

TRANSPORT News

**Jammu & Kashmir Railway Project -
On Track, On Target**

Quarterly Journal of the Centre for Transportation Research and Management

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*E*ditorial

The Jammu and Kashmir Rail Link Project has been on the horizon for more than a decade now. Started with fanfare, it got stuck in the quagmire of political resolve, compounded with a “resource crunch” mind set. But, happily, the scene is rapidly changing.

The Project is now rejuvenated and placed as a priority in the national agenda, and the credit goes to Prime Minister Atal Bihari Vajpayee and Railway Minister Nitish Kumar. On recent visits to the valley, both have made it very clear that the nation perceives the link to be vital, and have laid down unambiguous targets. The Railway Minister has also ensured that the required funding is now available.

The Jammu - Udhampur leg has to be commenced in March 2004, and the Udhampur - Katra leg by March 2005. Trains will roll in the Valley in December 2005, and the final linking will be achieved by completion of the Katra - Qazigund section in 2007, by running a train from Delhi to Srinagar. These are stiff targets, but Northern Railway, who are the owners of the project, have stepped on the pedal. They are reportedly on schedule to achieve the target dates.

J&K is currently served by National Highway 1A. During rains, this link suffers from land slides, and gets snow-blocked in the winters, and its annual average availability remains at around 65%. The Border Roads Organisation renders yeoman service in keeping this vital link functional, but an alternative communication link is the need felt for long. Northern Railway has planned well, and it will enter the valley across the Pir Panjal ranges below the snow line at Charil. The resultant tunnel will be the longest in India at about 12 kilometers, but it gives the Kashmir Valley its first truly all-weather mass transport system.

The construction challenges are huge, but Indian Railways team is on target, as brought out by the project’s Chief Administrative Officer Rakesh Chopra, in a paper in this issue.

Subsidy decisions have a vital effect on transport rating, and subsequent business modeling. A synopsis of elements of subsidy has been compiled and forms the second major issue studied in this issue. The compilation offers some insight into ensuring efficiency in subsidy decision making.

CTRAM and *TRANSPORT News* are also privileged to have Mr K.K. Aggarwal as its new leader, and we look forward to his stewardship.



Welcome

**Sh KK Aggarwal
President, CTRAM**

Sh KK Aggarwal, IRTS, took over as Member Traffic of Railway Board, and ex-officio Secretary to Government of India, in March 2003. As Member Traffic, Sh Aggarwal also took over as the new President of Centre for Transportation Research and Management.

Sh Aggarwal graduated from St Xavier's College, Ranchi, and completed his Masters in Economics from Ranchi University in 1965. He subsequently joined the Government of India, and belongs to the 1967 batch of the Indian Railway Traffic Service.

Sh Aggarwal has held key posts in Traffic and General Management on the zonal railways, and was the Divisional Railway Manager at Dhanbad on the Eastern Railway. He laid a solid foundation for the newly formed East Central Railway as its Officer on Special Duty, while holding the difficult charge of Additional Member in charge of the Commercial function, at the Railway Board. Prior to taking over as Member Traffic, he was General Manager of Western Railway.

In addition to in-service training at Mussoorie and Baroda, Sh Aggarwal has trained at Manchester Business School, in the area of Strategic Management. He is a member of the Chartered Institute of Transport.

To the valuable experience of managing India's infrastructure sector, Sh Aggarwal adds the wisdom of wide travel, and exposure to a trans-national culture. He has trained and consulted with international organizations in United Kingdom, France, Switzerland, Greece, amongst others.

TRANSPORT News welcomes Sh Aggarwal, and looks forward to his inspiring leadership.

Sh MC Srivastava, our out-going President, shall continue to guide us as Immediate Past President of CTRAM.

Key Issues in Subsidy Policies and Strategies for Reform

Subsidy policies may unintentionally be major causes of environmental degradation and unsustainable practices. They distort efficient price and incentive structures and lead to unsustainable production and consumption patterns. Subsidy policies are pervasive in both industrial and developing countries. Analyses show that subsidies are expensive policies that often do not serve their purposes while also causing severe damage to the environment. The first priority to promote sustainable development is to identify and reform subsidies that are ecologically destructive, economically inefficient and socially inequitable.

Applying a broad subsidy concept, covering a wide spectrum of both on- and off-budget support measures, studies show that subsidy policies involve large amounts of resources. OECD countries subsidize *energy* production by about \$75 billion per annum, mainly fossil fuels and nuclear energy. Developing countries heavily support energy consumption by keeping domestic prices below market level. Such subsidies to fossil fuels amounted to \$220 billion annually in the early 1990s, with another \$80 billion for electricity subsidies to be added, but since then, several major countries have increased domestic energy prices substantially and reduced fossil fuels subsidies by \$100 billion.

Subsidies to private *road transport* refer to the uncovered costs of providing roads, space and traffic services to road users. Such subsidies are between \$85 to \$200 billion in the USA, Japan and Germany, although other OECD countries like the Netherlands and France tax their road users. In developing countries, about \$15 billion each year is spent on premature road rehabilitation, while these resources could have been saved by better road management and maintenance. Subsidies to *water use* in developing countries amount to \$45 billion each year, while water prices in OECD countries generally do **not** cover capital costs. Irrigation is in both regions most heavily subsidized. *Agricultural* support in the OECD amount to \$335 billion in 1995 while developing countries tend to subsidize agricultural inputs.

Many subsidy policies are motivated by economic and social objectives such as to stimulate economic development, to support (poor) population groups or to provide access to basic living conditions. In sectors like energy and agriculture, the motive to subsidize may also be to protect sectoral employment or investments or to reduce the susceptibility of the economy to external shocks. However, analyses show that subsidies often do **not** serve their purposes but rather work against them. Furthermore, they generally entail a huge fiscal drain and cause serious harm to the environment while often ending up benefitting the rich

This is a compilation of studies on subsidy issues.

and better-off. Particularly subsidies linked to economic activities cause major distortions. Reshaping subsidies would in most cases yield economic, environmental and fiscal gains and may create greater equity as well. Policy makers should also be wary of introducing any new subsidies, because once they exist, subsidies are hard to remove.

The bottom line is that markets should take care of allocating resources whereas governments should refrain from interfering and surely from linking subsidies to production, consumption or inputs. Governments do have a fundamental role to play but rather towards defining and enforcing conditions for a better functioning of markets and ensuring fair competition. Sound pricing of resources, goods and services, covering full costs of production and consumption, is a key element of good governance. Policy objectives can often best be addressed by direct measures.

In practice, however, several obstacles may impede subsidy reform. The single most important barrier is opposition from vested interests. Subsidy policies favour particular interests and rent-seeking behaviour becomes dominant. Because subsidies get enshrined in price and income structures and affect the distribution of wealth, they create **addiction**: removing subsidies will affect more groups than was originally envisioned and, as with all addictions, breaking the habit will be difficult and painful. Furthermore, a full appreciation of the subsidy issue at hand is often lacking, because the costs are dispersed among a broad public while the benefits are more clearly visible. Distributional consequences, in particular when subsidies get capitalized into assets and create economic dependence, may be serious barriers. Uncertainty surrounding the outcomes of reform may become so dominant that it may result in a status-quo bias in which even people that would benefit from subsidy reform, may want to avoid any risk of losing. Countries may also be reluctant to act unilaterally because they fear to lose competitiveness or that benefits of domestic reform will leak away. Developing and transition economies may lack temporary financial resources to bridge the first stages of transition or require non-monetary foreign aid such as technical assistance. Administrative and skill barriers may also impede subsidy reform.

Creating **more transparency** is the key issue to subsidy reform. Making subsidies more visible is the best cure for breaking the habit; it contributes to a better and more balanced assessment of objectives. Second, transparency often implies **direct policy measures** which are generally more effective in reaching their objectives while minimizing the costs of economic distortions. Third, more transparency increases the political costs of irresponsible policies and creates incentives for policy makers to act responsibly. A practical way to create more transparency is to develop an informational framework on subsidy policies. Governments could introduce a formal **public burden of proof** and commit themselves to assess and report regularly on the need for subsidies, their (in)effectiveness, costs and distributive implications. A key issue is also to apply **alternative policies** that better target their objectives and to **compensate losers**. Such compensation may ultimately take the form of buying out existing stakeholders. Accompanying retraining and educational programs may be necessary to cushion transition.

There are no single or simple factors that determine the path or pace of subsidy reform. Practice shows that, whenever feasible, rapid reform should be attempted. However, when political commitments are solid and there is a need to build constituencies for change gradual reform, allowing sufficient time to adjust, may be preferred.

Furthermore, an international dialogue on subsidies must be initiated and stimulated. Such a dialogue would not only have to take place globally, but more importantly, on regional and

local levels since many subsidy issues deal with specific problems and details. International organisations may have a pivotal role to play, but NGOs and private sector representatives may be key participants by bridging the various levels and actors and actively building support for reform. International donors can contribute by targeting their funds to projects that may catalyse domestic reform, without formally linking both together. Instead, donors may

The Concept of a Subsidy: What it is and What it is not?

There is often still much debate what a subsidy is or, more specifically, what it should be. On the one hand, this discussion reflects the evolution of the subsidy concept but on the other hand, the debate has also contributed to confusion what a subsidy is and what it is not. A subsidy was initially regarded a payment or a tax concession from the government, but later extended to include policies that create transfers through the market mechanism. Some would also argue that the non-internalisation of external costs should be regarded a social subsidy. Recently, it is suggested to capture this conceptual diversity by referring to subsidies as the externalisation of costs.

The key issue to define a subsidy is what one regards as the right benchmark, both in theory and in practice. People from different countries and cultures or with different professional backgrounds may have different opinions on the choice of the benchmark and the definition of a subsidy. What in one country is regarded as a concession from the government and thus a subsidy, is part of the current standard in another country and surely not a subsidy. A subsidy can also be much broader than cash transfers alone and include (quantity) regulations with monetary implications. The problem is then again to determine the proper standard of rules and regulations. An even broader perspective on subsidies is to include alternative economic opportunities that have been foregone.

The latter view comprises a broader, economic approach towards defining a subsidy. From this perspective, the benchmark to define a subsidy is the efficient solution that maximises welfare. In theory, prices set equal to marginal costs will, in principle, generate the economically most optimal outcome. Therefore, any government intervention that leads to a deviation from marginal cost pricing will create inefficiencies and can be regarded a subsidy. In practice, however, marginal costs are hardly useful as an operational concept and a more feasible approach is often to focus on opportunity cost pricing (see Moor, forthcoming). World market prices are generally taken as the benchmark in the case of tradables, while cost recovery is a practical alternative reference point to identify subsidies to non-tradables.

In words, applying a broad subsidy concept, we define subsidies as comprising *all measures that keep prices for consumers below market level or keep prices for producers above market level or that reduce costs for consumers and producers by giving direct or indirect support*. To facilitate the identification and enumeration of subsidies in practice, we use the following *subsidy guide*, covering a wide spectrum of both on- and off-budget support measures:

budgetary effect of tax policies: direct expenditures such as direct grants or payments; tax subsidies such as tax credits, exemptions, deferrals, preferential rates; public provision of goods and services below cost such as uncovered costs for providing infrastructure services; capital cost subsidies such as preferential loans, favourable interest rates, debt forgiveness; policies that create transfers through the market mechanism: domestic oriented

policies such as price regulation, quantity controls, legislation; trade oriented policies such as import and export tariffs and non-tariff barriers.

This subsidy guide has been the basis for sectoral reviews to identify subsidy policies and indicate their quantitative implications. To avoid confusion in what our subsidy estimates represent, we would like to emphasize that they are much broader than cash money being transferred from the government to subsidy recipients. Our estimates may also include the *economic* costs of foregone alternative opportunities and represent the amount of resources that is shifted from one group to another. Consequently, removing an X amount of subsidies does *not* necessarily imply an equal amount of cash money generated for the public budget but reflects the amount of resources that may come available for the economy.

Also note that our subsidy guide does *not* include externalities, for both more fundamental and practical reasons. A fundamental difference is that subsidies in our definition arise from *active* government interventions while externalities refer to the *lack* of government policy. Furthermore, there are considerable methodological differences in measuring subsidies and external costs, in particular concerning their reliability. Estimates on subsidies and external costs are hardly comparable and do not add up easily. Finally, political considerations also warrant separate concepts and analyses.

The Size of Subsidy Policies: How large are they?

The subsidy guide has been used to identify subsidies in the energy, road transport, water and agricultural sector, covering both developed and developing countries. The magnitude suggests a severe addiction to subsidies in both developed and developing countries. Worldwide, governments are widely and deeply involved in their *energy* sectors. OECD countries mainly subsidize energy production, presumably motivated by the concern for industrial investment and employment creation. Producer subsidies in various OECD countries range from \$70 to \$80 billion. OECD subsidy policies take all kinds of forms, from direct grants to cover losses in coal production and tax allowances for fuel producers to price support to domestic producers and providing them with loans at low interest rates or favourable conditions. The bulk of OECD subsidies go to heavily polluting fossil fuels, in particular coal and oil. Also nuclear energy receives a large share of subsidies, mainly for R&D purposes.

Developing countries, on the other hand, subsidize energy consumption by keeping domestic energy prices below world market level, apparently to support households. Fossil fuels were heavily subsidized by about \$220 billion in the early 1990s, with another \$80 billion for electricity subsidies to be added. Two-thirds of the total amount was attributed to the former Soviet Union. Recently, however, several major subsidizing countries have started to reform their energy sectors. Russia, for example, has steadily removed most energy controls and regulations since 1992, which has driven domestic energy prices up from 20-40% in 1991 to more than 70% of world prices by the end of 1995 (see box 1 on removing energy subsidies). China has phased out coal subsidies by allowing coal prices to rise to world market level and they are now close to parity with international prices. Ongoing research by the World Bank and own tentative calculations indicate that the reduction in fossil fuel subsidies, as measured by the pricewedge, may well amount to \$100 billion. Energy subsidies in developing countries would now be in the range of \$150 and \$200

billion per annum.

Subsidies to *private road transport* basically comprise the uncovered costs of providing road users with roads, space and complementary traffic services. Such subsidies are estimated between \$85 to \$200 billion in the USA, Japan and Germany, reflecting a range estimate for parking subsidies and the costs of providing traffic services in the USA. Cost coverage in the USA is between 20% and 50%, while road users in Japan cover about 80% but that is without parking subsidies. Higher fuel levies and prices make that road transport subsidies are generally lower in OECD Europe and sometimes even turn into net taxation.

In Germany, cost coverage is about 70%, but road users in the Netherlands and France are taxed and pay 120%. Irrespective of subsidization or net taxation, cross subsidies exist in most countries, from passenger to freight transport, from rural to urban road users or from gasoline to diesel vehicle users. Note that the subsidy estimates do not include the external costs of pollution, climate change accidents and congestion caused by road transport which may be much higher.

It is generally believed that there are likely to be huge road transport subsidies in developing countries as well. However, comprehensive transport studies for developing countries are yet lacking and only partial evidence on road transport subsidization exists. A World Bank study by Swaroop (1994) finds somewhat mixed results when separating road user charges from government revenue. It shows that for five out of the seven developing countries involved, the ratio of road related charges to spending is well under 50%, indicating huge subsidies. On the other hand, in the case of Turkey, the ratio is as high as 217%, pointing to net taxation. In addition, the World Bank (1994) estimates that developing countries spend \$15 billion each year on premature road rehabilitation. These resources could have been saved with more efficient road maintenance.

The question arises whether these support measures, which make up about 60% of total assistance, are minimum entry and intervention prices, border measures, such as import taxes and export subsidies, and market withdrawals. Non-price support measures range from production-linked supports such as deficiency payments and budgetary payments for inputs to more sector-wide support such as inspection services, research and training. Total transfers in OECD countries amount to \$335 billion in 1995, equal to \$380 per capita or \$16,000 for each full-time farmer. Based on a narrower definition, OECD support is equal to 40% of OECD agricultural production or about two-thirds of border prices. Although there are some remarkable exceptions of countries that indeed have reduced their subsidies (see box 2 on subsidy reform in New Zealand), many OECD policies continue to maintain quotas, administered prices and border measures despite commitments to reduce the high level of support.

Water is severely underpriced in both developed and developing countries. Water prices in OECD countries are generally **not** sufficient to cover capital costs with subsidy rates between 30-50%, while in some cases, they do not even cover operating and maintenance costs. Water subsidies vary greatly within the OECD but are generally higher in Australia, Japan, Turkey and the USA. The highest subsidies are found for irrigation projects with subsidy rates up to 80%. An absolute estimate of subsidies is difficult to give because cost data are lacking but they may well run into tens of billions of dollars.

Cost recovery of providing drinking water services in developing countries is about 35% on average. Together with inefficiencies in production and illegal connections, the fiscal burden is estimated at \$22 billion each year (see World Bank, 1994). This amount is very likely to

grow, since future unit costs even triple compared with the cost of water from the current supply systems, and that is even before environmental costs are factored in. Because water will be increasingly difficult to obtain, large and growing urban areas, in particular, will face rising costs. In developing countries, cost recovery for irrigation is even much lower. Repetto (1988) estimated cost recovery rates for irrigation already below 10% to 20% in the 1980s with actual revenues often not sufficient to cover operating and maintenance costs, let alone capital costs. Currently, cost recovery rates are about 20-25% with total irrigation subsidies tentatively estimated between \$20 and 25 billion per annum. Together, subsidies for drinking water and irrigation in developing countries amount to roughly \$45 billion each year.

OECD governments heavily protect *agriculture* by subsidizing production through a wide variety of price and non-price measures. Typical examples of market price potential savings can be regarded as "subsidies", but they are actually maintaining and supporting an inefficient condition and use of road infrastructure. Furthermore, sooner or later, these losses will have to be absorbed by the public budget. The poor condition of road infrastructure in developing countries may also become an obstacle for economic development.

Identifying Motives and Impacts

In evaluating the sectoral subsidy policies, it is important to avoid too much generalization beforehand and emphasize that not all subsidies are "bad"; indeed, there are "good" subsidies. In fact, what makes the subsidy issue so complicated, is that the difference between beneficial and distortionary subsidies may well lie in the details. The key issues, though, are to assess whether subsidy policies actually serve their purposes or not, at what cost, how the costs and benefits are distributed and whether subsidies harm sustainable development; in short, to determine whether subsidies live up to their expectations.

Evaluating the sectoral analyses and the types of support, the following *key motives* seem to underlie most subsidy policies:

to stimulate (rural) economic development or growth; to protect (sectoral) employment and investments; to safeguard domestic supply and reduce external dependency; to abate poverty or to support the poor; to provide access to basic living conditions.

There can be important differences in subsidy motivation between industrialized and developing countries in some sectors, but the objectives might be quite similar in others. Many subsidy policies are motivated by economic and social considerations. In sectors such as energy and agriculture, the motive may also be to protect domestic industries and reduce the susceptibility of the national economy to external shocks.

Sectoral analyses reveal that many existing subsidy policies work against their motives. Support to both *energy* producers and consumers, in particular for fossil fuels, fail in most cases to achieve their (stated) purposes of promoting economic efficiency and may actually be detrimental. There is overwhelming evidence to conclude that removing and reshaping existing energy subsidies is a policy and would yield economic, environmental and fiscal gains. Removing all energy subsidies would reduce global carbon emissions by about 10% and similar declines of other forms of air pollution and, at the same time, improve economic development, or at least not hamper it. Securing domestic energy supply and protecting the national economy from external energy shocks in industrialised countries may have been

legitimate goals in the 1970s and early 1980s, but they now offer little justification for subsidies to energy production. Instead, producer support in OECD countries have become very expensive ways to protect sectoral investments and employment. On the other hand, countries may argue, in defence, that they feel forced to support their domestic sector, because other countries apply similar subsidy policies. When they contemplate reducing subsidies, competition might induce investment capital to go abroad.

Fossil fuel subsidies to consumers in developing countries also do not serve their purpose; they do not stimulate economic development but rather create and contribute to greater inefficiencies. Nor are such subsidies very effective in supporting the poorest population groups. In fact, the main conclusion of empirical case studies of energy reform policies in developing countries show that raising energy prices did not harm growth, industrial competitiveness or the poor (Hope and Singh, 1995). Furthermore, subsidizing energy is very costly and extremely harmful to the environment, contributing to air pollution, climate change and other forms of environmental damage.

The evidence clearly shows the perversity of energy subsidies and can only lead to the inevitable conclusion that they should be progressively eliminated. In most cases, it would be more cost-effective to decouple support from production or consumption and target the original policy objectives directly, for example, by switching to direct income support to the poor instead of subsidizing (all) consumption or direct labour subsidies to encourage employment instead of subsidizing production, preferably accompanied by retraining programs. For social purposes, it would be more cost-effective to provide targeted support to the poor, such as fuel coupons or vouchers or micro credit, rather than imposing overall price controls.

Economic development seem to be the key motivation behind subsidies for *private road transport*, in both developed and developing countries. Increasing factor mobility may indeed be an important consideration in promoting and enhancing economic development. More specifically, encouraging physical mobility of the poor may improve their employment opportunities and living conditions. However, subsidizing road transport through less than full cost recovery will not achieve these objectives, but instead, will work against them and induce overuse and lead to a higher than optimal mobility. This, in turn, will increase pollution and congestion, particularly in and around cities, of which there are so many examples worldwide.

National and city level studies indicate that pricing and cost internalization measures can be no-regret policies that may reduce carbon emissions without hampering economic development. For instance, removing road transport subsidies in the USA, either by targeted user fees or by gasoline taxes, would reduce CO₂ emissions by 10% to 15% over a 20 year period while growth in economic activity is hardly affected (OECD, 1997). Practical experience of area licensing in Singapore, license fees in inner London roads, entry fees in Milan, toll rings in Bergen and user charges in Stuttgart show that pricing measures can indeed be successful in reducing traffic and pollution in cities (see box 3 on incentives in urban transport). Specific price measures are even more effective when internationally implemented. A Dutch study by the Central Planning Bureau (1996) shows that a substantial increase in excises would reduce car use by 40% and emissions by more than 60% when internationally coordinated within the European Union, two to three times more when implemented in the Netherlands alone. This study concludes that such an internationally coordinated pricing policy would lead to significant changes in consumption patterns without creating major distortions to the economy.

Subsidizing private road transport also does not contribute to equity objectives; they tend to accrue to the better-off and richer population groups, that is car owners. Studies by the World Bank (1994) show that price subsidies to infrastructure in developing countries almost always benefit the non-poor disproportionately. Removing private road transport subsidies is therefore likely to have no or limited impact on the poor. What governments should do, is to charge road users at least the (private) costs of supplying them with roads, space and traffic services. Such a pricing policy will not only provide incentives for more efficient use, but will also generate the funds to build and maintain infrastructure. Furthermore, instead of subsidizing all road transport, it would be more cost-effective to target the transport demand of the poor directly by providing them with income and physical access or by stimulating the provision of alternative or non-motorized forms of transport.

Apart from irrigation purposes, *water* subsidies in developing countries seem to be inspired predominantly by social objectives. Subsidies to drinking water aim to ensure water availability to the poor because it is assumed that poor people could not pay high water prices. The facts, however, show the opposite and expose the myth that current water subsidies would actually serve these purposes (see World Bank, 1994 and Briscoe, 1995). Instead, water subsidies tend to benefit the haves instead of the have-nots. Furthermore, the poor often pay high water prices in practice, since they do not have ready access to the public water system and usually will have to buy expensive water from private vendors. In fact, current water subsidies act as a barrier to improve the conditions of the poor, because governments lack the financial resources to enhance and expand the public water system. Irrigation subsidies are supposedly intended to stimulate farm production. However, studies show that irrigation water is so cheap that farmers tend to use water at will without any consideration to costs or cost-effectiveness; they tend to over irrigate their lands, causing severe salinisation and declining fertility (Bhatia, Cestti and Winpenny, 1995, Food and Agricultural Organization, 1994 and Tsur and Dinar, 1995). Removing water subsidies would generate large efficiency gains and typically reduce water use by 20% to 30%. In general, there is scope for improved efficiency whenever the pricing method affects the demand for water; current practices of per area irrigation pricing in developing countries provide no incentive at all for efficient water use.

The woeful underpricing of water in both developed and developing countries offer the wrong incentives for water users. Water is simply so cheap that it causes massive squandering, a bitter observation when realising that over 20 countries face acute water shortages and more than 1.2 billion people still lack adequate access to safe water. Excessive water use also leads to ecologically destructive practices by causing salinisation of rivers and aquifers, land subsidence and loss of biodiversity. The clear conclusion is that proper water pricing is the key in addressing current and future water problems. Sound pricing policies would provide incentives for efficient use and may generate the resources to ensure an (equitable) access. To enhance water availability, governments may consider providing micro-credit to the poor to ensure income access, to issue water stamps or to apply lifeline pricing (see box 5 on reshaping water subsidies).

Agricultural subsidies are generally intended to support farm incomes. Countries may also subsidize to encourage agricultural production, an objective that may be particularly relevant to food-importing (developing) countries. A related motive is to secure a domestic food supply. However, analyses show that agricultural subsidies are very costly and ineffective ways to achieve these objectives, particularly those support measures linked to production or inputs.

A general conclusion is that consumers and taxpayers in the OECD would stand to gain

substantially more from subsidy reform than farmers would lose (Organisation for Economic Co-operation and Development, 1995 and Blandford and Dewbre, 1994). This conclusion is simply evident from the low efficiency ratio of OECD agricultural transfers in achieving the objective of maintaining farm household income. Research shows that input subsidies, price support and production-linked measures generate the largest distortions as regard their impacts on resource allocation and the extent to which they deter trade, far more than direct support measures. Furthermore, these measures show a much greater proportion of leakage, implying that such support generally does *not* accrue to the intended recipients. It is estimated that only 20% of OECD support by either taxpayers or consumers ends up as additional farm household income. About 55% is spent to purchase additional inputs, another 20% covers opportunity costs and 5% reflects additional costs from terms of trade effects. Moreover, OECD support, in particular those linked to economic activities, mostly accrue to large and rich(er) farmers.

Gradual reform towards free trade through an international policy of decoupling subsidies from production, would yield welfare gains for farmers, taxpayers and consumers. Multilateral decoupling would improve efficiency in agricultural production and reduce the fiscal burden (see also box 2). The environment is likely to benefit as well, in particular from a targeted subsidy reform; the environmental gains could be enhanced when farm support is reshaped towards promoting nature conservation practices. Subsidy reform need not hurt farm incomes, but in cases that small individual income losses would occur, accommodating direct income support could easily compensate.

Subsidy reform may also improve agricultural performance in developing countries. Although input subsidies may partly compensate the implicit tax on output in financial terms, both types of policies create various distortions in agricultural production. The use of inputs such as pesticides and fertilizers may be essential for production, but up to a certain point. Lowering their costs encourages farmers to use them more than they would have to and may turn out to be counterproductive to agricultural production as well as destructive to the environment. Case studies show that removing input subsidies in developing countries will reduce the fiscal drain, improve efficiency and generally *not* hurt small farmers; furthermore, the environment would benefit as well by reducing excessive use of irrigation and pesticides in particular.

In summary, many subsidy policies do not live up to their expectations. The main reason is that subsidies divert resources away from economically more profitable uses while they also have to be paid for and mostly, large opportunity costs are involved.. Generally, they therefore lead to lesser instead of more economic growth. In particular, subsidies linked to production, consumption or inputs are distortionary: they have the largest economic costs and the greatest leakages. Subsidies give the wrong sets of signals, leading to ecologically destructive practices. Subsidy structure also tend to be socially inequitable, generally ending up benefitting the rich and the haves.

Identifying Major Barriers to Subsidy Reform

After evaluating the motives and impacts of subsidy policies, it is important to identify possible other reasons for their existence or why subsidies tend to persist, particularly in those cases when subsidies do not deliver on their promises. Identifying major barriers is of vital importance when suggesting proposals for subsidy reform. Experience shows that the

key factors blocking subsidy reform are:

opposition from vested interests and stakeholders; distributional consequences; entitlements of existing stakeholders; uncertainty surrounding reform outcomes; international considerations; lack of (foreign) assistance; administrative, institutional and skill barriers.

The principal barriers result from addiction, by both subsidy recipient and provider. Subsidy policies favour particular interests and creates rent-seeking behaviour. Defensive coalitions of recipients and beneficiaries of subsidies are often very effective in mobilizing support, among others by heavily pointing to specific motives and objectives. When discussing subsidy reform, opposition of these vested interests will be strong and loud. Their arguments may be quite selective but they are often quite capable in turning the public and political opinion against subsidy reform.

Furthermore, a full appreciation of the subsidy issue at hand is often lacking, because the costs of support policies are dispersed among a broad public and do not impact on individual groups greatly while the benefits are much more clearly visible. This may also explain why subsidy policies are often hidden or implicit in practice; it is politically more comfortable to cover their costs while at the same time pointing to more visible benefits for specific groups. Linking support to production or consumption may be politically more attractive because it implies paying for efforts instead of public hand-outs, literally a get-value-for-money perspective. Subsidy recipients may also prefer implicit forms of support or linked to production, because they fear that explicit subsidies will be cut first in times of fiscal stress. However, support linked to products or services gets enshrined in price and income structures and affects the distribution of wealth. It creates addiction to subsidies: removing subsidies will affect more groups than was originally envisioned. And as with all addictions, breaking the habit will be difficult and painful.

Closely related are barriers that arise from potential distributional consequences of subsidy reform. Without sufficient measures that compensate or cushion negative effects of reform or assist in transition, distributional implications, or how they are perceived, may be unacceptable for groups or countries that would lose from subsidy reform, reflecting another form of addiction. It is also important that their (economic) interests are considered and adequately addressed. Subsidies tend to get capitalized in assets and may create legitimate claims by subsidy recipients when support policies have created and contributed to entitlements. Subsidy beneficiaries will have based decisions on support policies and may have grown dependent on them; in a way, they have become addicted to subsidies. For instance, (production-related) agricultural subsidies generally get capitalized in land values, so that removing them may cause land values to drop dramatically, which may make farmers insolvent and even drive them out of business. Particularly in sectors that matter politically, addiction to subsidies can be so strong, that (perceived) negative financial impacts may be a major barrier to reform.

Uncertainty surrounding progress and outcomes of reform can also act as a potential barrier to reform. Rodrik (1996) asserts that uncertainty may become so dominant that it may result in a status-quo bias. When the outcomes of subsidy reform are unclear or uncertain, people, even those who would benefit from policy reform, may prefer consolidating the existing situation rather than risking to lose at all. In plain language, they know what they have but they are not sure what they will get.

International considerations may become an impediment to reform. As noted earlier, countries may be reluctant to act unilaterally and lose international competitiveness. A

country may also fear that progress of domestic reform will leak away through an increase in imports and reform may thus not be effective in achieving the intended objectives. In fact, in both cases, the benefits of reform may be unclear or uncertain that countries may want to await international action before implementing reform domestically. It may also be politically opportune to shun domestic reform, particularly in times of elections.

In international context and in particular for developing countries and transition economies, the lack of foreign assistance can be a major barrier, both in monetary and non-monetary terms. Countries may lack temporary financial resources to bridge the first stages of the transition process and they may need short run foreign funds to get started. Furthermore, countries may also require non-monetary foreign aid, such as technical assistance and administrative skills in setting up legislative and control systems. Countries can also assist each other to promote and sustain reform through mutually and gradually exchanging and implementing policy changes.

Finally, administrative and institutional barriers may block subsidy reform. There may not be a great deal of enthusiasm on the part of management and organisations that administer the subsidies. They might be sceptical about the need to reform or feel threatened that their expertise will lose its value, or their jobs will be lost. Generally, it would take strong political action to slice through bureaucratic inertia and engage in administrative changes. In addition, there may also be a lack of training and juridical skills; many countries may lack the level and range of skills to assess policies, to develop alternatives or to efficiently and effectively implement reform policies.

Strategy for Subsidy Reform

This section identifies the main strategies to overcome barriers to subsidy reform. The key messages and strategies are:

create more *transparency* in subsidy issues;

Creating more transparency in the motives, costs and impacts of subsidy policies and making the addiction and addicted visible will raise questions about their effectiveness and existence. Exposing the costs and implications of subsidies will reveal more clearly the often implicit choices and priorities. More transparency also increases the political costs of irresponsible policies and provides incentives for policy makers to act responsibly. It is also easier to expose and reform a targeted, explicit subsidy than a hidden one. At the same time, such transparency is often the main underlying reason that support is made implicit, hidden or linked to activities; it is more attractive for both subsidy providers and recipients to hide their addiction to subsidies and disperse the costs. Nevertheless, one should aim to expose the facts on subsidies by demonstrating their costs, their (in)effectiveness in achieving the intended goals and showing who benefits and who pays. Such exposure may raise questions on subsidies, assess their existence and open up a debate, which in turn may lead to more pressures to make subsidies more visible. Finally, making subsidy policies more transparent allows to monitor and demonstrate government efforts to comply with international (trade) agreements.

introduce a *burden of proof* for subsidy policies;

One concrete way to create more transparency on subsidies is to develop an informational framework on subsidy policies and evaluating subsidies regularly and introduce a burden of proof for their need and implications. There is usually an information asymmetry in the costs and benefits of subsidies; the benefits and winners of subsidies are often more visible than

the costs and the losers, while the opposite applies to subsidy removal. However, introducing a burden of proof by a formal commitment or assessment to report on the need for subsidies, their effectiveness, costs and distributive impacts may lead to more and better information. The informational framework and the burden of proof could be institutionalized by governments committed to draft and issue public monitoring reports regularly, say each or every two years. Non-governmental organizations may also take a responsibility in exposing subsidy policies (see box 4 for the role and strength of NGO cooperation). Obviously, such monitoring reports would need predetermined, objective criteria.

Set up *retraining and educational programs*;

Building further on the need for an informational framework on subsidies, retraining and education programs may be needed to overcome administrative and skill barriers. Providing the tools and skills raises awareness and enables the identification and assessment of subsidies. It will also enable policy makers to develop and implement alternative policy measures. Sometimes, it will take strong political action to overcome administrative inertia and initiate necessary changes. Another key condition for successful subsidy reform is congruence of interests on the part of treasuries, environmental and sectoral agencies. Interdisciplinary teams consisting of fiscal and environmental experts, together with communication and sectoral specialists, may be well equipped to make transition successful.

develop an *alternative* policy that better addresses and targets the same objective and compensate losers in some way;

Although subsidies often do not serve their ends, the original objectives may remain valid although they need to be addressed more cost-effectively by better targeted policies (see for instance box 5). In most cases, direct (income) support is a superior policy option than subsidies linked to production, consumption or inputs. Direct subsidies are the least distortionary as regard their impacts on resource allocation and the extent to which they deter trade, while they generally accrue to the intended recipients far more than other forms of support that show greater leakages. Therefore, if the aim is to provide support to specific population groups, direct subsidies are superior policies. This would back up the urge for more transparency in subsidy policies.

buy out existing stakeholders;

As noted earlier, removing subsidies may have severe implications for recipients when they have economically grown dependent on them and become addicted. Governments may have to recognize existing entitlements and consider compensation by buying out existing stakeholders and breaking the habit once and for all. Some would regard this option as politically unacceptable because it would imply a confession to past failures or a surrender to vested interests but buying out stakeholders can be a pragmatic, structural solution. Buy-out may be costly in the short run but not necessarily costlier in the long run than maintaining current subsidies. Furthermore, it can create the opportunity to start with a clean slate and allow a more efficient resource allocation in an ecologically less destructive way (see also box 2).

initiate an *institutional mode shift*;

A long run strategy for reforming subsidies is to remove the foundations on which many subsidies seem to rest by initiating an institutional mode shift towards a market economy. Such a fundamental reform may be particularly relevant for countries that are far away from

being a market economy. In general, the purpose of an institutional mode shift is to reorganize ownership and incentive structures. A comprehensive policy reform involving liberalizing markets, restructuring sectors and creating ample room for (fair) competition eliminates many root causes of subsidy policies. Privatization and deregulation are first steps towards such a transition, although it must be borne in mind that the way these market-oriented reforms are put in place matters greatly; they are the *means* to an end. Another key element is to impose and sustain financial discipline, which is not only vital to enhance the restructuring of the economy, but may also contribute to control inflation. A comprehensive study by the World Bank (1996a) on the transition of economies has shown that economic growth deteriorates dramatically when inflation rates rise above a critical threshold of about 40% per annum. But restructuring existing firms and enterprises and imposing financial discipline is not enough to establish an incentive-based economy. The second key step is to create and distribute property rights. Free entry by new businesses, both domestic and foreign, are crucial for a proper functioning of a market economy and essential for economic development.

use *crises* to question and expose subsidy policies;

As regards the timing for subsidy reform, one could initiate a debate on subsidies and question their existence when governments contemplate (fiscal) reform during times of fiscal stress or environmental crises. Particularly in times of fiscal stress, defensive coalitions of interest groups may have been weakened, and their arguments in favour of subsidizing may be less valid or persuasive; alternatively, interest groups may be more readily convinced that they would have more to lose from overall reform. Environmental problems or crises may also trigger public attention and make people more receptive towards subsidy evaluation.

There are various timing strategies towards implementing subsidy reform. For argument's sake, we limit ourselves to two opposite, stylized options: rapid reform versus gradual change.

Rapid reform;

Governments could launch a vigorous, drastic reform in a shortest possible time. Such a shock therapy may be particularly relevant in cases where political commitments and stability are uncertain in the long run. Rapid reform may also be preferred when countries are already in or moving towards transition; many problems and barriers are then already being addressed (see the case of Russia in box 1). Governments could consider integrating subsidy reform as part of a package of overall policy reform. Another potential advantage of shock therapy is that it may produce early results that enable governments (politically) to sustain reform policies. Finally, experience seems to demonstrate that, whenever feasible, rapid reform should be attempted. The World Bank (1996a) concludes from a wide range of transition practices that countries, in which liberalisation has been most rapid and comprehensive, have been more successful than slow reformers. Advanced liberalisers have generally experienced an earlier and stronger recovery and also come out far ahead over a longer period.

Gradually *phasing in* reform;

However, rapid reform is far from a general panacea for all countries in all cases. Instead, governments are in practice constraint by initial, country-specific conditions such as the level of development and industrialization. But trade location, institutional settings, historical

practices and cultural attitudes are also decisive factors. Perhaps more importantly, governments may want to build a constituency that supports change and transition. Another way to implement subsidy reform is through a piecemeal approach and gradually phasing in necessary changes (see the Chinese example in box 1). Phased reform could start with localized experiments that allow them to expand as lessons come available and successes emerge. Phasing in reform may build support from subsidy recipients, because it would give them time to adapt along the way, where necessary accompanied by government programs, in this way minimizing the social costs of adjustment. However, gradually phasing in reform requires a long term (political) commitment to sustain adjustment, also when motivations diminish and opposition grows.

initiate and stimulate an international dialogue on subsidy reform;

Since multilateral or common action is often a condition for successful reform, an international dialogue on subsidies and subsidy reform should be initiated and stimulated. Given sufficient support, it may be worth considering to organise a series of Green Rounds on Subsidies to discuss and agree upon actions towards subsidy reform and providing (mutual) assistance. Such a dialogue would not only have to take place globally, but also, and perhaps even more importantly, on regional and local levels. Many subsidy issues encompass specific problems which often need to be dealt with at the lowest possible level. In a dialogue on subsidies, every player should do its share. International and multilateral bodies will have a pivotal role to play, among others by feeding the dialogue with facts and sound analyses. Non-governmental organisations (NGOs) may be key participants by bridging the various levels and actors, by exposing and reporting on subsidies and by building support from their constituencies for reform. For similar reasons, representatives of the private sector should be involved in the dialogue as well. Some key organisations, such as for example the Earth Council, IUCN and the World Business Council with their wide networks across sectors and interests, could catalyse the debate. They may also use their convening power to engage political and business representatives into the subsidy debate and bring them together to discuss and agree upon common actions towards subsidy reform. Finally, it is vital that some major countries take the political leadership and set the example by initiating reform. In particular, Finance Ministers or their representatives could play a key role; showing the costs of subsidy policies and their potential alternative uses may be a powerful argument to get them more actively involved into the dialogue on subsidies and sustainable development.

support and fund catalytic initiatives to reform;

International donors may contribute by developing policies to support and fund projects and initiatives that would catalyse domestic reform, without necessarily formally linking both together. Foreign assistance should refrain, whenever possible, from conditional assistance; this would be in sharp contrast with the intended market philosophy. Instead, donors may shape their responsibility by setting the example for private capital flows. For instance, donors could consider supporting start-up businesses that use innovative and environmentally friendly techniques which may also contribute to realizing an institutional mode-shift. Foreign support may also overcome the potential lack of sufficient, short run financial resources to bridge the first stages of transition; or even longer, since a fundamental change towards an incentive-based market economy may take many years to develop.

Summing Up: Guiding Principles

for Subsidy Reform

Subsidies are often motivated by economic and social considerations primarily. However, analyses show that many sectoral subsidy policies do *not* serve their purposes and do not live up to their expectations. The main reason is that subsidies shift costs from one group to another: from producers or consumers to one another, or to the government and thus to taxpayers. They distort efficient price and incentive structures and lead to unsustainable production and consumption patterns. Subsidies favour particular, often vested, interests and divert resources away from economically more profitable uses with usually large opportunity costs involved. This shift goes at the expense of economic efficiency and the environment while subsidy structures also tend to be socially inequitable, ending up benefitting the rich and the haves. Because subsidies favour particular interests, rent-seeking behaviour becomes dominant and through various ways, recipients get addicted to subsidies. Proposing subsidy reform will, therefore, raise heavy opposition of vested interests. A full appreciation of subsidies and their reform is further complicated, because the costs of subsidies tend to be dispersed among a broad public while the benefits are more clearly visible; vice versa, the costs and pain of removing subsidies are more visible and also more certain than the benefits. Several reasons. Making subsidies more transparent is the best cure for breaking the persistent habit; it contributes to a better and more balanced assessment of objectives and enables a sound and open discussion with the arguments, impacts, costs and distributive implications made explicit as possible. Second, transparency often implies direct policy measures which are generally more effective in targeting their objectives. Furthermore, direct measures are the least distortionary; they reduce the costs of economic distortions to a minimum. Third, more transparency increases the political costs of irresponsible policies and creates incentives for policy makers to act responsibly; it enhances control of government policies. Finally, more transparent subsidy policies offers real and convincing evidence of government efforts to comply with international (trade) agreements.

One should thus create pressures to stimulate transparency in subsidy policies. Key priorities are to raise awareness, to initiate a debate on subsidies and to build support for reform. Raising awareness can only be done when one has the *proper tools* to analyse subsidies. The first step is to identify a subsidy, for which our subsidy menu may serve as a helpful guide. Next, its size should be measured, both in fiscal and economic terms; in particular, the fiscal impact of subsidies may be a key factor in the subsidy debate.

Transparency is the key issue in subsidy reform, for showing the costs of subsidy policies may be a powerful motive to get Finance Ministers involved. The next step is to determine and assess the economic, environmental and social implications of subsidy policies. Choosing relevant criteria is important but may depend on the subsidy issue at hand.

Governments should be encouraged to develop an informational framework on subsidy policies. They should commit themselves to assess and report regularly on the need for subsidies, their effectiveness, costs and distributive implications. Introducing a *public burden of proof* for the need and impacts of subsidy policies is a concrete and practical way to create more transparency and initiate an open debate.

Raising more awareness and initiating a dialogue on subsidies should also be organised at the international level, in particular on regional and local levels to effectively deal with specific subsidy issues. It is vital that major countries take the political leadership and set the example by initiating action and real progress.

A key principle is also to focus on distributive implications and *identify winners and losers* of subsidies and their reform. This aspect is of particular importance in the political debate and in mobilizing support. Making clear who benefits and who pays, who wins and who loses creates the basis for reshaping subsidies and developing cost-effective alternatives and complementary measures to smooth the adjustment process. Compensation for groups and countries that (initially) may lose from subsidy reform is vital to give them ample room and time to adjust. Such compensation need not necessarily be in money terms, but may also take the form of providing technical, administrative or skills assistance, for example by setting up programs to retrain workers or assisting in developing a legislative, administrative and institutional system. To provide some practical guidance in pursuing subsidy reform, we can formulate the following *set of guiding principles for policy makers*.

The bottom line is that markets should take care of allocating resources whereas governments should refrain from interfering but rather move towards defining and enforcing conditions for a better functioning of markets. Governments do have a fundamental role to play, particularly in creating a framework for the efficient allocation of property rights and developing the institutional framework to ensure fair competition.

Proper pricing of resources, goods and services is a vital part of sound governance and the key to many existing sectoral problems. Sound pricing will provide the incentive for efficient use, enhance environmental concerns and reduce fiscal drain. As a general guideline, sound pricing policies should at least reflect private costs of production and consumption and, preferably, their full costs. Targeted user pricing, where possible, may avoid cross subsidies and intra-sectoral inefficiencies. Governments may also wish to consider applying mixed pricing systems such as lifeline pricing or two-tier pricing methods. These practices charge a low price for a basic subsistence level and a (sharply) increasing rate above that level, to reflect its "luxury" character. The advantages of such pricing policies is that they combine social and economic purposes while still feasible to implement.

So it all comes down to good governance: sound policies, a credible government and more transparency. Let the markets distribute resources and apply sound pricing policies. Accelerate efforts to desubsidise and shift resources towards sustainable practices. The costs and incentives should be put back where they belong - on users instead of on taxpayers or other groups.

CHALLENGES IN CONSTRUCTION OF MOUNTAIN RAILWAYS – THE LINK TO THE KASHMIR VALLEY

-Rakesh Chopra

INTRODUCTION

Railway construction started in India in the year 1852. This was a broad gauge line from Victoria Terminus. The broad gauge lines across the mountains came in latter. Within independent India, the still working and perhaps one of the most important links are the two links across the Ghats, one to Pune and the other to Igatpuri. Besides, there are many mountain links on meter and narrow gauge, such as Kalka- Simla, Pathankot- Palampur, Darjeeling Rail line, Nerul and in the Nilgiris. Each has a romance unparalleled and have many a story written about it.

Since independence, the biggest project in the construction of a mountain railway is the one through the Himalayas, the Jammu-Udhampur-Katra-Quazigund-Baramulla link.

Challenges in the construction of such Mountain Railways start right from the conception stage. The defined needs for which the construction is envisaged - speed, flatter gradient, easy curves, enhanced mobility, safety and low maintenance in future - only multiply the challenges one faces. Projects in mountainous regions are associated with deep cutting, high embankments, tall pier and long span bridges across deep gorges and fast flowing flash flood rivers with big boulders and long tunnels etc. These challenges enhance, if a project is executed in a terrain like the young Himalayas, where geology is poor, and changes frequently.

Surveys done and being planned have been a fascinating experience. The unexplored territory from Salal to Quazigund with virtually no habitation, road or tracking path through jungles, without light or water, and steep slopes is a survey storey in itself. In this part of the project, the engineers are expected to tackle tunnels for over 50 % of the length with the longest being more than 10 kms long. The tallest bridge is about 400 m above bed level and of over 1 km in length, single span, is also to be tackled in this reach over the river Chenab. The project is a challenge to the Engineers of India in general and to the Railway Engineers in particular.

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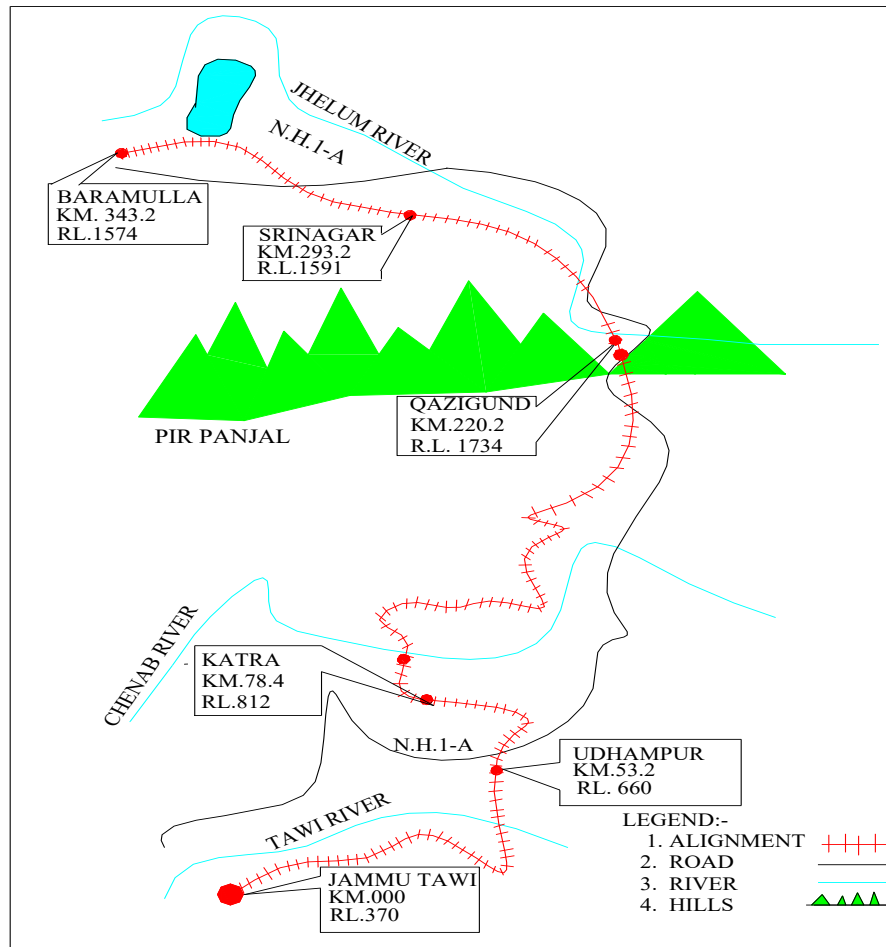


Figure 1. Alignment of Project

Indian railways are linking the Kashmir Valley by a rail link between Jammu and Baramulla. This project is perhaps the most difficult new railway line project undertaken on Indian subcontinent. The terrain passes through young Himalayas, which are full of geological surprises and numerous problems. The alignment of the project is shown in figure 1. For execution purpose, project has been divided into 4 sub-sections. Construction activities are in progress on Jammu-Udhampur, Udhampur-Katra and Quazigund-Srinagar-Baramulla section of the project. Further, preconstruction survey has been started on Katra – Quazigund section.

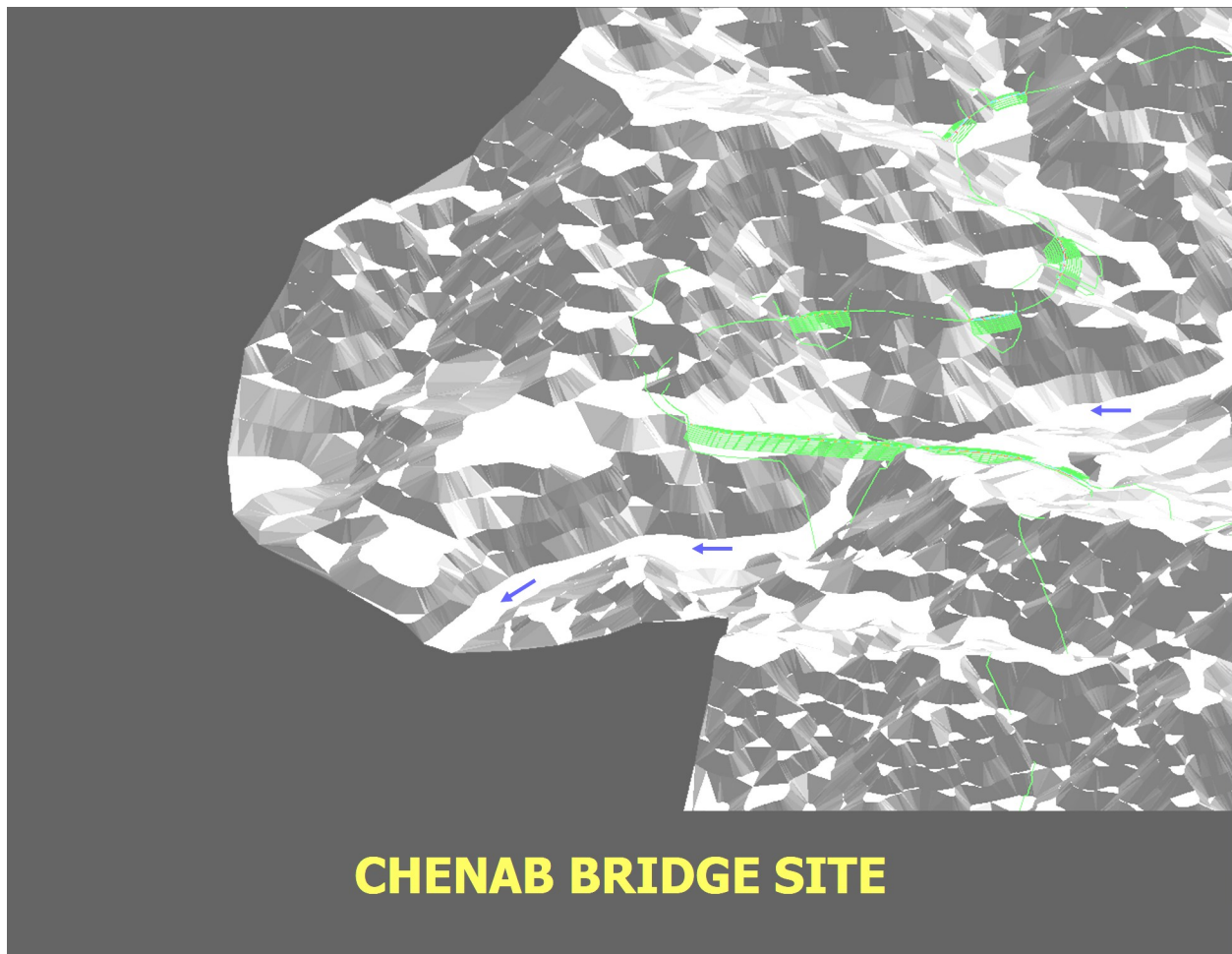
The new broad gauge single line is being constructed with a ruling gradient of 1 to 100, degree of curvature is restricted to 2.75° , so as to achieve a speed potential of 100 kmph. The route length is 340 kms. involving 413 lakh cubic meters of earthwork, 738 bridges and 109 kms of tunneling. This paper brings out the various challenges faced, solution found to meet these challenges, through improvisation and innovation, depending upon site requirements. This has resulted so far in the successful construction of a 42 mtr. high embankment, 68mtr. tall pier, 102 mtr long pre-stressed concrete girder with cantilever construction using NRS gantry, over 15 km tunneling in bouldery and flowing soil condition, where free standing time is even less than an hour.

THE CHALLENGES

1) SURVEY

The alignment of Jammu - Udhampur – Katra – Quazigund – Baramulla rail link project passes through highly undulating terrain, especially in Katra – Quazigund section. Construction activities are already in full swing in Jammu - Katra and Quazigund - Baramulla section. Beyond Katra (Km 30) upto Quazigund (Km 167) a part of alignment from km 50 to 120 falls in thick forest cover with no habitation and tracking path. Due to difficult site conditions, alignment proposed was marked on the topography sheet of 1 in 25000 scale with 20 mtrs contour interval, based on satellite imageries and aerial photographs. To study the alignment and terrain in detail before proceeding to further planning, this was converted into a Digital Terrain Model (DTM) and proposed alignment was transferred on it. This Model is being used for:-

- Checking and refinement of the alignment. For example, at a location from a model, it could be visualised that a stretch where earthwork is being planned, earthwork is not possible as embankment slope of 2(H) : 1(V) will block the drainage.
- Planning of project logistics before venturing into the field.





As the alignment was available with 20 meter contour interval based on satellite imagery, which is feature specific with an accuracy of (as of now) – 100 m in XY direction & 200 mtrs in Z direction , it was planned to go for Aerial Survey using kinetic GPS. It is also being planned to fix control points along the alignment during aerial survey. The Aerial Survey will provide maps at 1:5000 scale with contour interval of 2.5 mtrs at an accuracy of 15 cm in 3D, except in thickly wooded reach from Km 50 to 120. For Km 50-120 aerial survey is being planned to be supplemented with Airborne Laser Terrain Mapper (ALTM), which will give maps with 1 mtrs contour interval. Thus, through aerial survey, maps on a bigger scale of 1:5000 with 2.5 / 1 m contour interval and co-ordinates of control point will be available, greatly reducing the efforts in transferring the alignment on ground using total station, theodolite / levels.

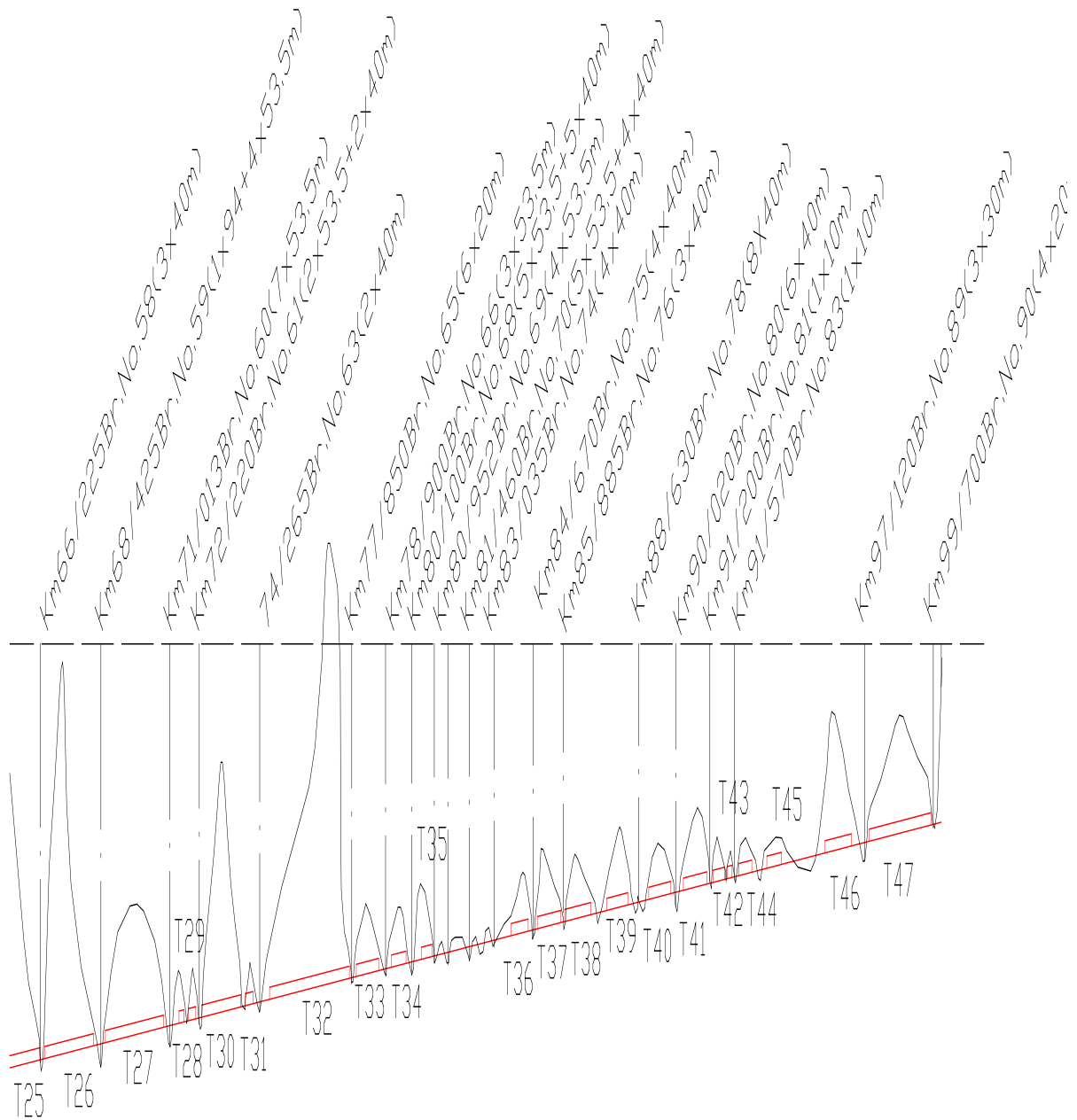
Intensive geophysical, geo-technical and hydrological studies have been conducted. The results of these studies so far tell us the following:

EARTHWORK

The project involves 413 lakh cum of earthwork. Such a huge quantum of earthwork posed nu-

KATRA-QUAZIGUND SECTION

L-SECTION FROM Km.66/00 To Km.100/00



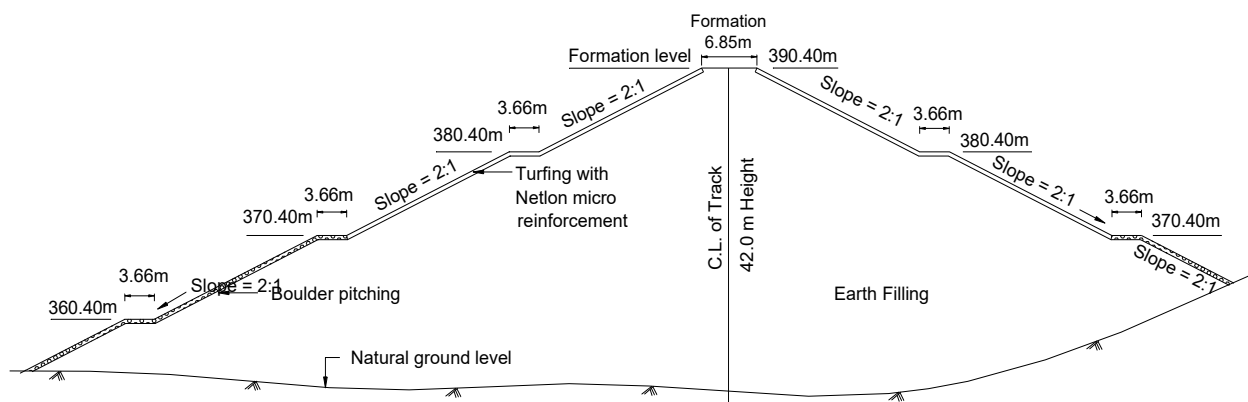
merous technical and logistical challenges. These challenges have been met by going for:

The project involves 413 lakh cum of earthwork. Such a huge quantum of earthwork posed

1. Construction of 42 mtrs high embankment
2. Reinforcement Soil to reduce embankment slope, wherever stable slope of 2(H) : 1(V) for the embankment was not meeting the ground or obstructing / blocking natural drainage or even national highway in a case.
3. Construction of viaduct where good quality earth was not available, called as preferred fill materials in railway parlance.
4. Construction of cut & cover at locations where cut slopes were not stable.
5. Provision of blankets to solve the formation problem.

CONSTRUCTION OF 42 MTRS HIGH EMBANKMENT

Cross section of bank is shown in figure above. The bank was designed by carrying out slope stability analysis through computer programmes based on Bishop's Modified Method. The



minimum factor of safety for circular slip surfaces is calculated and slopes changed to have adequate factor of safety. Effective stress analysis was used.

A slope of 2 H : 1(V) was provided , with berm of 3.66 mtrs at every 10 mtr height . All the fill area is demarcated with the help of toe lines and reference lines. All vegetations were removed and proper benching done as the natural ground is in slope. Earth is brought in tip-pers/dumpers from cutting /borrow area and is spread in layers of 400 mm (loose) with the help of bulldozers. Boulders more than 200 mm in size are separated out. The compaction was done with vibratory roller with the moisture contents in between + 1% to -2% of the optimum moisture contents (6% + 8 %) so that minimum 98% of maximum dry density corresponding to modified proctors compaction is achieved. The fill area is divided in 3 parts. In first part earth dumping, in the second rolling and in third part testing of density is done. Rolling is done in 30/40 m length. Overlapping of about 30 cm is ensured in each pass of the roller. Density is tested in each layer at every 15m intervals along the alignment. Further, to check erosion, turbing with netlon micro reinforcement provided on 2 top sides and grouted pitching below it.

REINFORCEMENT OF SOIL

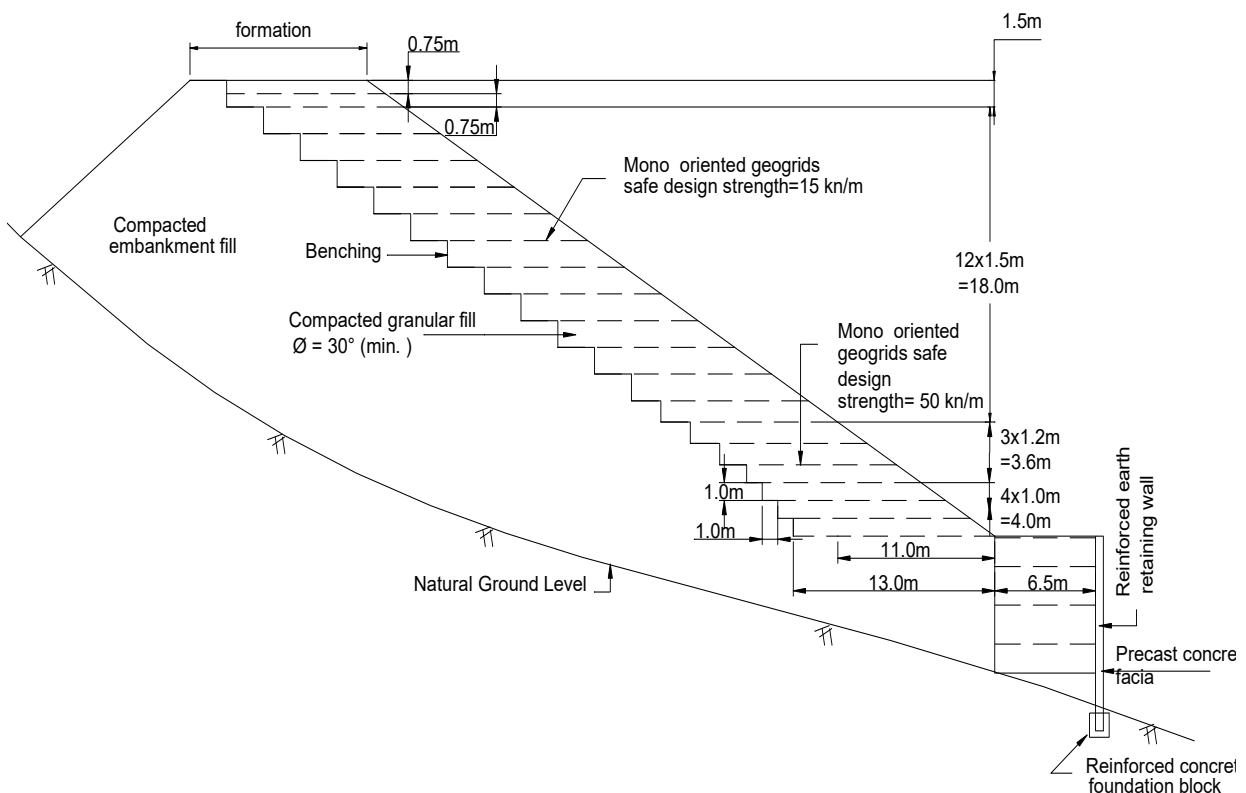
Reinforced soil is compacted soil reinforced with geogrids. Geogrids are stretched and ori-

ented grid structures made of HDPE polymer. The geogrid reinforced embankment has been designed by "Limit Equilibrium Method" using Jewell's Chart. The safe design strength of mono-oriented geogrids used in the design is 15 kN/m and 50 kN/m. The length of geogrid is 11m with total of 21 layers with spacing varying from 0.75m to 1.5m.

As per the construction scheme, granular fill material is laid and compacted in layers of 200mm thickness. Then mono oriented geogrid is placed at the designed spacing and then further 200 mm thick fill material is laid over the geogrid layer and compacted. It is ensured that geogrid alignment is horizontal. Polymeric micro reinforcement grids duly anchored are used for vegetation for erosion control of the slopes.

NON AVAILABILITY OF GOOD QUALITY EARTH

Good quality earth in railways parlands is defined as preferred fill material, whose technical requirements are laid by Geotechnical Engineering Directorate of Research design & standard organization, Lucknow. Few guidelines are the fill material should be coarse



grained soils with fines less than 50%, liquid limit less than 35% and plasticity index less than 15%.

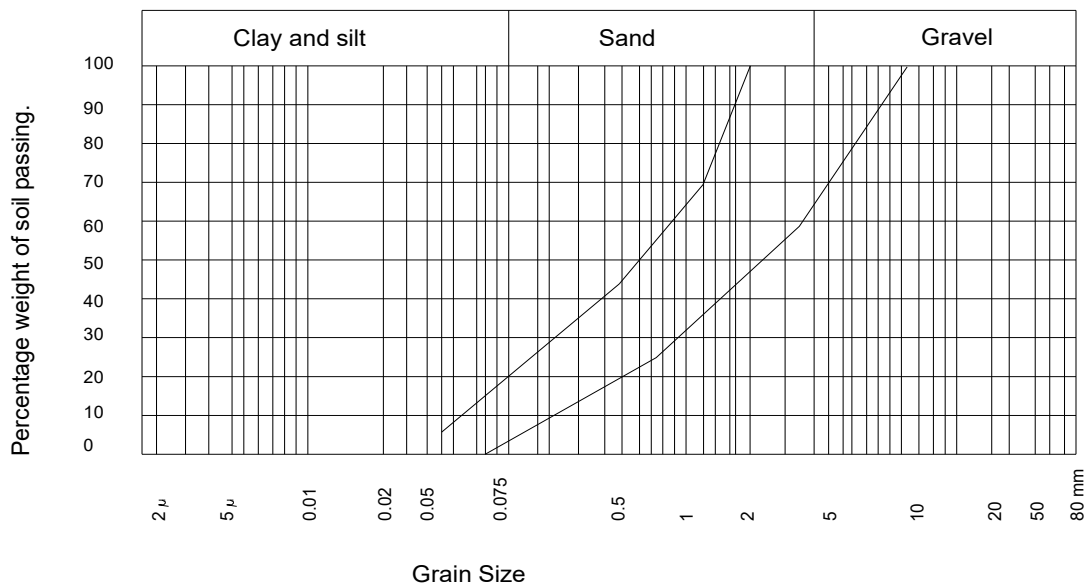
At a location on Jammu – Udhampur section. It was found that earth is not available and leading of earth from distance will not be economical. Thus, instead of embankment, construction of viaduct was planned and work on it is in progress.

CUT & COVER CONSTRUCTION

At many location where it was apprehended / found after Geo- technical investigation that cut slopes will not be stable or site was not permitting to go for cutting with 1(H):1(V) slope, construction of cut & cover in small stretch was resorted to. This has not only made construction activity safe but also eliminated the future safety concerns.

PROVISION OF BLANKET

The stresses caused by traffic are transferred from sleepers to sub grade soil through ballast and sub ballast/blanket. Formation like any other structure deforms under the traffic loads. If the deformations are small and terminating the formation is stable. If the induced stresses exceed the “threshold stress value” the formation fails. Large and permanent deformations in sub grade soils disturb track geometry and accumulate rain water. Stresses at the bottom of ballast may exceed the strength of subgrade soil resulting in puncturing of ballast and for-



Notes :-

- 1.No skip grading to be there.
- 2.Plastic fines should not exceed 2-5%
- 3.Non plastic fines allowed upto 8-12%.
- 4.Uniformity coefficient (D_{60}/D_{10}) in no case less than 4 preferably more than 7.
- 5.The coefficient of curvature ($D_{30}/D_{60} \times D_{10}$) to be within 1 and 3.

mation of ballast pockets.

Numerical analysis using Finite Element Modelling carried out in RDSO, Lucknow, in collaboration with IIT Kanpur, have shown that sub grade stresses reduce only marginally (4% to 6%) with the increase in rail section or sleeper density. However, the induced stresses reduce very drastically with the increase in depth of construction which is the sum total of depth of ballast and depth of sub ballast/blanket. Even experience gained on leading world railways show that provision of blanket layer of adequate depth is the most effective and economical way of reducing sub grade stresses to an acceptable level. Hence provision of blanketing as per requirement has been made.

BRIDGES

In the hilly terrain, the construction of the bridges has been a difficult task and posed numerous challenges. Apart from the complexity of design, the construction of these bridges requires great amount of planning and special techniques. The topography of the area resulted into long girders, combined with large pier heights. This part of paper presents various technical features and solutions adopted in construction of these bridges, some of which are being adopted for the first time on Indian Railways.

Planning of bridges

The alignment passes through unstable geological formations and highly undulating hilly terrain of Himalayas. A careful selection of alignment is being done to ensure shortest possible height and length of bridges, keeping in view the ruling gradient of 1 in 100 (compensated). The choice of alignment is most important for planning of bridges in hills. Detailed geological investigations were carried out. Geological features consisting of variable strata of sand rock, soft and hard shale, boulder studded soil, etc. have also influenced the bridge lengths and span arrangements. The long spans were necessitated due to siting of piers to avoid sloping banks and the flowing streams which are prone to flash floods and carry boulders. This has necessitated to go for cantilever method of bridge construction in some bridges. This method has the advantage of elimination of costly centering and false work and reduced requirement of shuttering and fast pace of construction. The design of the bridges in question has been a fairly complex and elaborate task. Detailed design criterion was developed which becomes bridge specific. Also the method statement was elaborated in the tender schedules. The long spans and tall piers associated with high seismic characteristics of the area have made the designs cumbersome and tricky. The bridges have been designed for Modified Broad Gauge (MBG) loading - 1987 as per Indian Railways Bridge Rules. The design complexities were further compounded by the stringent requirement of maintaining 5% residual compression in superstructure at all stages of construction which was finally relaxed to 'no tension' condition. For taking care of seismic conditions, site specific response spectrum was developed.

Site Specific Response Spectrum

The bridge sites lie in the Seismic Zone IV and V as per the current Seismic Zoning Map of India contained in IS:1893-1984. The data show that seismic events having Richter's magnitude greater than five occur at frequent intervals in this area. Therefore, a need was felt to prepare a site specific spectrum. The work was done by earthquake engineering department of University of Roorkee.

Geological Investigations

Trial bore holes using NX size heavy duty diamond rotary core drills were carried out at each foundation location upto a depth of about 1.5 times the width of foundation below the founding level. The soil samples collected were tested for bulk density, specific gravity, uni-axial compressive strength of rock and chemical analysis. The standard penetration test were carried out at very 30 cm depth. The founding strata consisted mostly of alternate bands of shale, sandstones, & boulder studded soil matrices. Hence, open raft foundations were adopted.

Construction of foundations

Excavation for foundations was done by drilling and blasting and mucking was done by hydraulic excavators. Well foundation were chosen for bridge No. 26 where aquifer was encountered during excavation and for Tawi Bridge because of heavy floods encountered in river Tawi, and scouring expected with the boulder-infested upper strata of the river bed. Pile foundations are not suitable for the boulder studded soils of the hilly region and hence were not used.

The cutting edge was fabricated in parts and then placed on the location and welded. There after, well curb was erected and concrete placed. Steining in M-25 grade of concrete was cast with the help of crane and concrete buckets and then sinking started. Blasting had to be resorted to dredge out conglomerate and sandstone, which was done very cautiously so as to avoid damage to the cutting edge and steining. Dredging was started with cranes and grab bucket, but later JCB loader (a small back hoe) was lowered with the help of cranes in the Tawi well, speeding up the dredging process.

Design of Foundations

Open foundations are designed in the usual manner. Some of them have become abnormally large due to the added problem of uplift of foundations owing to the large seismic moments. Minimum 75% contact area at the base has been ensured as per the provisions of IRS Codes for rocky strata.

The well foundations have been designed by and large as per IRC:78. The thickness of steining has been restricted to $1.25 (D/8 + H/100)$ subject to a minimum of 1.2m; wherein D = external diameter of well and H = height from bed level to founding level. Stability analysis for the well has also been done.

Construction of Piers

To avoid construction joints, piers are being cast using slipform construction. Slipform construction essentially consist of hanging shutters supported by yoke legs, which in turn are supported on the radial beams. This whole assembly continuously move upwards with the help of the jacks, taking reaction from the jack rods ensleeved in pier wall and resting on the bottom of pier. For tapering, the radius is reduced by turn buckles and sliding shutters. After completion of the piers the pier caps in M-40 grade of concrete were cast.

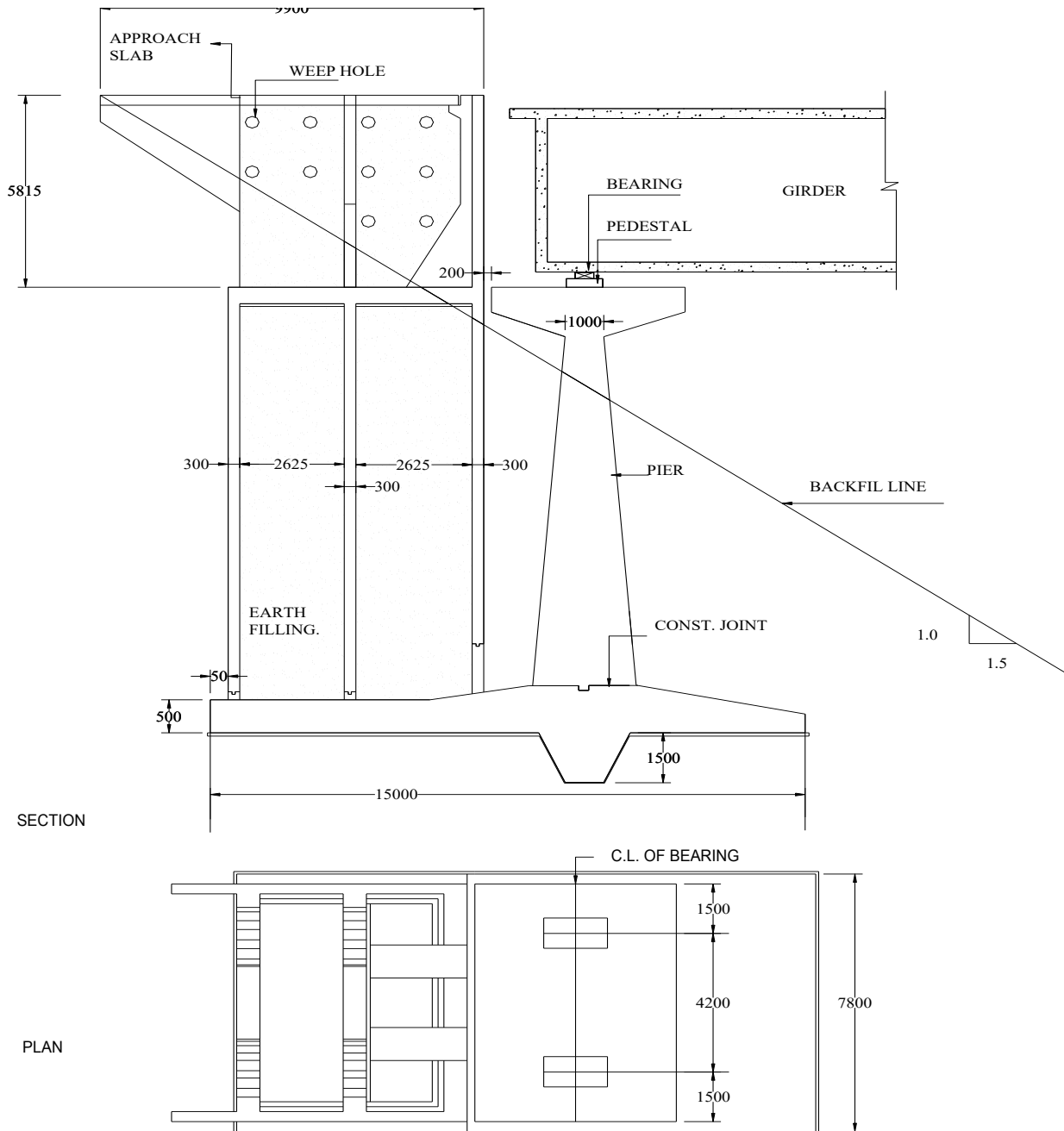
Design of Hollow RCC Piers

The hollow RCC piers constructed are of constant diameter and have been tapered. These are additionally checked for a temperature gradient of 20°C between the inside and outside faces of the pier shafts. Ventilation holes covered with GI wire mesh are being provided at regular intervals to reduce the temperature gradients.

Design and Detailing of Abutments

A unique design of abutment has been adopted. These innovative abutments are provided with a small size pier to take the vertical load and a reinforced cement concrete wall tank filled with earth for counter acting the horizontal forces, both supported by a common raft foundation with a provision of shear key at the base. This tank filled with earth adds to the weight and helps in overcoming the problem of sliding and the slender pier which is quite flexible, reduces the seismic forces.

Cantilever construction of Dudhar and Tawi bridges

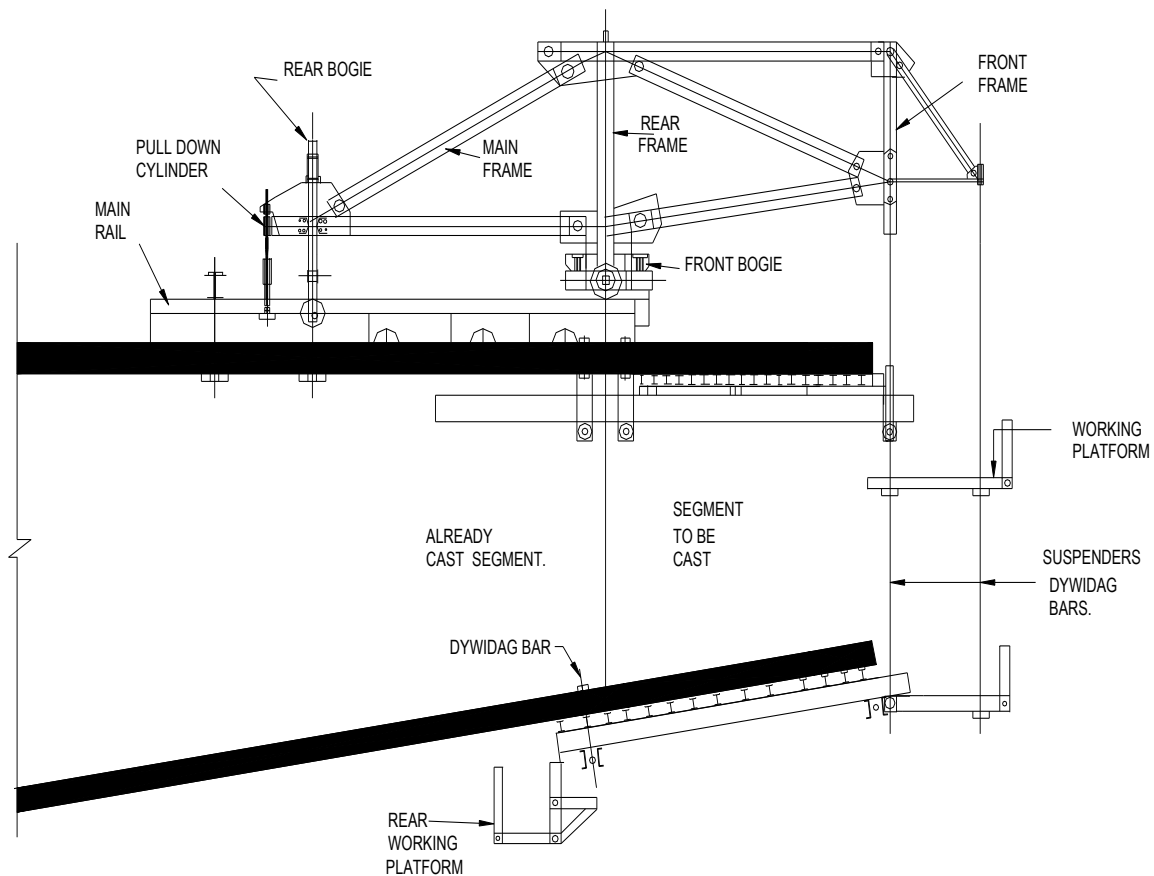


As per the cantilever construction sequence, pier head units about 10.5m long are cast over the pier cap and after attaining sufficient strength, the pier head segment is pre-stressed longitudinally. Then the cantilever construction equipment is erected over pier head unit and construction of cantilever segments starts. After casting of cantilever segments is complete, end span on either side is cast on staging and after concrete attains sufficient strength, the end span pre-stressed continuity cables are stressed. The vertical holding down pre-stress cables are cut off and packing plates removed so as to transfer the loads to the permanent bearings. Thereafter central segment for closure pour in the centre is cast on shuttering, supported from the two cantilever tips, and after concrete gains strength, the central span continuity cables are stressed.

TUNNELS

Tunnelling through Shivalik ranges of Himalayas is an extremely arduous and hazardous task. This part of the paper gives an overview of the planning, investigation and design, procedure for alignment control, methods of tunnelling and major difficulties faced so far along with their solutions.

Planning, investigation and design of support system



Railways engaged RITES, NHPC and WAPCOS for geo-technical investigation and provide consultancy on various aspect related to construction methodology, and design of tunnel support system for Jammu – Udhampur – Katra section. Geo – physical survey by seismic profile, and field and laboratory testing of soils and rocks was carried out. Further, geological profile were confirmed through core drilling. At many locations, investigation revealed that strata comprises of pebbles, cobbles, and boulders (upto 2 - 3 mtrs.) embedded in silty, sandy matrix, complete loss of return water indicating pervious nature of strata. Seismic velocity indicated that there is no firm bed rock , recovery very poor, and Rock Quality Designate was nil. Based on known geological condition, materials properties and construction procedure, tunnel support system was divided into five classes i.e. good, fair, poor, very poor, over burdened. Due to weak geology, it was decided to provide permanent steel support all along the length of tunnel along with provision of 300 mm thick concrete lining.

Procedure for alignment control

Before commencing the tunneling work, reference points were marked on ground and protected against damage from any construction activity. Relative position of reference points at both ends were determined in term of northing, easting and reduce levels. For this purpose, triangulation is done and also closed traverses are run along the alignment. The large overburden with thick forests and steep hills made this quite difficult. All permanent reference point are being maintained and checked from time to time for accuracy. In day to day checking, one second theodolite has been used where as periodical checking of alignment as well as permanent reference point has been done by Total Station. A slight difference between centre line of track and centre line of tunnel is kept in tunnels in curves to account for the tilt of the rail vehicle.

Method of tunneling

Key factors, determining the method of tunnelling, are the size and shape of tunnels, equipments available, conditions of geological formations and extent of supports needed. So far on Jammu – Udhampur – Katra section , use of Tunnel Boring Machine (TBM) was not preferred because of high initial cost of the equipment, small lengths of tunnels, the long commissioning and decommissioning time of TBMs, the requirement of D-shaped cross section for railway tunnels and non-availability of indigenous technology. Thus, the conventional method of tunnelling by drill and blast has been used. At locations where soft ground was encountered, the heading and benching method / multi drift method, using single / double ribs along with fore polling and grouting was adopted.

Problems faced and their solutions

SLIPS ENCOUNTERED

Work at Udhampur end of T.No. 1 on Udhampur – Katra section was started in May 2000 with following scheme.

1. Open excavation from Ch.2180 – 2220 i.e. 40 mtrs long.
2. RCC cut & cover from Ch. 2220 – 2290 i.e. 70 mtrs long.
3. Tunneling beyond Ch.2290 (Depth of cover at Ch.2290 = 22m)

Accordingly excavation was started between Ch.2180–2290. However, during Sept 2000

rains, the overlying loose strata on the LHS of alignment flowed over the underlying hard strata & the flowing material filled up the already excavated stretch between Ch.2240 – 2280. Slip got extended upto 80m on LHS of alignment. Due to the slip, construction scheme was revised as under:

- Cut & cover using single/double rib from ch. 2180 – 2270 i.e 90 mtrs long
- Tunneling beyond ch.2270.

However, while doing excavation beyond Ch. 2218, it was seen that slope on LHS were so unstable that it was impossible to concrete for cut and cover, due to continuous falling of loose material. In view of this, double rib construction methodology (by providing outer rib @ 500mm c/c, inner rib at @ 1000mm c/c & filling M-20 concrete in between the ribs) was adopted. Lagging was placed on outer face of outer rib & inner face of inner rib. This methodology made construction possible in this stretch, and accordingly, cut & cover with double rib was done upto Ch.2250 (i.e. for 32m). This scheme was executed taking 2 to 5 meter stretch at a time.

Tunneling through bouldery strata.

On Udhampur end of T.No. 1, Udhampur – Katra section, in a part length, the strata comprises of boulders embedded in sand / silt matrix. Tunneling through this strata posed serious problem, though it was planned with heading and benching along with fore polling. As the strata contains boulder, great difficulty was faced in driving fore poles. Also activity of fore polling was consuming unacceptable time and in 1st cycle, 22 fore poles of 28 mm diameter, 3 meters long, took 3 days. Since the fore polling was to be done in a considerable length, necessity of finding alternative scheme was felt. Accordingly, "fore polling adapter" was fabricated, which was attached to the jackhammer. This is a small improvised device fabricated with 40mm diameter G.I pipe 100-150mm long, with 10mm steel plate welded at one end. To enable placing of fore pole rods, side restraints are welded to 10mm steel plate. The adapter was then placed over a jack hammer fitted with a broken drill rod. Fore poles were then driven through a combination of jerky rotation & pushing action of the jack hammers. Due to this improvised tool, tunneling was made possible through bouldery strata soils.

CHIMENY FORMATION

Work at Katra end of Tunnel no. 1 was started in June 2000 with following construction scheme:

- i) 5/320 -5/280 Open excavation. i.e 40 mtrs long.
- (ii) 5/280 - 5/235 Cut & Cover. i.e 45 mtrs long.
- (iii) Beyond Ch. 5/235 tunneling.

Accordingly cut and cover construction was started from ch. 5/280 to 5/235 (i.e for 45 m) and tunneling was started from ch. 5/235 with full face conventional drilling & blasting method. The strata encountered in the beginning was pebbles in sand/silt matrix in a totally dry state. As tunneling progressed a patch of conglomerate started appearing on RHS of alignment. No difficulty was faced in carrying out tunneling upto ch. 5195. However, as a precautionary measure, no un-supported stretch was left at any stage during tunneling, and next cycle of drilling and blasting of 2 mtrs was carried out only when the earlier cycle of excavation was totally supported and backfilled. Beyond ch. 5195 some seepage was noticed and also loose

fall started occurring from the conglomerate patch on R.H.S, and the crown portion. Tunneling was continued beyond ch. 5195 upto ch. 5186.5, although the progress got slower due to difficult condition. At ch. 5186.5 the gap between the last backfilled rib (rib No. 97) and the face was only 30cm on RHS and Nil on LHS. However, due to loose strata, heavy loose fall started.

Inside the tunnel, cement bags filled with earth were placed to control the loose fall from rib no. 96- 97. Fore poling was done using girder ISHB 150 x 75 and umbrella was formed. Stiffening of already erected ribs were also carried out. Grouting from inside the tunnel and from the top, by drilling a hole, was carried out. Further ribs were placed by manual excavation following multi-drifting methodology.

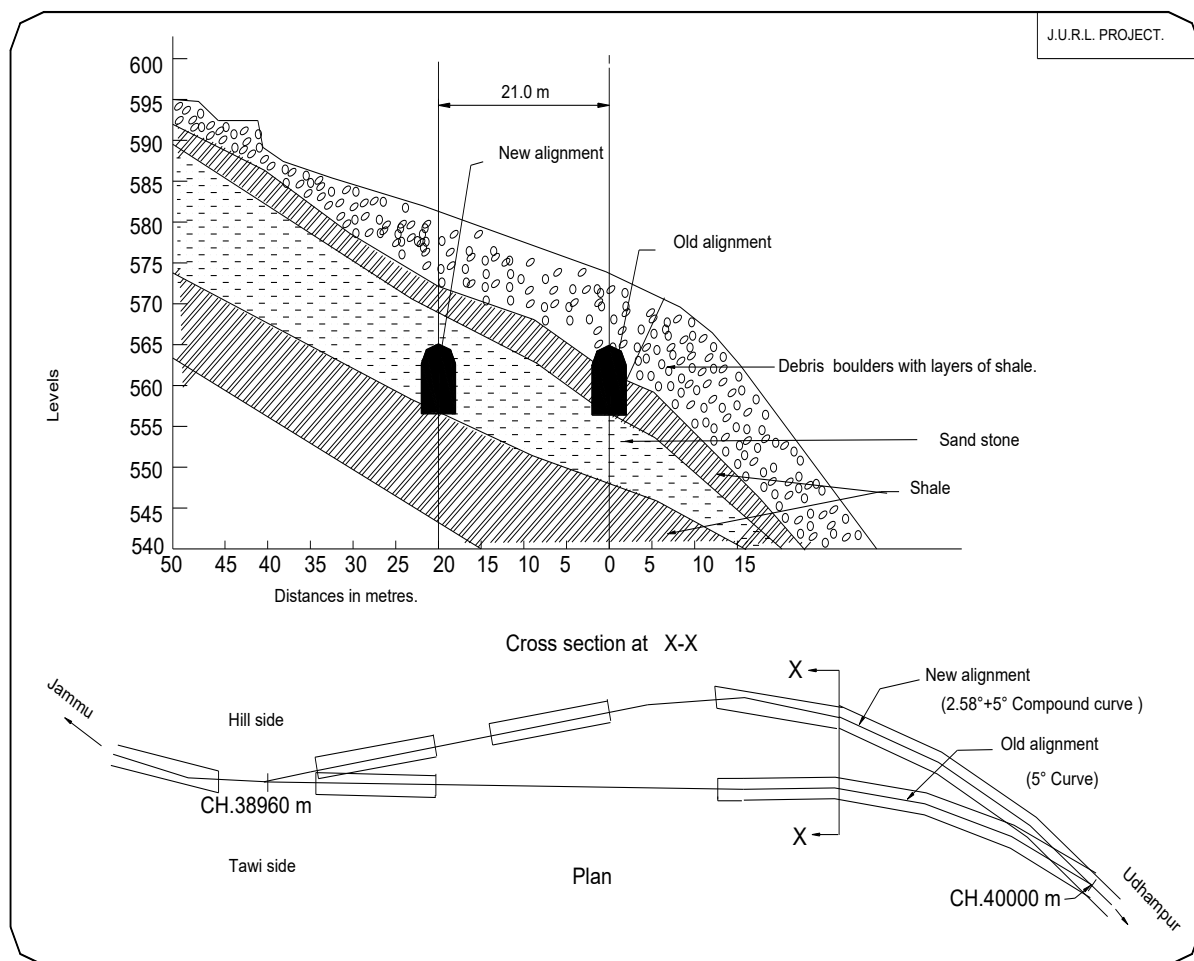
Alignment Shift

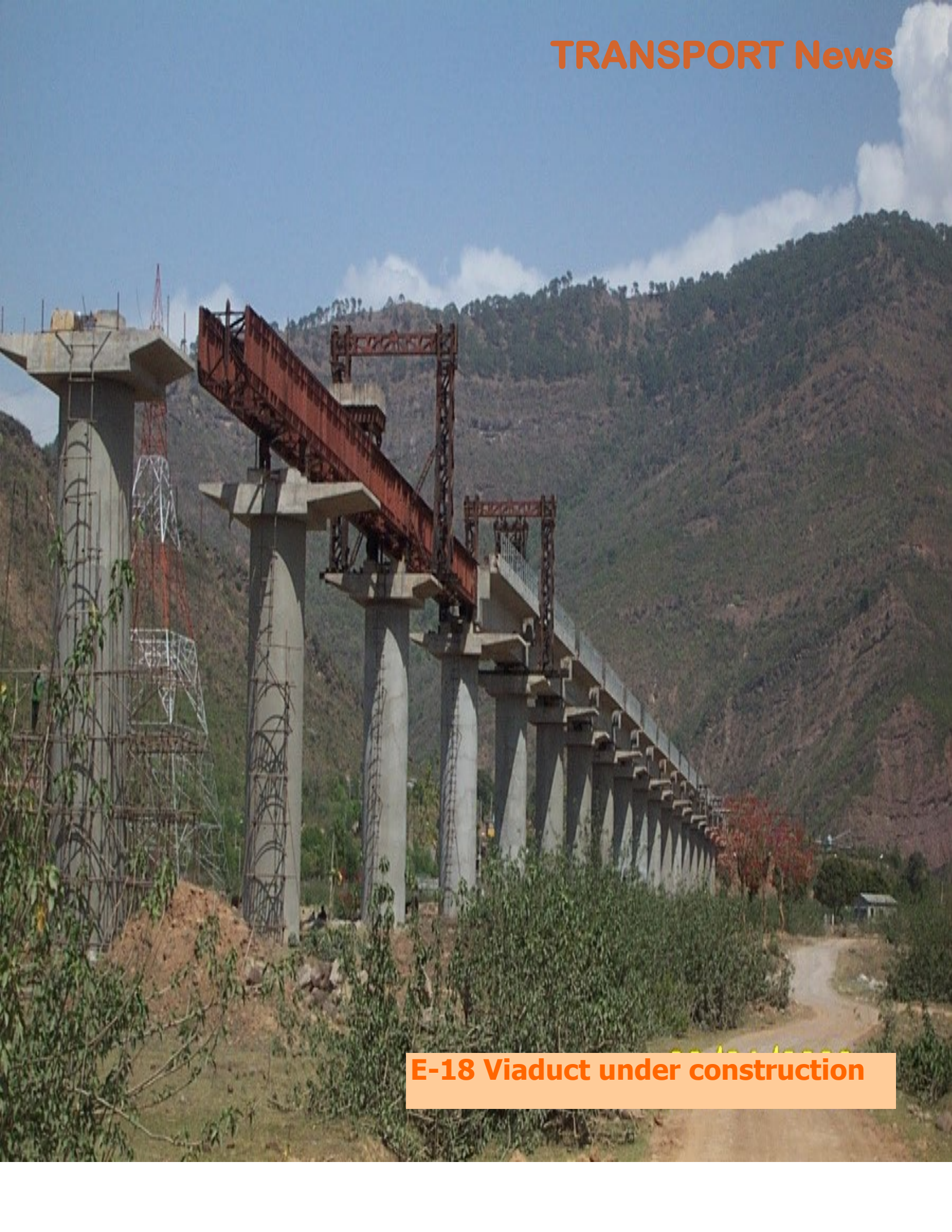
On Jammu – Udhampur section , tunnel No. 10 –E is in close proximity of Dhar-Udhampur Road. This alignment at some points passes across the hill with lateral ledge of about 20 m only. When the work was in progress some movement of ground was noticed on the hill slope. The detailed geo-technical investigations were carried out by boring 5 bore holes on the alignment, and up hill side. The over burden in this reach of the alignment consisted of loose boulders/debris in the upper strata of about 10-12 m thickness, and hence was found unsafe to undertake tunneling. It was decided to shift the alignment towards the up hill side by about 21m which ensured safe tunnelling. The over burden along this revised alignment was of loose boulders/debris in the upper strata of about 10-12 m thickness, and about 8 m thick cover of sand rock and shale which ensured safe tunnelling. This also gave additional lateral stability to the tunnel..

CONCLUSION

It is the romance of construction in such an area and in such a condition, that has brought the Railway engineers, along with so many others, to this project . The feeling of creating something in a territory never explored earlier by railway engineers, from an intellectual and professional view point, while exploring a fairyland, so much heard off, has lent an additional an interest in the project. Once a person gets linked to it, he or she wishes to be a part of it. The technological challenge has led the railways to pool in knowledge resources from many organizations. The engineers have learnt something new - in survey, in the creation of longitudinal sections of the alignment, and in creating the design criterion. They have improved upon the quality of work, and are creating methods and procedures for control and monitoring the soil in the Kashmir valley. Each step has been a challenge and a learning experience. This has been seen in the creation and fostering of team spirit amongst state, security and army agencies operating in the area. In the beginning, only a scanty few were willing to come to the project, and today many are wanting to.

After completion the public will see only the flora and the fauna while traveling by train, but some will wonder while travelling across the tall bridges, long tunnels, long viaducts and high embankments as to how they were envisioned, designed, and created. This will be a history of challenges, to be seen, and then re-told.





E-18 Viaduct under construction