Site report

# Railway connection for Tibet – concrete pump operates at 5,000 m altitude

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Somewhere on a plateau in Tibet: another track section between Golmud and Lhasa is finished

**Plans for the construction of a railway line in western China to Tibet were supported by Chinese politicians like Mao Ze Dong and Chou En Lai as early as 40 years ago. Since then the first segment of the Qinghai-Tibet railway line, 846 km long between Xining und Golmud (constructed 1958 – 1979), has been in operation for a long time. Further construction on the mammoth project was repeatedly interrupted during the 60s and 70s due to railway worker health problems, technical problems caused by permafrost and financial constraints. Construction of the remaining stretch of line, between Golmud and Lhasa, has now been resumed from both ends since June of 2001. Since more than 85 % of the route lies within an altitude range of between 4,000 and almost 5,100 m, the hardships imposed on men and machines are unbelievable. Even a PM truck-mounted concrete pump, type BSF 36.09, is keeping pace at heights of 5,000 m.**

The line's total length of 1,118 km traverses the Kunlun and Tanggula mountain ranges and passes through the cities Yushu, Haixi and Tuotuo Heyan. Overall, 286 bridges as well as tunnels with a combined length of 30 km must be built. However, from an engineering point of view the structures themselves are not nearly as challenging as the extreme heights at which the route is being built. The majority of the stretch passes through regions at altitudes between 4,000 and almost 5,100 m such that railway workers' ability to work and their stamina is noticeably limited. As an example of these difficulties, 160 km of the route lies at heights between 4,000 and 4,500 m and one 780 km section of the route must be laid at heights between 4,500 and 5,000 m. And there are even tunnels at these heights! The 1,338 m long Fenghuoshan tunnel, completed in



## Political and economic significance

The construction of the Qinghai-Tibet rail connection is one of the key projects in China's tenth five-year plan (2001 – 2005). This new route has immense political, military and economic significance for the People's Republic. From a political viewpoint, it will tie Tibet at the far western end of China much closer to the central government in Peking. This enhancement to the infrastructure will most surely make a marked improvement to commerce and the economy as an increased volume of freight movement is considered a certainty. The construction of a railway line under these extreme conditions at the top of the world is an act that just demands the respect of everyone.

The line between Golmud and Lhasa was officially opened up in July 2006.

Tunnels are built at altitudes of up to 4,905 m


A concrete mixing station along the line with a capacity of 2 x 50 m³/h. One of the biggest problems when constructing the Tibet railway is the lack of water.

**The Putzmeister Group**
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October of 2002, is at an altitude of 4,905 m. As if this were not enough – 20 km of the railway line are to be built above the 5,000 metre mark! At 5,072 m, Tanggula pass represents the highest point along the route of the Tibet railway.

According to official sources, this project continuously employs 67,000 workers and technicians. Another 16,000 seasonal workers are engaged in addition to the permanent personnel. It is almost unbelievable that hard physical work can be performed at all under these extreme conditions. The thin atmosphere makes frequent breaks an absolute necessity. Chinese newspapers emphasise the exemplary medical attention provided to the workers along the stretch. Because of the thin atmosphere at heights over 4,000 m, the daily exertion of a railway worker only amounts to a 2 hour effort under normal conditions. Despite medical examinations in advance, many workers cannot acclimate themselves to these hostile surroundings and are forced to give up after only a brief period of time. Pay scales for the Chinese and Tibetan railway workers here at the top of the world are about twice what they are for their colleagues at lower, „normal" construction sites.

## Still 30 m³/h delivery output at 5,000 m heights

PM truck-mounted concrete pumps are also utilised at individual construction lots, e.g. this BSF 36.09 that Putzmeister delivered to the construction firm CHINA RAILWAY CO. BUREAU NO. 3. This machine has a 36 metre, Z-folding boom as well as a pump unit capable of pumping up to 90 m³/h. A VOLVO FM7 serves as the carrier chassis, which is certainly not over-powered with its 228 kW turbo-diesel.

When some of these pictures were made, the Putzmeister M 36 was being used on a plateau in the Kunlun massif at altitudes between 4,800 and 5,000 m for work including concrete work on the track sub-structure of the Qinghai-Tibet railway. Because of the thin atmosphere, the vehicle's diesel motor is not capable of developing anywhere near its full power at these heights. A rule of thumb dictates de-rating power by 10 % for every 1,000 m of altitude – losses are less for modern, turbo-charged diesel motors. Certainly this drop in power also affects the delivery output of the concrete pump. The reduced static pressure on the concrete in the hopper also degrades the concrete pump's intake behaviour (see table). Despite this combination of environmental influences and logistics problems, the BSF 36.09 is still able to develop a pump performance of up to 30 m³/h.

| Altitude (m) | Air pressure in accordance with international altitude formula (mbar) |
|---|---|
| 0 | 1013 |
| 1,000 | 899 |
| 2,000 | 795 |
| 3,000 | 701 |
| 4,000 | 616 |
| 5,000 | 540 |
| 6,000 | 471 |

Aggregates with 50 mm maximum particle size are simply expected of the Putzmeister M 36 concrete pump (boom delivery line 125 mm)


Even the two M 36 machine operators, Wang and Gong (right), hang in there

Partially due to the acute lack of water on this barren plateau, the concrete output of mixer units has proven to be much more of a problem than the reduced performance of the concrete pump. There are also difficulties in the classification of concrete aggregate and in maintaining the desired grading curve. Aggregate frequently contains maximum-size particles of between 40 and 50 mm, concrete batches typically exhibit a slump size of about 13 cm.

## Recuperating in an oxygen tent

The M 36 Putzmeister is operated by two machinists. Pump unit drivers live with the other railway workers in large tent camps that are equipped with powerful oxygen systems. Strong emphasis is placed on supplying workers with fresh fruit and vegetables. Clean drinking water is brought up to the camps by trucks which are underway for hours to reach their destinations. According to a service technician for the Chinese PM subsidiary who visited the construction site to perform maintenance work, these machinists have no fixed working hours. Instead, they work only as long as they feel physically up to the job. However, they must frequently be relieved by a colleague after only an hour or so because of the continuous lack of oxygen.

## Permafrost obstructs construction

Permafrost is another fundamental problem, i.e. rock, gravel and soil are frozen as deep as 5 m down. During summer months the uppermost surfaces do thaw but as soon as the ice turns to water the problems become bigger than ever. Everything that was just built begins to swim in the soft quagmire. Severe landslides are a frequent occurrence. Russian experts who have gained permafrost experience in the construction of the eastern Siberian Baikal-Amur-Magistrale (BAM) can only give a limited amount of advice. This is because the great heights of Tibet allow the sun's radiation to be much more intense than further north in Siberia. This means that the surface thaws much deeper in the summer to cause individual construction sections enormous problems.

## Sandstorms, frost and earthquakes

Weather conditions are similarly extreme. Windstorms and sandstorms blow with at least category 8 wind-force on about 100 days of the year. Most workers on the job are helplessly exposed to these hazardous weather conditions, there isn't even any vegetation about to afford some protection. Outside temperatures are below 0 °C on 200 days of the year. About half of the stretch passes through areas which are endangered by earthquakes. Earthquakes in the range of 7 to 9 on the Richter scale have been registered here.

Whereas cars and trucks require about three days for the trip from Golmud to Lhasa on the single existing overland road, planners expect that freight trains will be able to cover the distance in 24 hours and passenger trains in as little as 18 hours. When the Qinghai-Tibet railway is completed, passenger train-cars are slated to be equipped with pressurised cabins like in an airplane. Onboard oxygen masks will be available as will medical personnel who accompany the trains. Since the route will not be electrified initially, the Chinese state railway has placed orders for special diesel-electric locomotives that are still able to even pull a train at these great heights. These type DF8CJ9001 locomotives develop 3,400 kW at an altitude of 2,800 m and can still develop 2,700 kW at an altitude of 5,100 m. It is expected that trains will be able to each top speeds of up to 100 km/h.


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