The Bandra-Worli Sea Link is a marvel of engineering technology and has also led to considerable easing of traffic in Mumbai.

It is gigantic. It is majestic. It is an engineering marvel and an architectural wonder too. The first-of-its-kind in India (first bridge to be constructed in open-sea conditions), the 5.6-km-long, eight-lane, approximately Rs 1,600-crore Bandra-Worli Sea Link (BWSL), which has now been renamed as the Rajiv Gandhi Sea Link, is an engineering marvel that aims to ease traffic in Mumbai, India’s commercial capital.

The construction is a miracle on the Arabian Sea that has an imposing presence on the Western horizon of Mumbai. One can imagine the strength and might of the bridge given the fact that it weighs nearly 30,000 African elephants and the length of steel wires used in the project is equivalent to the circumference of the Earth. And it has made the difference: the distance which earlier took nearly 45 minutes – from Bandra till Worli if one uses the old road – now takes just eight minutes.
It is for the first time that cable-stay bridges have been attempted on open seas in India. Coupled with the fact that the aesthetically designed pylons have an extremely complex geometry and one of the longest spans for concrete deck, the challenges encountered were indeed formidable. With its cable-stayed towers soaring gracefully skywards, the bridge was constructed by Hindustan Construction Co Ltd (HCC), an engineering, construction, infrastructure and integrated urban development and management giant and designed by UK-based Dar Consultants for Maharashtra State Road Development Corporation (MSRDC). It has today emerged as one of the prominent landmarks of Mumbai and also a popular tourism destination.

HCC Chairman and Managing Director Ajit Gulabchand said: “Construction of the Bandra-Worli Sea Link has been one of the most challenging infrastructure projects undertaken in recent times in India. We took on this project with the quest to set new benchmarks in precision engineering and prove India’s infrastructure development capabilities. Reflecting on the hard work of our engineers and over 3000 workers who have raised this Sea Link in rough open sea conditions, I am proud to say we have truly built a monument to human skills, enterprise and determination.”

People Behind the Bridge
A total of 2850 workers and 150 engineers were employed to work on the project and, over a span of eight years, a total 2,57,00,000 man hours were utilised between 2001 and 2009.

Several teams of foreign engineers and technicians have been involved in specialized tasks on the structure of the sea link. These include professionals from China, Egypt, Canada, Switzerland, Britain, Serbia, Singapore, Thailand, Hong Kong, Indonesia and the Philippines. In terms of language, cultural differences and methods of work these key people were different, yet the engineering challenges kept the group creatively involved.

Left above: Construction of the sea link in full flow;
Left below: A panoramic view of the bridge
Says Mr. S. Srinivasan, Director of Dar Consultants, UK, “This cable-stayed bridge is the longest bridge in South-East Asia and certainly the longest in India so far. The cable-stayed bridge gives aesthetic appeal to the bridge.”

Mr. Len Gower, a Canadian survey expert, who worked on evolved survey methodology for complex geometry of pylon said, “I was working on a project in China at that time and my friend from India had sent me a picture of the cable-stayed bridge. The picture hooked me so much that I left the ongoing project of Sutong Bridge and came to India. I have done nine projects and they all have the same boring design. I wanted to do something new, challenging and interesting so I joined this project. This sea link is technically challenging and aesthetically pleasing.”

M.C. Bhide, veteran engineer and Honorary Director-General of the Indian Institute of Bridge Engineers (IIBE) referred to the BWSL as an “engineering marvel” and one of the “best projects” in recent times.

A major chunk of steel for constructing the bridge came from the Steel Authority of India Ltd (SAIL). As a matter of fact, each cable can bear a load of 900 tonnes. The BWSL has gobbled up a total of nearly 22,235 tonnes of steel; SAIL’s share is pegged at over 13,780 tonnes, according to SAIL officials.

The sea link begins at the Mahim Interchange at the northern end and joins Khan Abdul Gaffar Khan Road on the Worli Sea Face at the southern end. The link connects Bandra to Worli by a 5.6 km long bridge. The Sea Link is primarily meant to provide an alternative to the Mahim Causeway route that is presently the only connection between the south Mumbai and the Western and Central suburbs.

Renamed Rajiv Gandhi Sea Link, the bridge is an engineering marvel that aims to ease traffic in Mumbai, India’s commercial capital.
The project was commissioned to offer a quicker alternative to the north-south traffic that presently amounts to some 125,000 cars a day in each direction and is expected to grow at the rate of 250 cars per day. The eight-lane flyover has a capacity of carrying about 1.40 lakh cars per day. Large multi-axle vehicles and two-wheelers would not be allowed on the sea link. Speed limit would have to be maintained at 100 km/hr.

Building Challenge
Building the Bandra-Worli Sea Link was a challenge indeed. The Link Bridge consists of twin continuous concrete box girder bridge sections for traffic in each direction. Each bridge section except at the cable-stayed portion is supported on piers typically spaced at 50 metres. Each section is meant for four lanes of traffic complete with concrete barriers and service side walks on one side. The bridge alignment is defined with vertical and horizontal curves.

The highlights of the Bandra-Worli Sea Link are the two aesthetically designed cable-stayed bridges, viz., the Bandra and Worli Cable-Stayed Bridges of 500 and 150 metre spans, respectively, with the highest towers soaring to a height of 126 metres, equivalent to the height of a 43-storied building. The cable-stayed design allows free movement of fishing boats.

The cable-stayed portion of the Bandra channel is 600 metres in overall length between expansion joints and consists of two 250 metres cable supported main spans flanked by 50 metres conventional approach spans. A centre tower with an overall height of 128 metres above the pile cap level supports the superstructure by means of four planes of stay cables in a semi-fan arrangement.

The cable-stayed portion of the Worli channel is 350 metres in overall length between expansion joints and consists of two 150 metres cable supported main spans flanked by 50 metres conventional approach spans. A centre tower with an overall height of 128 metres above the pile cap level supports the superstructure by means of four planes of stay cables in a semi-fan arrangement.
of 55 metres above the pile cap level supports the superstructure by means of four planes of stay cables in a semi-fan arrangement.

According to Mr. Araby EL Shenawy (Engineer and head of the Project Management Consulting team from Egypt), “The method of balanced cantilever was adopted for the construction of the deck for Bandra Cable-stayed Bridge. This is considered to be one of the biggest cable-stayed bridges in the world with concrete deck built with this method of construction. It was therefore a real challenge to monitor the behavior of the structure during all erection stages and to compare the same with the behavior of the corresponding theoretical computer model of the bridge, to ensure achievement of the desired geometry at the end of the construction. It was also essential to control the stresses in the critical bridge elements during every single construction stage to ensure the adequacy of the bridge elements all the time.”

Big Brother Watching!
Security of the Bandra-Worli Sea Link is a major issue. The Mumbai Police has factored in the security concerns and has taken a series of measures by putting up a high-tech security system. A special team of officers led by Joint Commissioner of Police (Traffic) Sanjay Barve monitored the traffic flow several times. CCTV cameras have been installed on the sealink at several places. Underneath the bridge also security gadgets have been installed.

Continuous Power Supply
For the entire project, a reliable and dependable power supply has been arranged. It will also house diesel generator sets and auto mains failure panels to cater to critical load e.g. monitoring, surveillance, and communication equipment emergency services like aviation obstruction lights. Adequate lighting levels have been maintained and energy saving luminaries are installed.

Special emphasis has been given to incorporate lighting protection at bridge tower and control room building to protect those buildings/structures and the sophisticated monitoring and communication equipment installed therein. A built-in feature of providing reliability and availability of equipment is achieved through duplicate cables for such equipment. Facade lighting for bridge tower and special lighting in landscaped area is also included.

One can imagine the strength and might of the bridge given the fact that it weighs nearly 50,000 African elephants and the length of steel wires used in the project is equivalent to the circumference of the Earth.

Bulky Equipment
Construction of the mammoth bridge structure required some huge cranes and several other equipments. Some of these included Jack-up platform, floating barrages, boats, crawler crane, tower crane, gantry crane, derrick crane, launching truss, placer boom, diesel generators, diesel & air compressors, concrete pump, transit mixers, reverse circulation drilling machine & ‘A’ frame barrage.

The equipment was brought together from various countries. A total of 130 equipments were used and the cost was Rs 190 crore. Twenty-five equipments were imported at a cost of Rs 78 crores.