



Preparations to weld pipe for the BTC Pipeline.

Ain't no mountain high enough to stop pipeline construction

by Stephanie Chan, Assistant Editor

Mountainous regions are found in most countries, presenting safety and economic challenges to pipeline construction worldwide. Here, a number of companies share their experiences with this kind of terrain, and the innovations that have been developed to overcome these challenges.

Mountainous regions are often characterised by their difficult, rocky terrain, dangerously steep slopes, and risky weather conditions, which can be hazardous to workers, equipment, as well as the pipeline itself.

According to pipeline construction equipment suppliers Allu and PipeLine Machinery International (PLM-Cat), a big challenge is keeping excavators and rock trucks from rolling over on steep mountain sides and seriously injuring workers. Gravity and its effect on the material being moved, as well as the equipment moving it, are important considerations that need to be taken into account.

Other factors that must be considered are geological conditions, active seismic areas such as fault lines, areas of potential

landslide risk, ravines, and environmentally sensitive areas.

Penspen Head of Pipeline Engineering Paul Trundle says "Construction in mountainous regions can pose additional hazards for the workers involved compared with more normal, open, flat construction spreads – particularly in winter months when flash rains, freezing conditions or rockslides may materialise unexpectedly – so clear and effective health and safety processes are paramount at all times.

"Environmental considerations can also represent an additional challenge in mountainous regions. Reduced working width and/or workspaces can be one condition that is sometimes imposed in order to minimise environmental impact and disruption, and of course, such additional

requirements require additional procedures and planning to be put in place prior to the start of construction."

Protecting the pipeline

Mr Trundle says that by its nature, construction in mountain terrain often takes place on a slope or ridge, in a deep trench or with rocky terrain on all sides, meaning the potential for incidents and mechanical damage to the pipeline is multiplied.

"For this reason, additional protective coatings are sometimes applied in mountainous terrain," he explains.

"For example, thicker polyethylene or polypropylene coatings, concrete or geotextile/plastic sleeving may be used on top of the standard pipeline coating to protect the pipeline from mechanical damage.

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Similarly, rock crushing, padding machines or imported backfill – or a combination of all three – are often used to protect the coatings from damage during backfill and operation of the pipeline.”

Bredero Shaw Marketing and Sales Manager Vlad Popovici says “Steel wire mesh-reinforced concrete coatings are the two types of mechanical protection concrete coatings. These offer excellent damage resistance – minimum impact resistance of 150 J for the fibre-reinforced concrete coatings and 450 J for the wire-reinforced concrete coatings.

“Concrete coatings are currently the only supplementary mechanical protection systems that protect steel pipe through all the construction and service life phases – from transportation, handling and storage to lowering-in, backfilling and long-term service life.

“Sand bedding and padding is still the most frequently used supplementary mechanical protection system. The sand layer usually has a thickness of 20–30 cm around the pipe and has a minimum impact resistance of 300–450 J. This system protects the pipe during the pipeline backfilling and operation phases, and industry experience shows that potential sand washouts can reduce long-term protection.

“Non-woven geotextile materials have a wide range of technical performance. As an example, their minimum impact resistance is in the 25–35 J range. These materials protect the pipe during lowering-in, backfilling and the pipeline service life. The installation of these materials is very slow, taking approximately 15 minutes for a team of three people to protect just one pipe joint, and the quality of the protection is highly dependent on the skills of the field installation team.”

Specialised equipment for specific needs

Over the years, specialised equipment has been developed by a number of suppliers to address the issues presented by mountainous terrain, including PLM-Cat and Allu.

Allu USA National Sales Manager Dale Mickle says that importing backfill can increase the cost of a project in mountainous terrain because sand must be purchased, loaded, hauled in to the jobsite, and then placed into the pipe trench on top of the pipe. To counter this, Allu has developed the ‘D’ series screener crushers, which improve safety on the construction spread while keeping costs down.

“Using Allu, the excavator can simply screen the excavated material that was placed

SHERRY GETTIS’ TOP TIP FOR OPERATING MACHINERY IN THE MOUNTAINS:

“Modern, well-maintained equipment is the key to safe operations. Proper anchoring of machines on extreme slopes is crucial. Experienced supervisors and operators who have worked as a team and know and trust the capabilities of the other operators will be more successful in traversing difficult terrain.”

alongside the pipe trench on top of the pipe, eliminating the need to haul new sand into extreme terrain sites,” says Mr Mickle.

PLM-Cat Communications Manager Sherry Gettis says “Contractors need to ensure that they have sufficient winching capability on slopes. Winches need to be reliable and available on machines like dozers so they can ‘yo-yo’ other lighter units. These keep them anchored, helping them ease up a slope, or holding them back when easing down a slope.

“Sometimes two or more dozers will be attached to an excavator to enhance the safety factor during yo-yo action, and to allow more precise control of side-to-side movement. In some cases, custom cabling needs to be fabricated to handle machine anchoring when drawbar loads exceed the manufacturer’s specifications – generally one and a half times the sale weight of the machine,” adds Ms Gettis.

In addition to specifying Allied or Paccar winches on all its track-type tractors and pipelayers, PLM-Cat also offers the new PL87 and PL83 pipelayers, the Cranesmart Pipelayer System, and the Deckhand Pipe Handling System to assist with mountain pipeline construction.

DALE MICKLE’S TOP TIP FOR OPERATING MACHINERY IN THE MOUNTAINS:

“Safety and pre-planning is number one for preparation to take on difficult mountainous terrain projects. Cable tethering excavators to bulldozers anchored on top of mountainous hillsides give excavators added safety as pipeline workers pad pipe while scaling mountainous uphill terrain.”

Modifications to mitigate mountainous terrain

If specialised equipment is not available, modifications can be made to existing equipment to improve safety. For example, Mr Mickle says that installing excavator tracks on any equipment and adding ballast for the up-hill climb makes any machine safer to use and more capable of safely scaling difficult mountainous terrain. Ms Gettis also adds that in severe slope conditions, machines without towing winches will require tow cables of sufficient



An Allu screener crusher being used on the Columbia Gulf Gas Pipeline project.

diameter and length to allow for safe operation.

Alternative construction techniques can also be adopted for steep terrain. Pensions Pipeline Construction Manager Geoff Key says that pipelines are normally routed directly up a slope and along a ridge, so pipe strings are often welded at the foot of a hill, before being winched up the slope and placed into the trench.

“The working area is usually reduced in width to minimise impact on the environment,” says Mr Keys. “In extreme cases, it may be necessary to haul pipes on cableways. It is common practice to haul pipes on cableways, and create static welding bays, then winch pipe up the mountain side.

“In extreme cases, pipe shipment using heavy lift helicopters has been implemented in order to overcome the difficulties of access in such areas. Activities in the mountainous areas will be carried out at the safest time of the year, normally during the summer months.”

Project case studies

The Punj Lloyd Pipeline Team shared with *Pipelines International* some of the challenges it has encountered when constructing pipeline projects through mountainous terrain.

BAKU – TBILISI – CEYHAN (BTC) PIPELINE

STATUS

Commissioned in June 2006

SPECS

Length – 1,760 km; diameter – 34, 42 and 46 inches; capacity – 1 MMbbl/d of oil

CHALLENGE

The BTC Pipeline traversed through extremely steep slopes and mountains with 85 per cent of the route in sloping, high elevation and rocky areas. To compound the challenge, the pipeline passed through a seismic zone – the Cokak Geographical Fault – making health, safety and environmental aspects a top concern.

SOLUTION

For safe construction on precarious slopes at dangerous heights, the Punj Lloyd Pipeline Team adopted several special measures including:

- Customised training for all workers onsite;
- Anchoring of equipment; and,
- Barbed fencing and retaining walls to protect the earthwork.

DABHOL – BANGALORE PIPELINE

STATUS

Under construction; completion scheduled in June 2012

SPECS

Length – 1,000 km; diameter – 30 and 36 inches; capacity – 16 MMcm/d of gas

CHALLENGE

The hilly section – criss-crossed by several small roads, tracks and streams at short intervals – increased the number of crossings and tie-in joints. The undulating terrain has called for a large number of pipe bends, almost 60 per cent of the total number of pipes in two of the spreads in Maharashtra.

SOLUTION

For transportation of pipes and bends, and hauling and stringing in the hilly Ghat area, special sledges and heavy towing equipment are being used. A unique execution plan has also been formulated to overcome the challenges, which includes:

- A configuration of work in seven independent spreads;
- Close monitoring of the spreads through video conferencing;
- Increased number of mini crews in tough and undulating terrain, to ensure that the required productivity is achieved;
- Pipe shifting by dozers and excavators with sledges on steep slopes; and,
- Mobilisation of 14 semi-auto and eight automatic mainline welding crews, along with 45 tie-in crews.

SABAH SARAWAK GAS PIPELINE (SSGP) PROJECT

STATUS

Under construction; completion scheduled in June 2012

SPECS

Length – 512 km; diameter – 36 inch; capacity – 750 MMcf/d of gas

CHALLENGE

The Punj Lloyd Pipeline Team says that the SSGP project is one of the most challenging pipeline projects it has ever undertaken. The terrain is extremely harsh with rocky and steep mountain slopes with an altitude of up to 3,300 feet. This undulating terrain has resulted in 39 per cent of the pipeline consisting of field cold bends – a total of 16,380 bends. Constant rain further hampers access to the right-of-way (RoW).

SOLUTION

Heavy-duty winches, walking spider excavators and a ropeway crane system have been mobilised for the installation of the pipeline on steep slopes. Air crane helicopters were used for the transportation of the pipes and bends, as well as for hauling and stringing. Punj Lloyd has also had to construct and maintain more than 200 km of inaccessible RoW, approach roads and bridges, and logging roads to access the site.

While mountainous regions present a challenge for pipeline construction, the innovation of project management and construction contractors has ensured that pipelines will continue to be successfully laid through this difficult terrain, with progressive suppliers continually developing pipeline machinery to help them do this in the safest, and most cost-effective manner. [🌐](#)



Preparing to lower in the Dabhol – Bangalore Pipeline.