

JAL/PHPA II/DAM/C-1/2016/.....<sup>21518</sup>  
March 14, 2016

**TO WHOM SO EVER IT MAY CONCERN**

**SUB: Execution of the work of Permeation Grouting beneath Upstream Cofferdam of the Punatsangchhu II Hydroelectric Project located in Wangdue, Bhutan.**

It is certified that M/s BAUER Spezialtiefbau GmbH, Registered office at BAUER Strass 1, 86522 Schrobenhausen, Germany, have executed the work of seepage barrier with Permeation Grouting for the upstream Cofferdam of Punatsangchhu-II Hydroelectric Project located on the river Punatsangchhu in Wangdue District of central Bhutan as a subcontractor to the main Contractor M/s Jaiprakash Associates Limited and for the principle employer Punatsangchhu II Hydroelectric Project Authority (PHPA II).

M/s BAUER were engaged by M/s Jaiprakash Associates Limited, for the work of seepage barrier with Permeation Grouting in the overburden and the river sediments beneath upstream Cofferdam of Punatsangchhu II Hydroelectric Project built on the Punatsangchhu River for the purpose to prevent the seepage in the main dam pit during its construction.

M/s BAUER were able, together with M/S JAL & PHPA II to optimize in a combination of chemical and cement grout to ensure sufficient water tightness of the heterogeneous strata beneath the Cofferdam. The design approach and the most of the technical details were prepared by the experts of Bauer's head office in Schrobenhausen, Germany.

The work of Permeation Grouting consisted of drilling 1,125 small diameter holes (133mm) up to the bed rock level and penetration of rock by 2 m and installing sleeve tubes 50 mm in diameter which are sealed by annular grout (sleeve Mix) into the drilled hole, then finally injection of grout under pressure between packers through the rubber sleeve valves through ports at 0.5 m intervals from bottom to top of the tube. Three grout rows were used to form the Permeation Grouting curtain wall. Cement grouts (cement +Bentonite) were used for the outer rows and the Gel Grouts (Sodium Silicates +Hardener) were used for the inner row.

A total of approximately 4,500 sqm of curtain wall was created. On Mobilisation of equipments the works started on 20<sup>th</sup> May 2014 and were completed on 14<sup>th</sup> July 2015 as per schedule.

At the peak times M/s BAUER had engaged up to 15 skilled expat employees on the site in day and night shifts in addition to the approx. 45 local semi-

skilled workers to work and to ensure quality standards. It is to mention, that during the execution of all construction works, M/s BAUER's representatives on site had the full technical and logistical support in order to complete the project with high ranks on quality and performance.

M/s BAUER were equipped with all professional ways for the team preparedness and work execution and proactive in seeking a quick solutions for the site issues, maintaining highest standards of quality for the product and the professional approach towards health, safety and environment (HSE) was excellent.

**Description of Geology:-**

The Punatsangchu Valley has no slope waste in the area of the very steep shores. It slopes in parts with an angle of up to 80 degrees towards the existing river bed. The shore on the right bank has more moderate slopes. There are also a large scale colluvial slope overburdens, as well as river sediments. The soil material is very heterogeneous. The existing rock in the valley bottom also varies both in its course and its strength.

The project was executed within the agreed schedule. It has been observed during the execution of excavation in the main dam pit that the seepage barrier is effective and has successfully arrested the seepage in the excavated pit.

**FOR JAIPRAKASH ASSOCIATES LIMITED**



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14.3.16

**(K.K. Sood)**  
**Project Manager**