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Cover Story

Legacy of Railways in Pakistan

History: The Euro Tunnel

The Pakistan Civil Engineer

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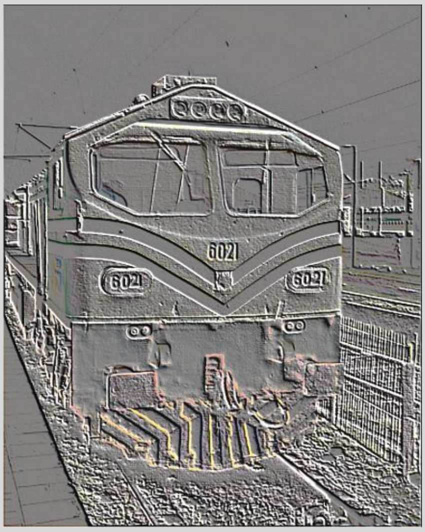


Editorial

It is a matter of some consolation – if not pride – that PSCE, despite its extremely meagre resources, is successfully taking out the sixth issue of the Pakistan Civil Engineer.

Undertaking small, but regular and professionally significant activities, PSCE feels that it is one of the most active professional bodies of the country.

We would wish to have further support from the readers, by way of their contributions, than is currently available to us.

Rizwan Mirza

Rizwan Mirza
Editor-in-Chief

Cover Story

Legacy of Railways in Pakistan

Rizwan Mirza
CEO, Rizwan Mirza, Consulting Engineers

The present railway network of Pakistan was inherited, from the British Raj. It was in 1937 that the British started the forerunner of a modern economy in their Indian colony – a railway train. This was not only new for India, but also a relatively new mode of transport in the whole world.

There is evidence that the first railway line, in British India, was an initially three mile long line from Red Hills – to the north of Madras City, which gets its name from the red hills there – to the stone quarries around Little Mount – a small hillock in Chennai, along the banks of the River Adyar – but this eventually merged with RHR's permanent line. The purpose of the line was transportation of granite for the construction of roads, which lead to an estimated annual saving of Rs 28,000 in a Rs 60,000 budget for building roads in the Presidency. Although, the train was primarily intended for freight, it did carry some passengers. Interestingly, the initial concept was that the train would be pulled by animals but two or three steam locomotives were also employed. The rolling stock is believed to have comprised very unpretentious road-carts on railway wheels. The rail, itself, was produced in Parangipettai, Cuddalore district.

However, the commonly accepted date of the start of railways in India is 1861 and not 1937, as has been reflected in the commemorative postage stamp above.

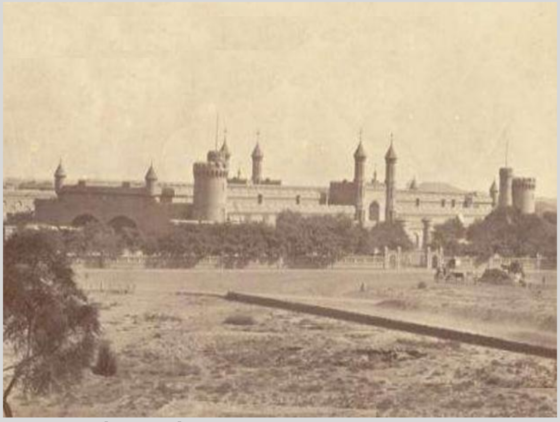


Figure 1: Lahore Railway Station, 1886

The 1840s witnessed the discourse that lead to the formation of railway companies. Two major railway companies were formed in the 1840s: the East India Railway Company (EICR) in 1845 and the Great Indian Peninsular Railway (GIPR) in 1849. The Madras Railway Company (MRC) was formed a little later, in 1853.

In Britain, the 1840s was a period of enhanced and feverish interest in railways, with investment directed towards the stocks of rather unregulated railway companies, especially during a period of 1844 to 1847. This had widespread effects that spilled over to Europe as well as to the British colonies.

In India, the issue of railways was a topic of general debate both at the official level as well as in the newspapers. Special interest was noticed in Bombay and Calcutta.

Figure 2: Rowland Macdonald Stephenson

The key proponents of railway development were Rowland Macdonald Stephenson (1808–95) and Lord Dalhousie. Stephenson eyed places beyond Calcutta or India and had railway plans extending to China too, linking Calcutta, Peking and Hong Kong. In 1859, he travelled to Hong Kong to muster support for his idea. In 1844, John Chapman (1801–54) prepared the first proposal for the GIPR, and this plan was favourably received by Stephenson. Stephenson had submitted his first private proposal to the East India Company in 1841, only to be rebuffed as an impractical concept. He, however, continued to doggedly pursue the idea and travelled to Calcutta in 1843, as a representative of the Steam Navigation Company, to lobby the government of India officials, in this regard.

In Calcutta, he wrote a piece advocating his idea, which was published in the *Englishman* in 1844. He had no less than six main railway lines in mind:

	From	To	
1	Calcutta	Mirzapur / Delhi	through coal fields and with an extension to Ferozepur
2	Bombay	Mirzapur / Delhi	
3	Bombay	Hyderabad	Leading to Calcutta
4	Hyderabad	Madras	
5	Madras	Bangalore	Mysore and Calicut
6	Madras	the southernmost tip of the country	via Arcot

The proposed network considered both military as well as trade reasons, connecting the interior to the nearest ports.

His success began with the 1844-45 report resulting in the formation of EICR in 1845, with Stephenson as the first agent and chief engineer. Stephenson's actual plans were more ambitious. He wanted to connect London and Calcutta, with two breaks: one at the English Channel and the other at the Dardanelles, which plans he even proposed to the British government.

Stephenson found many local businessmen whose interests coincided with his as they also hoped to greatly benefit from the two-way trade that would follow. These included Dwarakanath Tagore (1794-1846) , Ramkamal Sen (1783–1844), Mutty Lall Seal (1791–1854) and Ram Gopal Ghosh (1815–68). Ram Gopal Ghosh, a truly modern mind, even discussed the social changes that the railway revolution was likely to bring. He proposed segregation of carriages to reflect the grossly stratified society, especially mentioning the Muslims, the high-class Hindus, the low-class Hindus and the women.

Figure 3: Dwaraka Nath Tagore

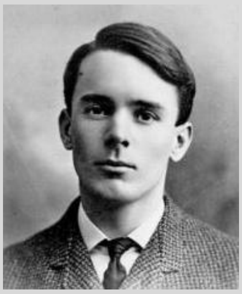


Figure 4: Ram Kamal Sen

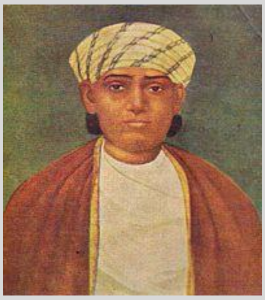


Figure 5: Moti Lal Seal

Figure 6: Ram Gopal Ghosh

The class system conceived at that time outlived the expedience of the time.

Figure 7: The class system of carriages

Gauges, across the early British collieries, had not been standardised as yet. Public railway gauges adopted those followed by collieries. The existing lack of standardisation, thus, crept into the public railways also. It ranged from 1,219 mm (4'-0") to 1,524 mm (5'-0"). In India and Pakistan, the broad gauge is 1,676 mm (5'-6"); there is a metric gauge of 1,000 mm (3'- 3 $^{3}/_{8}$"); and narrow gauges measuring 610 mm (2'-0") or 762 mm (2'-6").

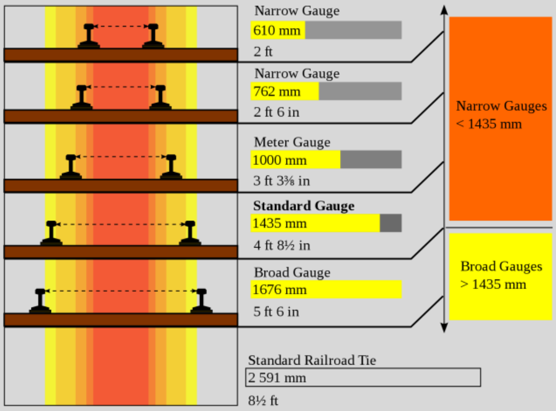


Figure 8: Diversity of Railway Gauges

Britain, in 1845, set up a Royal Commission on Railway Gauges, which lead to the promulgation of the Railway Regulation (Gauge) Act, of 18th August, 1846. It prescribed standard gauges of 4 ft 8 ½ in (1,435 mm) for Great Britain, and 5 ft 3 in (1,600 mm) for Ireland. The 7 ft (2,134 mm) gauge, designed by Isambard Kingdom Brunel, when engineering the Great Western Railway, was limited to the south west of England and Wales. The law stated that these railways "shall be constructed on the Gauge of Seven Feet". Being so singled out, the 7'-0" broad gauge of Brunel, gradually went out of favour.

In that 1850, Lord Dalhousie suggested a gauge that would be between 4 ft 8½ inches and 7 ft. The former is still followed in Gawadar, Pakistan.

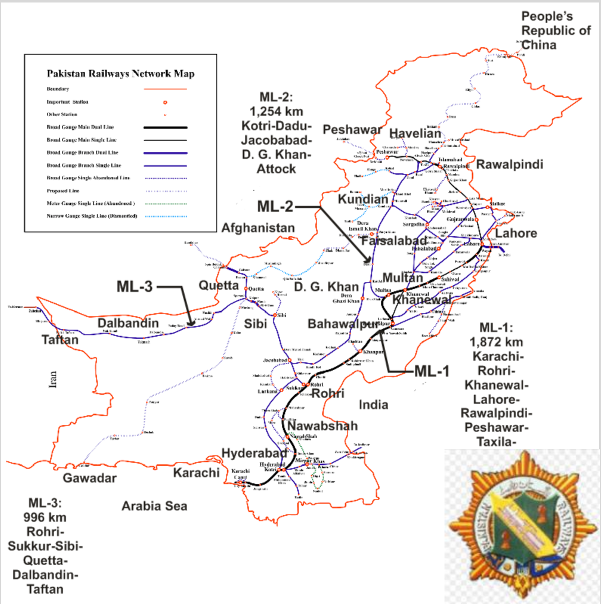
The railways became a major employer of people during the British period. Railway colonies were constructed to accommodate the foreign and local employees.

Figure 9: A view of Mayo Gardens -- the colony constructed for British railway officers, during the Raj days

Trains also played their role during partition. Images of crowded trains, during the mass and bloody migration of 1947, still haunt the memories of people on each side of the divide.


Figure 10: Crowded trains during mass migration in 1947

Following map shows the present railway network of Pakistan:



According to official data, the network of Pakistan Railways has 7,791 kilo meters of line which connects most of the major cities of Pakistan, with a total of 527 railway stations. The system owns 465 diesel electric locomotives. The rolling stock comprises 1,822 passenger coaches and 16,159 freight wagons. Every day, some 123 passenger trains and 23 freight trains ply on the network.


Figure 11: The crowded railway station of Lahore

During the fiscal year 2018-19, more than 60 million passengers travelled through Pakistan Railways while more than 8 million tons of freight was transported. The passenger traffic volume is around 26 billion passenger kilometres per year while freight traffic volume is 8 billion ton kilometres per year.

In 1993, Pakistan Railways establish a locomotive manufacturing facility at Risalpur. Spread over 257 Acres of land, it has an installed capacity of 25 DE locomotives per year.


Figure 12: PR Locomotive manufacturing facility, Risalpur

Pakistan Railways has the following maintenance facilities:

	City	Description	Year
1	Lahore	Loco shop, Mughalpura	1912
2	Lahore	Carriage and Wagon shop, Mughalpura	1927
3	Karachi	Diesel Workshop	1962
4	Rawalpindi	Central Diesel Locomotive Workshop	1965

As the entire system of Pakistan Railways ages, railways bridges are no exception and merit immediate attention. There are some 13,959 bridges in the network of Pakistan Railways, out of which 159 bridges need some repair works, according to the government figures.


Figure 13: Railway bridge at Attock, over Indus River

On 2nd July, 2015 at 1200 hours, a Pakistan Army mixed train was derailed near at Chanawan bridge on the Upper Lower Chanawan Canal, near Jam ke Chatta, Gujranwala. At least seventeen people were killed and over 90 were injured. The army battalion had boarded the train at Pannu Aqil and was heading towards the garrison town of Kharian. Suspected reasons ranged from sudden braking after over-speeding to sabotage. The steel plate-girder bridge deck rested over brick masonry piers, typical of such bridges in the British period.

Figure 14: Collapsed Chanawan steel plate-girder bridge

Figure 15: Collapsed Chanawan steel plate-girder bridge – A close-up

The unfortunate history of Pakistan Railways is full of accidents, starting as early as in 1953. These include collisions, derailing, fire and sabotage. But unfortunately, the real causes are never made public and apparently no actions are taken to prevent a repetition of these incidences in future.

The importance of railways, as a mass transit system, can hardly be overemphasized. If the British could realize its potential as early as in 1940's, it is not understandable why the huge infrastructure inherited from the Raj cannot be managed to advantage today. Professionals are required to analyze the system, identify its long-term and short-term dividends and suggest a logical line of action.

Dynamic Compaction – A Ground Improvement Technique

Muhammad Ashfaq Hanif[1]

Soil improvement, in its broadest sense, is the alteration of any property of a soil to improve its engineering performance such as strength, reduced compressibility, reduced permeability, or improved ground water condition.

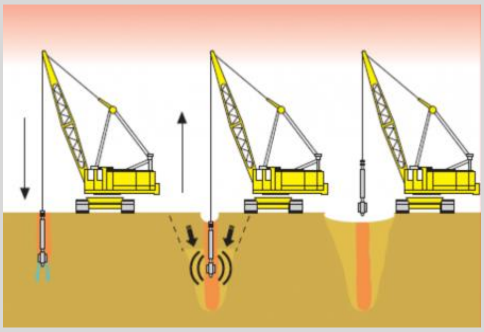
Ground Improvement refers to a technique that improves the engineering properties of the soil mass treated. Usually, the properties that are modified are shear strength, stiffness and permeability. Ground improvement has developed into a sophisticated tool to support foundations for a wide variety of structures. This may be either a temporary process to permit the construction of a facility or may be a permanent measure to improve the performance of the completed facility.

One of the oldest methods of soil densification is surface compaction.

Construction of a new road, a runway, an embankment or any soft or loose site needs a compacted base for laying the structure. If the depth to be densified is less, the surface compaction alone can solve the problem. The usual surface compaction devices are rollers, tampers and rammers. All conventional rollers like smooth wheel, rubber-wheeled, sheep foot, vibratory and grid rollers could be used.

[1] Project Manager, Saudi Electricity Company, KSA

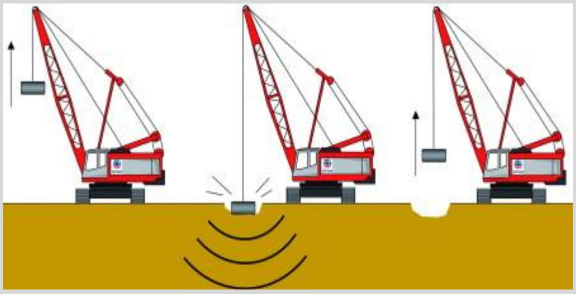
Vibration methods can be effectively used for rapid densification of saturated non-cohesive soils. Vibrations and shock waves in loose deposits of such materials cause liquefaction followed by densification accompanying the dissipation of excess pore water pressures. Some of the mostly adopted vibration methods are blasting, Vibrating probe, Vibratory rollers, Vibro-displacement Compaction Piles, Vibro-floatation, Heavy Tamping etc.



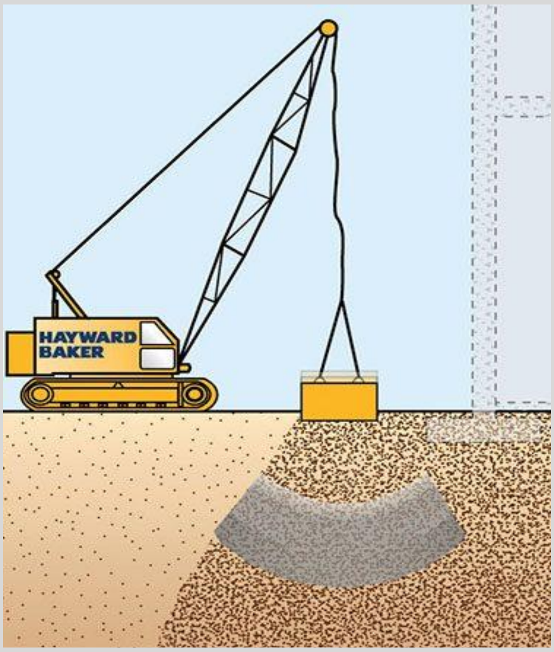
Chemical Stabilization has been widely used in the form of lime, cement, fly ash and the combination of the above is widely used in soil stabilization. Chemical Stabilizations reduce permeability of the soils, improve shear strength, increase bearing capacity, decrease settlement and expedite construction. Chemical Stabilization is used for surface soils more successfully. Mixtures of soils and chemicals are mixed either mechanically in place or by batch process. Some of the chemicals used are Lime, Cement, and Fly Ash. Dynamic compaction is a ground improvement technique that densifies soils and fill materials by using a drop weight. A heavy tamper is repeatedly raised and dropped from a specified height to impact onto the ground surface, thereby transmitting high compaction energy into the soil mass. The depth of improvement depends upon the tonnage of the weight and the height of the fall. The degree of improvement depends upon the amount of energy applied per unit area. The tamper shall be raised and dropped by a single cable with a free spool hoisting drum. Dynamic compaction uses the energy from a falling weight (10 to 40 ton tamper) to improve granular soils and fills. The drop weight, typically steel, is lifted by a crane and repeatedly dropped onto the ground surface. Vibrations transmitted below the surface improve soils at depth. The drop locations are typically located on a grid pattern, the spacing of which is determined by the subsurface conditions and foundation loading and geometry.

Treated granular soils and fills have increased density, friction angle, and stiffness. It has also been used to compact construction debris and urban fill as well as sanitary landfills prior to construction of parking lots, roadways, and embankments. The removal of compressible, contaminated fills can sometimes be avoided.

The impact of the free fall creates stress waves that help in the densification of the soil. These stress waves can penetrate up to 10m. In cohesion less soils, these waves create liquefaction that is followed by the compaction of the soil, and in cohesive soils, they create an increased amount of pore water pressure that is followed by the compaction of the soil. Pore-water pressure is the pressure of water that is trapped within the particles of rocks and soils.



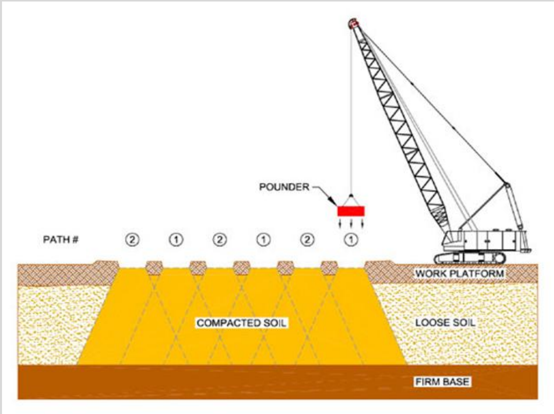
The degree of compaction depends on the weight of the hammer or tamper, the height from which the hammer is dropped, and the spacing of the locations at which the hammer is dropped. The initial weight dropping has the most impact, and penetrates up to a greater depth. The following drops, if spaced closer to one another, compact the shallower layers and the process is completed by compacting the soil at the surface.



Most soil types can be improved with dynamic compaction. Old fills and granular soils are most often treated. The soils that are below the water table have to be treated carefully to permit emission of the excess pore water pressure that is created when the weight is dropped onto the surface.

Dynamic compaction works best on deposits where the degree of saturation is low, the permeability of the soil mass is high, and drainage is good. Deposits considered most appropriate for dynamic compaction include pervious granular soils. If these deposits are situated above the water table, densification is immediate as the soil particles are forced into a denser state of packing. If these deposits are situated below the water table, the permeability is sufficiently high, excess pore water pressures generated by the impact of the tamper dissipate almost immediately, and densification is nearly immediate. Pervious granular deposits include not only natural sands and gravels but also fill deposits consisting of building rubble, some mine spoil, some industrial waste fill such as slag, and decomposed refuse deposits. Dynamic compaction extends the range of compactable soils beyond that which is ordinarily undertaken by conventional compaction. Ordinary roller compaction would be very difficult on some of the coarser grained pervious deposits such as boulders and cobbles, building rubble, or slag deposits.

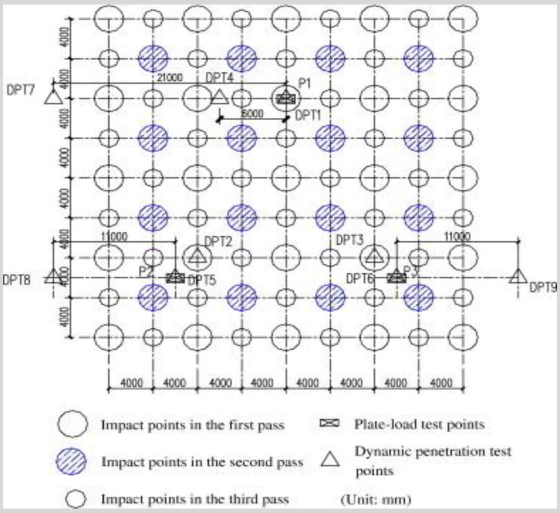
When a tamper strikes the ground, vibrations are transmitted off site. The vibrations are largest when heavier tampers and higher drop heights are used. If dynamic compaction is undertaken in a congested area, some off-site structures could be affected by the ground vibrations.



Predicting settlement before and after dynamic compaction can be done using the test results of conventional procedures such as the SPT, CPT, or PMT tests. In very loose deposits such as recent landfills, SPT, CPT, or PMT test procedures for estimating settlement can be misleadingly low. Settlement predictions in recent and mid-age landfills based upon SPT and PMT tests have been found to underestimate the settlement that was measured by actual load tests on landfills before dynamic compaction. Large objects within the loose fill matrix cause misleadingly high SPT values that result in low settlement predictions. The pressure meter is inappropriate in deposits that are still consolidating under their own weight. Except for these recent-age landfills, conventional settlement predictions made for other sites provide reasonable estimates of settlement and differential settlement.

The depth of improvement is primarily a function of the mass of the tamper and the drop height. Using tampers in the range of 18.1 to 22.7 Tons and drop heights on the order of 22.9 to 30.5 m, the maximum predicted depth of improvement would range from about 9.1 to 12.2 m. For most projects, this is an adequate depth of improvement. Even if loose deposits extend below these levels, the pressure increase relative to the existing overburden pressure is generally very small, so the contribution of settlement from these deeper unimproved deposits may not be large. If ground improvement must be attained at depths greater than 9.1 to 12.2 m, dynamic compaction in combination with other Improvement systems can be used.

The energy is generally applied at a relatively tight grid spacing over the entire area to be densified. The high energy drop point locations do not have to be contiguous since some of the energy distributes laterally into the soil mass. A drop point spacing of 1% to 2% times the diameter or width of the tamper is common. In the fine grain soils where there is a concern with pore water pressures developing in the soil, the work plan should provide for two or more phases.



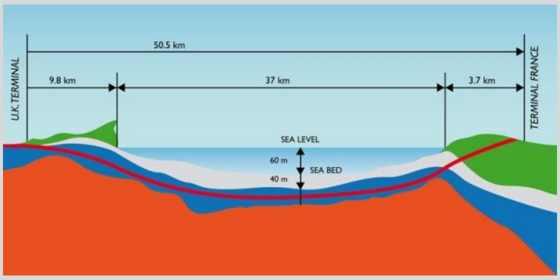
The first phase would involve dropping the tamper at every second or third drop point location. After a period of time to allow dissipation of pore pressures, the intermediate drop point locations could be densified as part of the second or third phase. Normally, 7 to 15 drops of high level energy are applied at each drop point. If significantly less than 7 or more than 15 drops are calculated, better to consider adjusting the grid spacing instead of more drops.

Following are some of the advantages of dynamic compaction:

- Compacts large areas of loose granular fills.
- Reduces the volume of landfill waste.
- Increases in situ density and the voids are collapsed.
- Increased bearing capacity.
- Reduces post-construction settlements.

Civil Engineering History

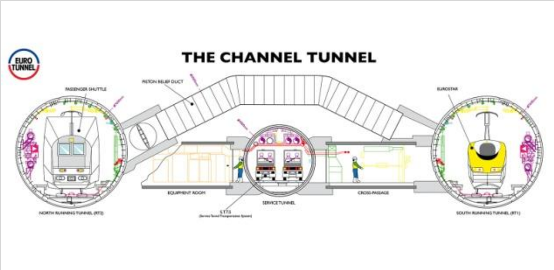
The Euro Tunnel



English Channel Tunnel, also called **Eurotunnel**, Chunnel and Trans-Channel Tunnel, is a rail tunnel connecting the British Isles with mainland Europe, running beneath the English Channel.

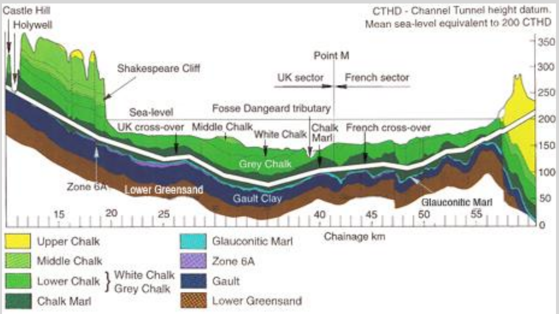
The often-considered idea of constructing a tunnel under the English Channel was revived in 1986 by the United Kingdom and France. A rail tunnel was chosen over proposals for a very long suspension bridge, a bridge-and-tunnel link, and a combined rail-and-road link, and the project was privately financed by a consortium of British and French corporations and banks; the Anglo-French company operating the tunnel is called Eurotunnel. Digging began on both sides of the Strait of Dover in 1987–88 and was completed in 1991. The tunnel was officially opened on 6th May, 1994.

With Folkestone, England at one end and Sangatte (near Calais), France, at the other, the Channel Tunnel has a terminal-to-terminal length of 50 km and length of 37 km, below sea. Its average depth below sea bed is around 50 m. Comprising three tunnels: two for rail traffic (7.6 m diameter) and the third and central tunnel (4.8 m dia) for services and security.



All three tunnels are connected every 375 meters by a cross-passage, which gives access to the service tunnel in case of emergency. The cross-passages are also used for ventilation and maintenance service access. Every 200 meters, the two rail tunnels are linked by piston relief ducts. These are used for the regulation of the air pressure in the tunnels. All three tunnels are lined with concrete linings.

Geology
Satellite data from geophysical surveys provided information about the geology and helped to determine the alignment and route of the tunnel.



To maximize the favourable ground conditions, the tunnels were excavated in the layer of chalk marl except for a 3-kilometer section on the French side.
Construction

Millions of tons of earth were moved to build the project fifteen thousand people were employed at the peak of construction. Ten people were killed during construction.

Sangate - Construction Site in France
In 1987, construction of the Channel Tunnel began in France at Sangatte on the Nord-Pas de Calais coastline at a location just over 3 kilometers away from the French terminal site at Coquelles.
A circular access shaft, 70 meters deep and 55 meters in diameter was excavated and lined with concrete. A hangar -like shed was built to shelter the shaft in the centre of the large construction site, which also contained offices and a lining segment manufacturing factory

All materials, workers and equipment were lowered down the shaft to the working platform at 47 meters, where the tunnel boring machines (TBM) could be assembled in dry conditions.
From this point, three machines excavated the undersea rail tunnels and service tunnel beneath the seabed towards Kent and two boring machines began the drive underground and inland towards the terminal site. One of these machines was then re-assembled to excavate the second running tunnel, thus using only 5 machines on the French side.

Gantry cranes with pulleys were used to lower the TBM sections and subsequently the concrete lining segments.

Once tunneling began, construction trains with a variety of wagons were used to transport the linings, the spoil and the workers. A railway control room at the top of the shaft regulated the movements of all the construction trains.
At the base of the shaft, a spoil treatment plant mixed the waste rock with water before pumping it 500 meter to the disposal site at Fond Pignon.
Once construction work was complete, the Sangatte shaft was transformed into a permanent feature of the tunnel system, housing the ventilation and cooling system installations.

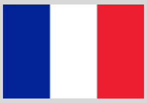
The rest of the construction site has been landscaped and rehabilitation work continues with environmental monitoring of the Fond Pignon site.

Shakespeare Cliff - Construction Site in Great Britain
Construction work began on the British side at a platform located at the foot of Shakespeare Cliff. Situated between Folkestone and Dover on the Kent coast, this had been the site of a previous tunnel attempt in 1974.

The earlier tunnel workings were used as one of the two access shafts to the underground workings, with a rack and pinion railway used to convey equipment and materials to the marshalling area underground. The six TBMs were each assembled in a large cavern area, over 20 meters high and equipped with overhead cranes for lifting the TBM sections, which had first been excavated to accommodate the 8.6 meter diameter machines.
From this point under the platform at Shakespeare Cliff, three undersea tunnels were bored towards France and three underground tunnels towards the terminal site at Folkestone.

The service tunnel machine on both sides bored in advance of the two running tunnel machines.
Probes on the service tunnel machine provided advance warning of difficult ground conditions and the data obtained provided data on alignment and conditions for the larger tunnel drives.

Tunnel Boring Machines

Sr #	Description		
1	Total Number		
a)	Under Sea	=	6
b)	Under land	=	5[2]
c)	Total	=	11
			
2	UK TBMs		
2.1	Under Sea		
2.1.1	Rail Tunnel		
a)	Diameter	=	8.36 m
b)	Length	=	230 m
2.1.2	Service Tunnel	=	
a)	Diameter	=	5.36 m
b)	Length	=	225 m
2.2	Under Land		
2.2.1	Rail Tunnel		
a)	Diameter	=	8.72 m
b)	Length	=	253 m
2.2.2	Service Tunnel	=	
a)	Diameter	=	5.76 m
b)	Length	=	225 m
2.3	Progress		
a)	Best day	=	75.5 m
b)	Best week	=	428.0 m
c)	Best month	=	1,719.1 m
			
3	French TBMs		
3.1	Under Sea		
3.1.1	Rail Tunnel		
a)	Diameter	=	8.72 m
b)	Length	=	265 m
3.1.2	Service Tunnel	=	
a)	Diameter	=	5.72 m
b)	Length	=	318 m
3.2	Under Land		
3.2.1	Rail Tunnel		
a)	Diameter	=	8.62 m
b)	Length	=	211 m
3.2.2	Service Tunnel	=	
a)	Diameter	=	5.59 m
b)	Length	=	204 m
3.3	Progress		
a)	Best day	=	56.0 m
b)	Best week	=	292.6 m
c)	Best month	=	1,105.7 m

[2] One French TBM bored two under land tunnels

Dates

	Description		Date
1	Commencement		
a)	Date tunnelling commenced	=	1st Dec., 1987
2	Dates of Breakthrough		
a)	Under sea service tunnel	=	1st Dec., 1990
b)	Under sea rail tunnel, north	=	22nd May, 1991
c)	Under sea rail tunnel, south	=	28th June, 1991

Finished Tunnel Diameters

	Description	=	Diameter
1	Rail Tunnels	=	7.60 m
2	Service Tunnel	=	4.80 m

Cost

The projects $21 billion cost was roughly twice the original estimate, and completion was a year behind schedule. One year into service, Eurotunnel (the operator of the tunnel) announced a huge loss, one of the biggest in United Kingdom corporate history at the time. A scheme in which banks agreed to swap billions of pounds worth of loans for shares saved the tunnel from going under and it showed its first net profit in 1999.

Operation

The tunnel is used for both freight and passenger traffic. Passengers can travel either by ordinary rail coach or within their own motor vehicles, which are loaded onto special railcars. Trains can travel through the tunnel at speeds as high as 100 miles (160 km) per hour, the trip taking about 35 minutes.

Each day, about 30,000 people, 6,000 cars and 3,500 trucks journey through the Chunnel on passenger, shuttle and freight trains.

Past Attempts

Napoleon's engineer, Albert Mathieu, planned the first tunnel under the English Channel in 1802, envisioning an underground passage with ventilation chimneys that would stretch above the waves. In 1880, the first real attempt was made by Colonel Beaumont, who bore a tunnel more than a mile long before abandoning the project. Other efforts followed in the 20th century, but none on the scale of the tunnels begun in June 1988.

Professional Practice

Professional Fees

It is a matter of extreme concern that some of the professionals, in Pakistan, are charging such fees for professional services as are significantly below the actual cost of rendering quality services. One needs to know if such persons are duly filing their income tax returns and those of provincial sales tax on services.

This is obviously at the cost of the quality of the services being provided. It is, therefore, not a surprise that slipshod work is becoming more and more common, with public safety being compromised and and the objective of a judicious use of client's money no longer remaining a priority. That a country, already under the mounting pressure of brain-drain, can ill-afford such a trend, is obvious.

There is a dire need to put in place accountability mechanisms whereby those producing sub-standard work are taken to task. Till such time that this is done, the negative trends would remain unchecked and the society would continue to suffer.

Changing Climate

Gulf Witnesses Incessant Rain

Civil engineers note with concern that climate is changing faster than one can can keep pace with. Arid GCC region, between 11th and 13th January, 2020, witnessed incessant rainfall rather for the region, with showers along the coastline stretching from the capital of UAE up to Ras Al Khaimah. A rainfall of 150 mm per hour for two-and-a-half hours brought havoc to the Northern Emirates and its eastern areas.

Figure 16: Streets full of storm water

Flights had to be cancelled and normal life was disrupted.

It has been said that records of two-and-a-half decades have been broken by this event.

Biography

Fazlur Rahman Khan – the Father of Tubular Structural Systems for Tall Buildings

Amina Siddique[3]

Fazlur R. Khan, (born April 3, 1929, Dacca, India and died March 27, 1982, Jiddah, Saudi Arabia), a Pakistani-turned-Bangladeshi-turned-American was a civil and structural engineer well known in the world for his introduction of tubular structural systems now used in tall buildings.

Dr Khan obtained his bachelor's degree in civil engineering from the University of Dacca, Pakistan, in 1950 and worked as assistant engineer for the highway department and also taught at the University of Dacca. Obtaining a scholarship in 1952, he enrolled at the University of Illinois in Champaign-Urbana, where he received master's degrees in both applied mechanics and structural engineering and a Ph.D. in structural engineering.

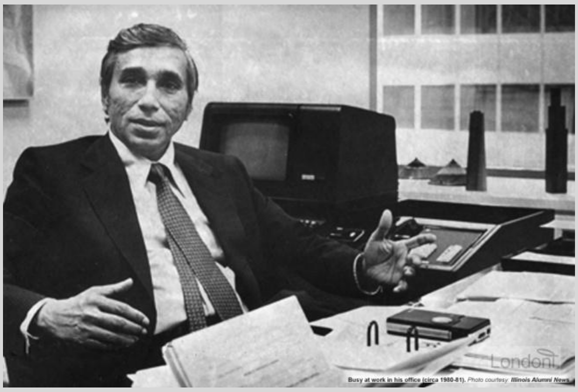


Figure 17: Khan, in his office (circa 1980-81)

He returned to Pakistan to join Karachi Development Authority (KDA), as an executive engineer. But soon, he was frustrated by administrative demands of the job that kept him from design work and returned to the United States, where he joined the prestigious architectural firm of Skidmore, Owings & Merrill in Chicago in 1955, eventually becoming a partner, in 1966. In 1967 he became a naturalized U.S. citizen.

Figure 18: John Hancock Center, Chicago (1970)

Figure 19: Dr Khan with his daughter, Yasmin Sabina Khan

[3] Civil and Structural Engineer, Rizwan Mirza, Consulting Engineers

Khan's many skyscraper projects include Chicago's John Hancock Center (1970) and Sears (now Willis) Tower (1973), which are among the world's tallest buildings. The Sears Tower was his first skyscraper to employ the "bundled tube" structural system, which consists of a group of narrow steel cylinders that are clustered together to form a thicker column.

This innovative system minimized the amount of steel needed for high towers, eliminated internal wind braces (since the perimeter columns bear the weight of the wind force), and permitted freer organization of the interior space.

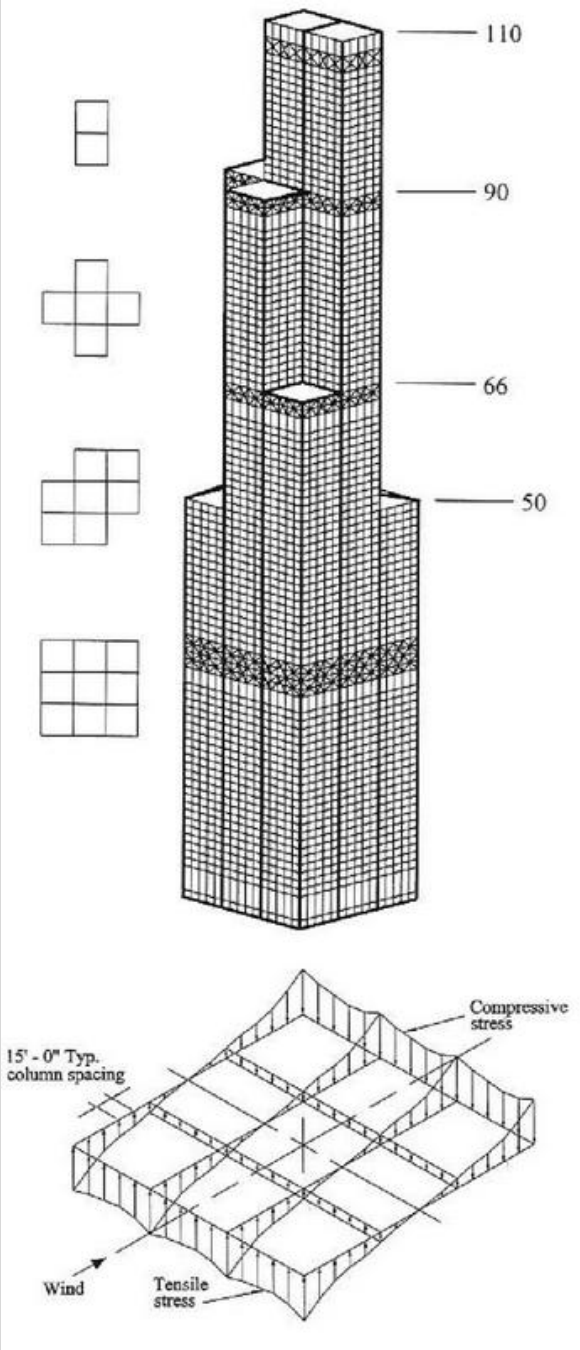
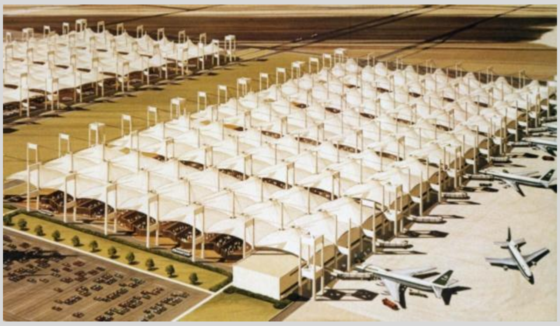


Figure 20: Bundled tube system used in Sears Tower

Khan's later projects include the strikingly original Haj Terminal of the King Abdul Aziz International Airport (1976–81) in Jiddah, Saudi Arabia, and King Abdul Aziz University (1977–78), also in Jiddah.



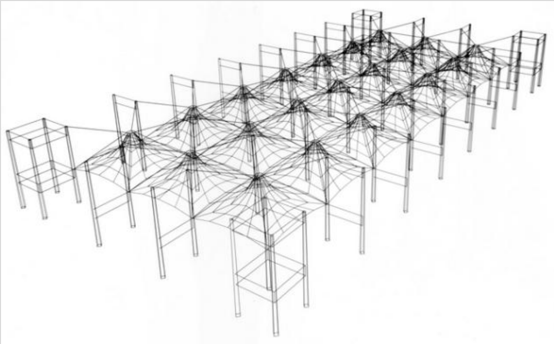


Figure 21: Haj Terminal, King Abdul Aziz International Airport

Dr Khan was married to Liselotte, an immigrant from Austria.

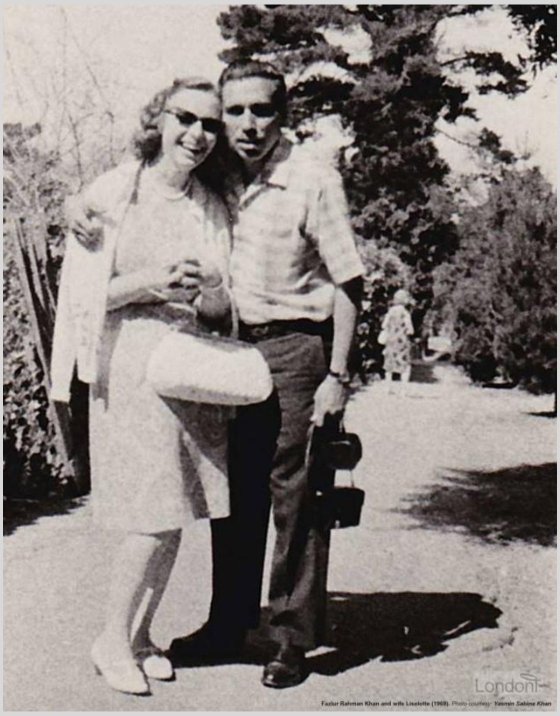


Figure 22: Dr Khan with his wife (1969)

Letters to Editor

The views and comments expressed are those of the writer and not necessarily those of this periodical.

Rights to edit the letters are reserved by the editorial board.

Abdul Waheed Mir

Dear Sir:

September 2-19 Issue of [Pakistan Civil Engineer] PSCE

Thank you for the subject publication. It is well laid out and nicely presented. I would like to comment or add as under:

1. Figure-2 on Page No. 3 Kerosene operated fans, such fans were manufactured in Lahore, way back in 50s and I have seen them on sale in shops near Mayo Hospital. Why they went out of style, particularly when remote villages in our country do not have access to uninterrupted electricity. Fan manufacturers of Gujranwala and Gujarat should be encouraged to go back of making Kerosene operated fans.

   In the 60s, Kerosene Oil-operated refrigerators, made in Europe, were available in East Africa. With the people in the villages and small towns, where electricity was not available, they were popular. On field survey works, in remote and far off places, Kerosene operated lamps and refrigerators were common. I never saw one in our country.

2. The article," Water Resources Projects - the key to Cheap Electricity in Pakistan", this statement is true to some extent. Lack of funds has delayed many of our hydropower schemes I projects. Lack of vision on the part of the decision makers based in Islamabad is a major cause of delay in undertaking major hydropower projects. Financing is available within the country for all of these mega-projects. There is need to tap it.

   Let us take the case of Basha Daimir Dam Project (BDDP). Government has been . . . . . [soliciting bilateral and multilateral international funding], with zero success. Why can't we float Basha-Daimir Dam Company (BDDC) in Pakistan and make shares available to general public. The state will also be a shareholder because it has spent funds towards the project planning and design plus purchase of land for the project.

   The company will be in private sector with minimum interference of the Government Departments. The Lahore, Sialkot, Faisalabad, Gujranwala and Karachi Chamber members have money available to finance BDDP. The condition will be that this company will be run and headed by an honest member of the one of the Chambers and *not* by *baboos* or *ex-generals*. This is because the businessmen know how to run companies, *baboos* and *generals* are trained for different tasks and they are good at them.

   Once the project starts generating power, the profit will be distributed among the shareholders as dividend. This way the money stays within the country and does not end up in the hands of some . . . . . [foreign] bank. After 30 or 40 years the project shall revert back to the state.

3. We have ignored the free source of electric power, that God has gifted to our country and this source is sunshine – solar energy. We get plenty of sun

shine all year round but do not tap it. An investment of Rs. 500,000 in solar system will generate enough power to take care of the electricity needs of a 10 Marla house. Solar energy should be introduced in our country on war footing.

Solar Power System should be introduced as under;

i. All government offices and official accommodation of civil servants.
ii. Make it mandatory that all new private houses.
iii. Private companies offices.

Banks should be instructed to provide funding to private individuals who cannot afford to finance the installation of solar system. This way we shall take a fair chunk of the load from the national grid.

Best regards.

Yours truly,

A.W. Mir

Contributing to the Pakistan Civil Engineer

The Pakistan Civil Engineers would be happy to receive your contributions. Send a soft copy, whenever possible. You can send:

a) Articles
b) Interesting project pictures (original or free of copyrights)
c) Details of significant civil engineering projects
d) Your professional and reasoned opinion on an important issue.
e) News of professional significance including newspaper clippings, citing source
f) Other important professional information
g) Identification of a topic that merits our attention
h) A letter to the editor

You do not need to be a writer in order to contribute; your professional skill is all we need. Please allow us to make editorial changes before we finally adopt a contribution.

Please make sure that your contributions are free of plagiarism. Where you rely on other sources, please acknowledge and provide complete reference.

Also, please do send us your text contribution in editable format also. The editorial board would have the authority to accept or reject any contribution and also to make editorial changes in the content.