i) **Power supply/Transmission/power electronics:** for transmission of power and control

Further details about the planning, design, construction and operation of these components are available in Brown (1958), Mosoyni (1966), Barrows (1999), Nigam (2000), Dandekar(2002).

NEED FOR QUALITY IMPROVEMENT IN TECHNICAL EDUCATION

It is apparent from above that highly qualified and experienced manpower is needed to address the various challenges and problems in hydro-power development. In fact, hydro-power should be introduced as a separate post-graduate (PG) course. In some institutes (like IITs), hydro-power is offered as an elective subject at undergraduate level or as one of the subjects in the post-graduate curricula. Post graduate course in hydro-power is taught in the department of water resources development and management, IIT (Roorkee) formerly known as WRDTC which was earlier under the control of Ministry of Water Resources, Govt. of India, before its merger with IIT(R) under the Ministry of Human Resource Deveopment. At IIT (Roorkee), there is also a training center (Alternate hydro) for in service engineers.

Present status of post-graduate teaching and research in India is highly unsatisfactory due to a number of reasons explained earlier by Mazumder (2007a, 2008). Main problem is non-availability of teaching and technical staff with appropriate qualifications and field experience and lack of other infrastructures e.g. laboratory, research and training facilities etc. Teaching, design, laboratory and field training, research and project guidance etc. at PG-level need a great deal of co-operation and inter-institute collaboration (Mazumder, 2007b).

In our country, we have encouraged mushroom growth of degree-level engineering institutions whose products are not up to the mark-especially those from majority of private institutions which are affiliated to nearby universities/deemed-to-be universities which have very little control in academic, financial and administrative matters of these colleges . Performance of most of these colleges and affiliating type universities/deemed to be universities - run on commercial basis- is highly deplorable since their primary motive is to make profit. These colleges and universities/deemed to be universities can never be developed by so called contractual teachers, retired old faculty members and guest faculty which comprise majority of the teaching staff. Running hundreds of engineering colleges in and around a city as in India to-day is unheard of in any developed country in the world. Under the existing environment in most of our engineering institutions, no worthy person is going to join them as a teacher and take initiative for developing post-graduate education and research program e.g. hydro-power development. There is a big vacuum in higher engineering education and research activities which really act as a nucleus for all other developmental activities. Unless the present system changes, we will remain ever dependent on foreign universities as far as higher education and research in engineering are concerned.

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