CHINA STUDY TOUR
BY NEW DELHI OFFICE TRANSPORT TEAM

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NDO Transport Team
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1.0 INTRODUCTION

1.1 The Government of India is planning to increase investment in the infrastructure sectors from the current level at 5% of GDP to 8% of GDP by the end of the 11th Five Year Plan. Based on broad economic indicators, it has been estimated that the investment needs among the infrastructure sectors during the period 2006-07 to 2010-11 would amount to about US$360 billion. Investment on this large scale will only succeed if the construction industry undergoes major reforms and the capacity of Government agencies is enhanced to implement large numbers of projects. The road subsector would need investments of about $55 billion in these five years, out of which 44% are estimated to be private investment in the form of PPP projects.

1.2 The World Bank’s transport sector portfolio in India has now reached about $5 billion, mainly in the road subsector, including the National Highway Development Program, various state highway programs, and the national Rural Roads Program. However it is likely that the Bank’s involvement in other subsectors like ports, railways and urban transport will also increase in the near future. These developments are quite similar to China’s extensive infrastructure development programs following their reforms during the 1980s and 1990s and their recent expressway development program.

1.3 In order to gain first-hand experience of reforms and effective project implementation, the transport team of the India country office undertook a study tour to China from October 21st to 28th, 2007. The objective of the study tour was to raise awareness and learn from China’s experience with transport sector reforms, road construction industry initiatives and effective project management measures to achieve accelerated delivery of large infrastructure projects. The focus of the study tour was on the road and urban transport subsectors.

1.4 The team visited Bank-funded projects in Hubei province, which included the Hubei Shi-Man Highway Project, an inland waterway project (the Bank’s fifth in China), a completed stretch of the Hubei Xiao-Xiang Expressway and the Wuhan Urban Transport Project. In addition, the team held fruitful discussions and meetings with officials of the Ministry of Communications (MOC), Hubei Provincial Communications Department, the Wuhan Urban Transport Project Office, contractors, consultants and the transport team of the World Bank Beijing office.

1.5 This report presents the experience gained and lessons learned during the tour, which could benefit transport unit staff in their day-to-day task management and sector dialogue with the industry stakeholders, including the Government of India.

2.0 HISTORY OF HIGHWAY PLANNING AND DEVELOPMENT IN CHINA

2.1 Roads in China are classified as national highways, provincial highways (equivalent to state highways in India), county roads (equivalent to district roads in India), township/community roads (urban roads), village roads and special purpose roads based on the administrative jurisdiction. Classification by technical standards includes Expressways1 (width 28m), Class I (25.5m), Class II (12m), Class III (8.5m) and Class IV (7m). The national highways link the provinces, autonomous regions, municipalities, important large and medium towns, economic and

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1 ‘Expressway’ is the term used in China for what in Europe is called a ‘motorway’ and in the USA an ‘interstate’ or its equivalent: a divided highway with grade-separated interchanges and controlled access throughout, closed to non-motorized vehicles. Almost all national expressways are tolled.
technological development zones, key raw material sources, major transport terminals and other important economic centers. The network growth in China by technical classification is presented in Table 1 below.

Table 1: Highway Network Growth by Technical Classification

<table>
<thead>
<tr>
<th>Year</th>
<th>Total (‘000)</th>
<th>Expressway</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Class IV</th>
<th>Non-classified</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>942</td>
<td>0.0</td>
<td>0.4</td>
<td>21.3</td>
<td>128.5</td>
<td>456.3</td>
<td>336.0</td>
</tr>
<tr>
<td>1990</td>
<td>1,028</td>
<td>0.5</td>
<td>2.6</td>
<td>43.4</td>
<td>169.8</td>
<td>524.8</td>
<td>287.2</td>
</tr>
<tr>
<td>1995</td>
<td>1,157</td>
<td>2.1</td>
<td>9.6</td>
<td>84.9</td>
<td>207.3</td>
<td>606.8</td>
<td>246.2</td>
</tr>
<tr>
<td>2000</td>
<td>1,403</td>
<td>16.3</td>
<td>20.1</td>
<td>152.7</td>
<td>276.7</td>
<td>750.3</td>
<td>186.7</td>
</tr>
<tr>
<td>2004</td>
<td>1,871</td>
<td>34.3</td>
<td>33.5</td>
<td>231.7</td>
<td>335.3</td>
<td>880.9</td>
<td>354.8</td>
</tr>
</tbody>
</table>

Source: NDRC Comprehensive Transportation Research Center, October 22, 2005
Note 1: After a road census in 2000 the length of unclassified roads was adjusted

2.2 As evident from the table, from 1990 to 2006 during the period of the eighth, ninth and tenth five-year plans, China completed nearly 45,000 km of high-grade toll expressways through the investment of about $40 billion per year. This unprecedented expansion in the expressway network was accompanied by continuing development of intermediate Class I and II roads under the coordinated efforts of the Central Government and the 31 provinces and municipalities. No other country has been able to create such a major enhancement to its national road asset base in such a short period.

2.3 The development of expressways occurred in two stages. The first, from 1988 to 1997, was called the “kick off”, since expansion was gentle. The second stage was from 1998 to the present, and known as the “rapid development” period. There was no real middle stage because of the Asian financial crisis in the late 90s, in response to which the Chinese used highway construction as a vehicle for stimulating the economy.

2.4 Development of roads and road transport has been assigned strategic importance in the economic development of the country since the implementation of the Reform and Opening Up Policy in 1978. In 1992, the State Council issued a National Trunk Highway Development Program (also known as “5-7 Trunk Highway Development Plan” or NTHDP), consisting of five vertical (N-S) and seven horizontal (E-W) routes with a total length of 35,000 km, to be developed for implementation in 15 years. However, the government has achieved this target much sooner and over 45,000 km expressways have already been built by the end of 2007. In 2005 the central government issued the revised “7-9-18” Expressway Trunk Development Plan, to expand the initial “5-7” plan to have expressways link all provincial capitals and all the large and medium-sized cities with populations of more than 200,000. This was to be achieved by the construction of 7 vertical, 9 horizontal and 18 expressways linking the others through radial and grid patterns to maximize coverage and connectivity. The current NTHDP target is to complete 85,000 km by the end of 2020.

2.5 The NTHDP has been planned ‘strategically’ to inter-connect the country through high-speed road corridors connecting all the important centers of activities, rather than based on a detailed economic analysis, considering projected economics, centers of economic growth, traffic growth and distribution. The basic approach for network planning in China is: (i) the tree rooted at Beijing connecting all the provincial capitals, (ii) all chords connecting provincial capitals, (iii) all cities with population over 200,000, (iv) all rail hubs, (v) all ports, (vi) all major airports, and
(vii) the old trading routes. The traffic growth has been forecasted using the elasticity approach with respect to GDP, assuming 0.8-0.9 for passenger traffic and 0.6-0.8 for freight traffic. Many of the completed expressways carry low volumes of traffic, only 5,000 to 10,000 vehicles a day – well below the volumes normally required for economic viability. However, the construction costs of most Chinese expressways are unusually low and the share of trucks is unusually high, as is the rate of traffic growth. A further consideration is that toll rates may have been set too high. So at least in some cases the correct conclusion may be that they were built a few years earlier than warranted by economic cost-benefit analysis, and/or that toll rates should be cut.

2.6 The Government has started to pay increased attention to rural roads development since 2003. During the period 2003-05, $7 billion were invested in rural roads. The Government has adopted a policy to provide at least one paved road to each big village. The state council has provided about $19 billion for the period 2006-2010 for development of rural roads. The MOC has also developed guidelines for rural roads design. They have pavements 4m wide and 200mm thick, made of cement concrete, at an average cost of only $40,000 per km. In some places brick pavements and cement-treated bases are also used.

3.0 CURRENT ADMINISTRATIVE STRUCTURE OF HIGHWAY SECTOR

3.1 The administrative system of highways in China has four levels based on the principle of “Unified leadership with multi-level authorities.” The MOC is responsible for the formulation, implementation and supervision of the development strategies. Provincial communications departments (PCDs) established by the provinces, autonomous regions or the largest municipal governments 2 are responsible for the construction, maintenance and administration of highways within their jurisdiction. The detailed administrative works are implemented by highway and expressway divisions or bureaus established under the PCDs. Municipalities and counties also have their own communication bureaus (divisions).

4.0 FINANCING THE NATIONAL TRUNK HIGHWAY DEVELOPMENT PROGRAM

4.1 In the past five years the government has invested about RMB 2,000 billion ($250 billion) in road construction. Thereby it has increased the total road network to about 3.5 million km, including rural and local roads, connecting 100 percent of counties, 98 percent of townships and 86 percent of administrative villages. The highway investment in 2006 was $90 billion.

4.2 The funding is provided through general tax revenue, a tax on vehicle purchase (central government), the so-called ‘road maintenance fee’ (an annual tax on commercial vehicles), a Passenger and Freight Service Fee, tolls, bonds (partly central government), loans from international organizations and foreign governments (the debt service for which is fully passed down to the province), domestic loans and private investment. Central funding is made up of plan funds and the auxiliary tax on vehicle purchase (10 percent of the vehicle price). Provincial funding consists of government investment, highway construction/maintenance funds and bank loans. So-called ‘social’ fund raising consists of bonds, stocks and paid transfer rights for collecting tolls, as well as contributions by farmers for rural roads.

4.3 The main sources of funds, almost 85 percent of the total for the road sector, are the local funds and domestic bank loans. Of the local funds, about two thirds are in the form of loans by

2 The four largest cities—Beijing, Shanghai, Guangzhou and Tianjin—have the legal and administrative status of a province.
the different levels of local governments. The central government provides only limited funding, about 10 percent, for the national highway system and the rest is provided by the provinces. The so-called ‘private’ investment (generally equity investment by state-owned enterprises managed independently) is less than 10 percent of the total investment. Direct private investment in the construction and operation of expressways is not significant. The state budgets and foreign loans provide the remaining funds.

4.4 **Tolling** is one of the main sources of financing the expressways. Tolls are used for servicing the debts of the local governments, as well as to pay for maintenance and operating expenses. In most cases, where the construction is funded by the government, the tolls are collected only until the loans are repaid. The toll rates in China are very high in comparison to the affordability of the users. In terms of toll to be paid for travelling 1,600 km on expressways as a percentage of per capita income, it is the highest in the world, at over 2 percent, compared to only 0.2-0.3 percent in the USA and 0.5 percent in most other developed countries. This causes some commercial traffic to divert to local roads or to overload in order to cut down their operating costs. Besides the expressways, tolls are also charged on Class I and Class II national highways, albeit at lower rates than for expressways. These roads use an open tolling system with toll gates at an average of every 60 km. However, there is much resentment in the public on the tolling of Class II roads and the government is thinking about ending this practice.

4.5 Most roads suffer from inadequate funding for maintenance. Only about one third of the ‘maintenance fee’ collected from users is actually spent on maintenance and the rest on new construction. The total requirement for maintenance of the major road network, excluding rural roads, is of the order of RMB 120 billion per year but only RMB 50 billion is provided. It is estimated that the maintenance backlog is about RMB 150 - 200 billion. There is a need for improving the maintenance funding and planning to ensure proper asset management.

5.0 **INDUSTRY REFORMS BY CHINA TO IMPLEMENT NTHDP - ONE OF THE LARGEST CONSTRUCTION PROGRAMS IN THE WORLD**

5.1 **Building Management and Technical Capacity**

5.1.1 At the beginning of the expressway planning in the late 70s, the Chinese construction industry had no experience of high-quality design, procurement, construction and management of highways. The expressway expansion was discussed and planned for 10 years before it really took off in 1988. Major challenges in the 1980s were to provide an efficient highway network which could meet the needs of various clusters of the society; to cope with rapid traffic growth on major transport corridors; to provide fast highway linkages between developed and underdeveloped regions; and to reduce high accident rates due to the lack of separation between fast and slow-moving traffic. The common debate among policy makers was to decide whether China really needed an expressway system. What about the financing and in-house technology? Was China’s construction industry ready?

5.1.2 All companies in China were state-owned enterprises (SOEs) but none were adequately experienced to undertake the new expressway expansion on their own. The government of China understood that international contractors who undertake mainly large scale and technically complicated projects would bring to their Chinese counterparts advanced technology, improved management techniques and modern, high-tech equipment. They therefore invited the international contracting community to become involved with their initial expressway projects, but with strict requirements that all contractors had to bid the project as a joint venture with local Chinese construction companies as partners. This was specifically required to ensure that the
local highway construction industry could benefit from technology transfer and develop its own capacity. The international contractors attracted to China were mainly from Hong Kong, Japan and South Korea.

5.1.3 MOC reported that in the early stage of expressway development they facilitated bringing together 500 road engineers from several SOEs and formed a team which brainstormed and developed a blue print for the NTHDP. Ably assisted by some international specialists, this task force reviewed the international (mainly USA, Australian and Japanese) standards and developed the expressway standards and specifications to be adopted for China. The MOC organized training to build capacity in the provincial agencies, while provinces dispatched study tours to other countries to improve their knowledge. During these early days China was learning and building capacity.

5.2 Evolution of the Industry Structure

5.2.1 Prior to 1976 during the leadership of Mao Zedong business enterprises and communes, including construction organizations, were all directly controlled by the central or provincial governments. This was the time of the “iron rice bowl”, when enterprise workers were guaranteed life-long employment and security even if the enterprise was over-staffed and lacked financing to provide adequate services. Construction was viewed at this time as a simple activity of assembling materials, plant and other items made by the other sectors of the economy to create building or civil engineering works and was considered to add no significant value to the total social product. Most of the central ministries formed their own construction companies to implement their own specific capital projects.

5.2.2 In December 1978 the Government announced the decision to shift the focus of its work from class struggles to economic development. This historic decision catapulted a major economic reform. The need for reform in China was highlighted by the problems with the SOEs. In 1984 it had been recognized that the policy of using SOEs as a social framework for employment was leading to major inefficiencies and debt due to bloated pay rolls, redundant construction, and incompetent management. Accordingly the Government introduced a “responsibility” system for enterprise managers to separate economic management of the enterprise from political presence within these organizations. This provided the managers with much greater flexibility and control over whom they could hire and fire. This in turn led to SOE employees, who once had a job-for-life situation, now facing job insecurity and working on temporary contracts. In 1993 the Government decided that due to the inefficient operation of SOEs, large and medium-sized SOEs should in future be run on a corporate basis. Accordingly the State Economic and Trade Commission was set up in May 1993 to formulate sectoral programs for SOE reform. Since 1998 the number of SOE employees has dramatically reduced and incompetent managers have been sacked. Many SOEs turned to the talent market for new management recruits, including attempts to attract foreign managers.

5.2.3 The government started believing that construction could be a profit making industry. Agreement was reached on a series of reform programs which introduced market mechanisms into the construction industry. The reforms required state bodies to:

- Diversify ownership of construction enterprises.
- Deregulate employment in the construction industry to allow companies to hire and fire or downsize to reflect the actual market conditions.
- Deregulate building materials supply to avoid manufacturing or supply based on central policy rather than demand.
• Diversify the business scope of construction enterprises.
• Use bidding procedures to allocate construction work.
• Bring the construction industry under the unified administration of the Ministry of Construction (MOCn) and its local agencies.
• Further privatize the state-owned construction enterprises.
• Separate field operations from management.

5.2.4 In many cases the SOEs were assigned to provinces, autonomous regions, municipalities and counties, for the purpose of carrying out construction projects in those areas—a practice continued to the present. The companies assigned to local governments are normally grouped in one or more corporations that report to the local construction commission. These corporations plan, organize, direct and coordinate the activities of the subordinate companies. At present there are about 1,000 such construction entities and 400 design institutes employing about 2.2 million workers. Out of those about 500 firms are in the Class A category, with some having annual turnover in excess of $30 billion. In addition to the SOEs there are collective construction enterprises in both urban and rural areas that have expanded rapidly since the 1984 reforms. Urban collectives have been developed and are under the administration of municipal, borough, district, and town governments or community committees. They are normally given small and relatively simple work to complete and act somewhat like a small public works unit. There are approximately 25,000 urban collectives. Rural collectives or brigades are owned and run by townships or villages and are employed to build houses or small projects. There are currently some 50,000 such brigades in China. They are normally restricted to their own communities, although they can take part in projects in other parts of the country with permission from the local construction commissions. Both urban and rural construction brigades are allowed to work in urban areas as either a general contractor, subcontractor or a labor-only contractor on major works for the SOEs.

5.2.5 From the start of the expressways program it was established that the provincial governments would be responsible for the design, implementation and construction of the expressways and each province had its specific SOE teams to complete the work. The quality was initially not good but it improved gradually with imported technology and the experience of working with international consortia. Every project they completed led to greater experience and the number of teams developed rapidly. In the early days the provincial communications departments would tend to use their local construction enterprises, but the principle of competitive bidding became very well established in China and SOEs centrally and provincially were permitted to bid against each other for contracts. This led to a strengthening of the industry’s capacity through good and transparent business practices.

5.2.6 As the expressway program developed, small entirely private enterprises were spawned from the SOEs. These are still small and are normally specialist subcontractors. The general consensus is that the prospect of large, fully independent, private construction companies being created in China is not likely in the near future, due mainly to the competition and experience of the SOEs. However the reality is that the large SOEs are, in many cases, operating according to the same market principles and forces as a completely private company and enjoy substantial private ownership through share holdings. According to some estimates, the Chinese highway construction industry has developed its capacity to a level estimated at three times greater than demand, so China’s construction capacity is now being exported.
5.3 Building Manpower Capacity

5.3.1 China enjoys wide manpower resources from the many central and provincial SOEs. It was only up to the mid/late 90s that the capacity was considered to be insufficient to meet the demands of the expressway program. The Chinese highway industry rapidly learned from their international joint venture partners and the MOC now reports that it is now unusual to require the assistance of the international highway building community on expressways. The process by which large SOEs win expressway bids in the provinces and then hire smaller SOEs and private subcontractors to complete specific sections or supply particular trades on the project has rapidly developed the supply chain for manpower in the industry. There are also technical colleges and professional schools where some higher caliber labor can be trained.

5.3.2 Skilled operators for plant and equipment have been trained initially by the international machine manufacturing companies who, when selling plant and equipment to Chinese companies, arranged either to train operators in their own country and/or to send trainers to China with their equipment to work alongside the trainee operators.

5.3.3 There has never been a shortage of high caliber civil engineers in China. The profession is highly regarded in the community and salaries are higher than the average for other professions and even the IT industry. There is great competition for students entering civil engineering streams in certain universities, and particularly in certain institutions.

5.4 Procurement and Legal Framework

5.4.1 In 1996 a Construction Law was prepared by the central, provincial and municipal governments to unify all issues such as qualifications for entry into the construction industry, procurement, delivery of works, construction supervision, safety and quality, legal liability, market regulations and procedures in construction projects. The law integrates all existing construction related regulations issued from different sources and was intended to govern all activities in the construction industry. It was enacted in November 1997 and put into effect in March 1998.

5.4.2 Generally contracts are competitively bid as regular price contracts based on a bill of quantities and the winning SOE then sublets to smaller subcontractors. Sub-contracting is capped at 30% of the overall contract value. Occasionally SOE contractors may be awarded a contract through a negotiated agreement, but this is only for a very small portion of the projects. If private money is being used through a concessionaire contract, the concessionaire may elect to use a particular contractor or the contractor may be part of the concessionaire’s venture. There has also been a growing acceptance in China to use other forms of procurement such as Design Build/ Turnkey and BOT. However, the use of BOT has been seen not to be too successful in the Chinese highway construction market.

5.4.3 Up to 2003 competitive bidding had been recommended but was not mandatory. This changed in May 2003 when “Measures on Tenders and Bids for Contracts for Construction Projects” became effective. These measures provide procedural and substantive requirements for the tendering, bidding, opening of sealed tenders, evaluation of tenders, declaration of winning tenders and the awarding of contracts. It is a process that is mandatory for the selection of a contractor for all projects where the size falls within the scope set by the Rules on Standards of the Scope and Size of Construction Projects for Tenders. The bids are highly competitive and it was reported by the MOC that for highway projects on average bids come in about 20% lower than the estimated costs.
5.4.4 Transparency International reported in May 2004 that “China is leading the way in introducing international best practice into its tendering and project management anti-corruption systems”. China has also recently (2004) introduced blacklisting measures for any companies found to be guilty of bribery or corrupt practices.

6.0 PROJECT IMPLEMENTATION

6.1 Project Management

6.1.1 The project implementation units (PIU) or the ‘legal persons’, as they are called in China, are set up for each project. These units have a high degree of autonomy in project implementation and are fully accountable for timely and quality completion of the project. Such units are typically headed by an officer of Chief Engineer rank ably supported by several competent construction engineers and managers, engaged for the full project term and rotated from one project site to the next. Typically for an expressway project (of say 100 km) the PIU consists of a fully dedicated team of about 50-60 staff. It is responsible for overall project implementation, including procuring and managing design and construction supervision services, carrying out pre-construction activities, and procuring and managing the construction contracts. The Finance Bureau in the respective province plays a key role in overall coordination, management and monitoring of project implementation. The Finance Bureau’s anticorruption department (equivalent to CVC in India), audit departments and comprehensive department (responsible for overall coordination among various agencies) are fully involved during implementation and collectively endorse large contract variations (above 15% of contract value).

6.1.2 Urban transport projects are often completely located within a municipal area. This is the case of World Bank-financed projects in Wuhan and other large cities such as Shanghai or Tianjin. In such case agencies in charge of road construction, bus operation and several utilities report to the same vice-mayor. This reporting relationship facilitates the coordination and speedy implementation of urban road transport projects. However, such institutional integration does not extend to rail systems, nor to traffic police, making coordination with them difficult. [Some projects have been complicated by the allocation of responsibility for the inner city to the municipal counterpart of the Ministry of Construction, while responsibility for the suburbs rests with the counterpart of the Ministry of Communications.]

6.2 Project Preparation - Surveys and Design

6.2.1 Great attention is paid and precision is attached to surveys, investigations and detailed project designs. In China, there are about 15,000 qualified highway design engineers employed in 410 large (Class A and B combined) survey and design institutes in the 31 provinces. In addition, there are several hundred small Class C design institutes responsible for design of rural and lower category roads. Entry requirements to the design institutes are often quite stringent and a Masters degree in a relevant field is a minimum. These institutes attract the best talent, as salaries offered are substantially higher than those in construction.

6.2.2 Precision and advanced topographic survey methods (like aerial photogrammetry and GPS) are followed and due care is taken in quality control, as surveys, investigations and designs are carried out by the same agency. China follows a lifetime accountability system for project designers and constructors, which creates a strong incentive for quality and precision in designs. It is well recognized that designs are dynamic in nature and the core design team is maintained.

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3 The Finance Bureau is the counterpart at province level of the Ministry of Finance
throughout the project implementation. Time and cost overruns on account of design deficiencies are unheard of in China.

6.2.3 For a greenfield expressway project (of say 100 km length) concept to detailed design typically takes about 36 months, almost the same time required for construction. The cost of designs is typically 2.5-3% of the overall project cost (compared to about 1% or less in India). There are also several levels of checks and balances in the design process. After the preliminary concept designs and alignments are verified by the MOC and the National Development and Reform Commission, the detailed designs are assigned to the provincial survey and design institutes. Further, the detailed designs are independently verified by other competent design institutes and academicians in reputed institutes. Moreover, the survey control points are handed over by the designers to the implementing agency and the contractor(s) after a thorough joint verification at the start of construction and the designers remain liable for any clarifications on the survey issues during the entire period of implementation. The result of this strong review and checking procedure is fewer design changes or surprises during construction in China.

6.3 Project Preparation – Preconstruction Activities

6.3.1 In China land is collectively owned and is usually acquired for public projects by land redistribution among the affected communities. Loss of livelihood is also compensated with generous benefits, including resettlement housing and sometimes with job guarantees. The provinces negotiate with the local counties and villages for redistribution of land and provide adequate compensation for the households. Typically 100% of land acquisition and 90% of pre-construction activities are completed before the contracts are awarded and projects spend up to 5% of the overall cost for such activities. Special rehabilitation cells are formed as part of the project implementation units to handle the land acquisition and resettlement issues. Usually land acquisition is completed in a month, while resettlement and rehabilitation activities take about 5-6 months. Moreover, utility relocation is usually well coordinated among the implementing agency and other utility agencies and the provincial Finance Bureau also plays a coordinating role to expedite such relocations.

6.4 Project Supervision

6.4.1 The supervision team at project level is composed of provincial government staff led by the Chief Engineer, fully authorized to make on-site decisions and to issue instructions. Design engineers are available to guide supervision staff throughout the construction period. The supervision is quite manpower intensive. To give an example, for a 100 km long expressway about 150 full-time supervision staff are employed for the full duration. The highway/expressway works are typically implemented in two stages. In the first stage earthworks, protection works, cross drainage and bridge works are undertaken in contracts of about 10 km each stretch. In the second stage all pavement works, road furniture, electrical and mechanical (e.g. traffic signals, lighting, and ventilation in tunnels) and other finishing works are taken up in contracts covering stretches of 30-40 km. The time duration for each stage is about 18 months for a new greenfield project. Usually all projects are completed in time and within cost, in spite of no provision of penalties for late completion in the contract. Completion dates (with countdowns) are publicly displayed and delay in completion is considered a failure on part of both the implementing agencies and the contractors, which carry with them substantial reputation risks.

6.4.2 During implementation, four levels of quality control are exercised. While intense supervision is carried out by the project implementation unit and the supervision consultants supporting the implementation units, periodic inspections are carried out by MOC and also the
local community (called social inspection). The construction enterprises also perform their own ‘enterprise self checking’ to ensure strict quality control.

6.4.3 Mobilization requirements are quite stringent. To cite an example, the contractors for structural works have to mobilize at least 25% of the formwork required so that the structures can be completed in 4-5 pourings. Use of mobilization advances (typically 10% of the contract) is closely monitored by the implementing agency, and joint accounts operated by joint signatures are set up for all expenses out of the advance. Advanced resource-based project management tools are employed for monitoring project progress. All contracts have dispute resolution provisions that include adjudication, through an individual adjudicator or a dispute review board (DRB), followed by arbitration as the next step. Due to the Chinese culture that encourages a team approach to resolving problems, disputes are generally resolved rapidly and at site level. Apparently it is considered a failure on behalf of the project team if a dispute were ever to get to arbitration and the actual use of the adjudicator or DRB on highway projects has generally not been necessary, due to the intent of all parties to resolve issues as they occur.

7.0 VENDER QUALIFICATION AND CREDIT SYSTEM

7.1 The MOC is responsible for managing the qualification and performance management system of Project Legal Person, Contractors, Supervision Enterprise and Survey/Design Enterprise in the country, in close coordination with the provincial communications departments.

7.2 The MOC and provincial communication departments are responsible for appointing the Project Legal Person for each project. Project Legal Persons are classified as Class A for all classes of highways or Class B for just Class II highways and below.

7.3 **Contractors:** Construction agencies are broadly divided into three categories: General Highway Construction Contracting Enterprise (highway, railway, hydraulics etc), Professional Contracting Enterprise (bridges, tunnels etc) and Labor Subcontracting Enterprise (by the type of work). The classification ‘General Highway Construction Contracting Enterprise’ is further divided into three categories, namely Highway Road Surface Project Professional Contracting (pavement works), Highway Roadbed Project Professional Contracting (earthworks) and Highway Transportation Project Professional Contracting. The following are the classification/qualification categories and numbers of General Highway Construction Contracting Enterprises in China:

- **Special Class Enterprise : General Project Contracting (7)**
- **Class I Enterprise : Highway Projects of all Classes (482)**
- **Class I Professional : Highway Projects of all Classes (79)**
- **Class II Enterprise : Highway Projects of Class I and below**
- **Class III Enterprise : Highway Projects of Class II and below**

7.4 **Supervision Agencies:** Project Supervision Enterprises are classified into three grades (A, B and C) and three specialties (special independent bridge, special independent tunnel and electrical-mechanical engineering). Grade A and B are approved by MOC, while Grade C is approved by PCDs. There are 270 Grade A, 100 Grade B and 300 Grade C supervision enterprises in China.

7.5 **Survey and Design Institutes:** Survey and Design enterprises are also classified into three grades (A, B and C). Grade A and B are approved by MOC, while Grade C is approved by PCDs. The following are the classification criteria and numbers of survey and design institutes in
China:
- Grade A: divided into highway, bridge, tunnel and transportation projects (150)
- Grade B: Highways of Class II and below (300)
- Grade C: Highways of Class III and below (1000)

7.5 Highway Construction Credit System: The MOC has recently set up a national highway construction enterprise information system, and some provinces are also developing provincial information systems. These systems are intended to share the classification and credit rating of these enterprises among stakeholders, including the public. The MOC is currently working at a five-level credit evaluation system (AA, A, B, C and D) to monitor performance of the enterprises.

8.0 ROAD SAFETY

8.1 Road accidents have been a major problem all over the world. Every year about 1.2 million people are killed and 50 million people are injured on the world’s roads. In China also, road accidents have been increasing. In 1999 there were 83,500 deaths and 286,000 injuries. These have increased to 98,738 deaths and 469,911 injuries in 2005. China’s accident rate of 7.6 deaths per 10,000 vehicles is high compared with the accident rates in countries like the USA, Japan and Malaysia. However, China is addressing the road safety issue in a comprehensive manner following international best approaches. These include collection and analysis of road accident data, setting targets for improved safety, defining the agencies responsible for achieving them, enacting legislative procedures for supporting interventions, and addressing safety issues in all parts of the project cycle i.e. during planning, design, construction and operation of highways.

8.2 During the planning stages of the NTHDP, China developed standards for the highway system to be adopted for the upcoming highway and expressway projects. This approach resulted in uniform standards all over the country, fostering uniformity, reliability and safety during driving.

8.3 China has been able to reduce the accident rate on its high-traffic core network by: (a) reducing the number of possible conflict points at each intersection from over 20 to zero, (b) eliminating slow moving and two-wheeler traffic on the core network, (c) controlling access to the network through well designed entrance and exit ramps. The long-distance traffic which uses the expressway network enjoys the advantages of gentle and long slopes, long curves, long sight distances, good drainage systems facilitating quick disposal of water and improving skid resistance, large traffic sign boards, elaborate road markings, crash barriers on the median and along the sides to avoid head-on collisions and vehicles overturning. These design features contribute to reducing the number and severity of accidents. The team also noted that pavement surfacing in China uses relatively open-graded courses with mastic asphalt, which improve the skid resistance of the surface.

8.4 The MOC and the PCDs are responsible for the ‘Engineering’ aspects of road safety. For ‘Education’ and ‘Enforcement’ the Ministry of Public Security (police) and provincial communications departments are responsible. The Ministry of Public Security is also responsible for compliance with regulations on licenses, vehicle conditions and driver testing. In 2004 the Chinese Government enacted a Highway Law and its first National Road Safety Law, which define the regulations, agency responsibilities and implementation arrangements. Enforcement activities undertaken by Chinese authorities include compulsory seatbelt wearing, speed limit restrictions, and checking overloading.
9.0 SOCIAL AND ENVIRONMENTAL ASPECTS

9.1 As discussed above, China has streamlined procedures and policies for land acquisition, resettlement and rehabilitation. In addition, a social assessment manual has also been prepared jointly by the World Bank and the Asian Development Bank in consultation with the Chinese government. It is widely used during preparation of external aided projects. The norms of compensation are rather generous and the credibility of the government is very high in terms of timely payments to the project-affected people, thus there is little resistance from the public. Each major project generally has a resettlement office working from the design stage through to the construction. The entire land acquisition, resettlement and rehabilitation activities take about 5-6 months. However, project-affected people are becoming more active and resettlement implementation time is lengthening in China.

9.2 The emphasis on environmental measures like Bio Engineering and drainage is given high priority during design as well as construction. The team noted some good practice examples for slope treatment during the field visit using bio engineering.

10.0 LESSONS LEARNED WHICH CAN BE APPLIED IN THE INDIAN CONTEXT

Several lessons learned from China’s experience can be applied in Indian conditions.

10.1 Strong need for advance planning and capacity building. Before embarking upon any major highway development program, the stakeholders, particularly the government, should undertake assessment and measures to enhance the country’s policy and design capabilities and to augment the capacity of construction and the associated supply chain industry to meet the demand, in addition to developing uniform policies and standards.

10.2 Strong emphasis on design quality and reviews. There should be a strong design review mechanism built into the system of project approvals. The design consultants should have a life-time responsibility for their work built into contracts and their input should continue until construction is complete. More effort and time should be spent on surveying, data collection and design and more funds should be allocated for these very important project preparatory activities. The design costs are much higher in China (typically 2.5% of project cost) compared to India (typically 1%) and in China about 40-50% of the overall project period is spent in surveys and design, while in India it is less than 20% of total time [but the extra time and cost spent on design are more than recouped later through timely construction within budget]. To ensure better quality engineers, the salaries for design engineers have to be comparable with other industries. In China the design engineers are offered substantially higher salaries than their counterparts in construction or even than the average pay in the IT industry. Entry requirements to the design institutes in China are often quite stringent and a Masters degree in a relevant field is a minimum.

10.3 Putting enough manpower and attention into completing land acquisition and pre-construction before starting works is also amply rewarded by subsequent rapid construction. In Hubei, although land acquisition and resettlement are easier than in India, large teams are mobilized within the implementing agency to work speedily on these issues with success.

10.4 Precision and advanced topographic survey methods (like aerial photogrammetry and GPS) are followed, and due care is taken in quality control, as surveys, investigations and designs are carried out by the same agency. The lifetime accountability system for project designers and constructors also creates a strong incentive for quality and precision in designs. It is well
recognized that designs are dynamic in nature and the core design team is maintained throughout project implementation. Time and cost overruns on account of design deficiencies are unheard of in China.

10.5 **Partnering approach among stakeholders:** There is a need to inculcate a partnering approach among the contractors, consultants and employer for the success of the project, which the team observed during its visits to project offices in China. In China most disputes are resolved mutually and very few disputes are referred to arbitration.

10.6 **Contract enforcement.** Chinese experience demonstrates the efficacy of strict contract enforcement, management, and monitoring of completion dates by government officials at highest level. The majority of contracts in China finish within the stipulated contract time and budget due to this practice. The project completion dates and completion countdown measures are publicly displayed, which puts substantial societal pressure on the project authority for timely completion of projects.

10.7 **Stricter mobilization requirements and control.** In China joint accounts are set up for mobilization advances to monitor their use and avoid the diversion of funds to other contracts by the contractor. Moreover, the mobilization requirements are much more stringent in China than in India. To cite an example, for structures the contractor must mobilize 25% of the staging, centering and shuttering materials (formwork), so that the work can be completed in four to five cycles of casting.

10.8 **Supply chain industry.** There is a need to strengthen the supply chain industry and agencies specialized in pavement, earthwork, road furniture and maintenance, etc. The strong supply chain industry can attract foreign contractors with good project management skills.

10.9 **Faster decisions on variations and design changes.** Decision making in China is fairly decentralized, in contrast to the highly centralized decision making practice in India. Moreover, the overwhelming fear of vigilance (intrusive audits) also slows down decision making in projects in India. In China such situations are averted by fully involving the design consultant, the anticorruption department (equivalent to CVC) and the audit department in arriving at decisions on large variation orders.

10.10 The **Ministry of Finance’s role in coordination.** There is a need for the Ministry of Finance and its provincial counterpart (state level in India) to play a major role in inter-agency coordination for large projects and programs, which the team observed in China. There is a separate department under the Ministry of Finance in China called “Comprehensive Department’ for carrying out this role, including the relocation of utilities and the inter-departmental transfer of assets.

10.11 **Vendor database and performance monitoring system.** The Government should develop a national and state-level database of the various classes of contractors and consultants, as well as a system to monitor their performance.

10.12 The creation of authorities effectively empowered for coordination of planning and implementation of the multiple agencies involved in urban transport projects in a given urban area will facilitate speedy implementation.