Good example of research paper on britannia bridge on the border of staffordshire...

Engineering

Introduction:

Suspsension bridges have been around for quite a long time but the first one ever built was the Britannia Bridge which has been renamed as the Menai Suspension Bridge and is a suspension bridge which begins on the island of Anglesey and connects the mainland of Wales. The bridge was designed by the famed engineer Thomas Telford and was finished in 1826. It was described as the first modern suspension bridge in the world and won several plaudits upon its completion. It was described as a brilliant piece of engineering and daring which resulted in several other bridges following suit in later decades amongst which one may count the Brooklyn Bridge and the Golden Gate Bridge in San Francisco.

Historical background

The island of Anglesey had no connection to the mainland so it was hampered as regards travel from the island to the mainland. The movements between the island and Wales were usually by ferry or on foot when the tide was low. Since the main source of income for the island was the selling of cattle, it was imperative for these to be moved to the inland counties markets and London, the animals had to be driven into water and swum over across the Menai Straits, a difficult and highly dangerous undertaking which often resulted in the animals being unfortunately lost. After the Act of Union in 1800, the urgency to build a bridge increased considerably since there was a clamor for transport to Ireland too. One of the main terminals in Ireland was that of Holyhead and it was thus decided that a bridge should be built across the Menai Straits.

The famed engineer Thomas Telford was given the task of improving the long route from London to Holyhead and one of his suggestions was the building of a suspension bridge over the Menai Strait. The route chosen was a point near Bangor on the Welsh mainland and a point in the village of Porthaethwy on the island of Anglesey. This village is now known as Menai Bridge. Due to military requirements, the bridge's design had to allow ships of the Royal Navy which were over 100 feet tall to pass under the bridge's deck when it was high tide whilst no scaffolding was allowed during its construction since it would have violated certain building rules.

The bridge's construction began in the year 1819 when two large towers were constructed on both sides of the Menai Strait. These ingenious structures were built using Penmon limestone which came from the region and were also hollow apart from having internal walls which were crossed. The next part of the bridge's construction were sixteen chain cables which were described as enormous and which were made out of an incredible 935 irons bars. These in turn supported the 577 feet span of the bridge. A number of ingenious and innovative methods were employed in the construction of the bridge. For example, to eliminate the possibility of rusting between the time of manufacture and that of use, the bridge's iron was first soaked in linseed oil and then painted. The use of top quality steel throughout made the bridge endure up to this day with relatively little wear and tear.

The chains had incredible suspension power which was eventually calculated at just over 2000 tons with each chain weighing no less than 121 tons. The bridge was eventually opened on the 30 of January 1826 where it was hailed as one of the greatest engineering feats of the time. It reduced the journey from London to Holyhead by an impressive 9 hours from the normal 36 to 27 so this could be made in just over a day which was no mean feat. The bridge has since been used by millions of persons and has also been one of the major conduits for other forms of transport such as trains and cars.

Some characteristics

The bridge’s roadway was only 24 feet wide so it proved to be very unstable when huge wind gusts blew. Eventually the deck of the Britannia Bridge was overhauled and considerably strengthened by the engineer W A Provis. The surface which was made of wood was eventually completely replaced with a huge steel deck that was designed by Sir Benjamin Baker. With a limit of just 4. 5 tonnes, the bridge’s use proved to be a problem for the massive freight industry and in 1938 the original chains were replaced with steel chains to strengthen the suspension capability.

Construction of the second Brittania Bridge

The vastly increasing popularity of travel by rail resulted in the construction of the Chester and Holyhead Railway by the famed engineer Robert Stephenson. Since the existing Menai Bridge was seen as being too weak to take on the large number of trains which were expected to cross the strait, there was the need to build another bridge which was christened as the Brittania Bridge. This was important to provide a direct railway link between the ports of London and Holyhead with the latter fast growing into a crucial transport hub.

Several railway schemes were eventually proposed and one of them was to use the existing Menai Bridge but Stephenson objected to its use since the suspension bridge was not strong enough to take the weight and bulk of trains according to him. A Treasury Committee which had been formed to study the possibility of a railway bridge eventually accepted Stephenson's proposals to build a bridge over the Strait in 1840. The bridge's design and construction were eventually approved in 1840 with George Stephenson's son Robert appointed as the Chief Engineer for the project.

Second bridge design:

The bridge's design was required to make it accessible to shipping while it was being constructed and to be as strong as possible to support the heavy load which was normally associated with trains. Robert Stephenson constructed the bridge with two main spans of 460 feet long iron tubes which were rectangular in shape and which weighed around 17oo tons. Each of these spans were supported by masonry piers with the one in the centre built on what was then known as Brittania Rock. Two additional spans which were 230 feet wide completed the length of the bridge which resulted in a girder of 1511 feet. The trains were to travel to and fro from the tubes.

The bridge's engineers alongside Stephenson were William Fairbairn and Eaton Hodgkinson who differed regarding their opinion on how to support the bridge. The latter advocated the use of suspension from chains while the former described this as unnecessary. Fairbarn's opinion finally saw through and the bridge was constructed without chains. After a model was constructed and tested at a shipyard, this was used as a final design and the rectangular section adopted by Fairbairn was taken on board. The tubes were constructed with a cellular method while the side panels were also strengthened.

The bridge’s construction began in March 1846 and was opened in 1850. It was variously described as a bridge of great magnitude and singular novelty since it greatly surpassed other gird iron bridges of the same period. The construction methods used were also novel and avante garde and these included assembling the box sections of the bridge on shore, these were then floated out into their position. They were then gradually lifted into their place with jacks that were extremely powerful.

There had been a railway station operating on the east side of the bridge before the tunnel entrance, this was run by the Chester and Holyhead Railway company and served local traffic in both directions. The station eventually closed after just over eight years mainly due to low passenger volumes. The station is no longer extant with a new railway station called Menai Bridge opening just afterwards.

The bridge’s construction techniques influenced several other engineers such as Isambard Kingdom Brunel when he worked on the Royal Albert Bridge which crosses the River Tamar at Saltash

The bridge was damaged substantially in 1970 when it caught fire with the tar coated wooden roof easily spreading the fire. Although the bridge remained standing, its structural integrity was severely compromised. The bridge was eventually rebuilt using concrete methods by Husband and Co although when it reopened in 1972, only a single line of rails with reduced speed was in operation. In 1980, the A5 road opened with a single carriageway section on the upper level of the bridge.

Other similar bridges:

The Britannia Bridge is quite unique in its method of construction since the tubular iron method was rarely used in other projects as it was not economical. However there were other bridges which used the tubular construction design such as those between Llandudno Junction and Conwy as well as the Victoria Bridge which crosses the St Lawrence River in Montreal. Interestingly, the Conwy railway bridge remains in use and is currently the only tubular bridge remaining which is still in use. One can admire this bridge when looking at it from the Conwy Suspension Bridge which was also built by Thomas Telford.

At the time it was built, the Victoria Bridge was the longest bridge in the world upon its completion in 1859. It was eventually rebuilt in 1898 and was listed as the first bridge every to cross the mighty St Lawrence River.

Constructing the bridge today

The project of constructing the Britannia Bridge would have been much easier if it was built today due to a number of factors, not least the elimination of building a tubular style bridge. The larger and more functional cranes which are available today also would have made the job far easier. Incidentally, the Britannia Bridge was planned exclusively for rail users since there had been plans to use the original Menai Strait Bridge for rail travel with the locomotive travelling to Menai Bridge and carriages eventually crossing and drawn by horses. This was however a quite unfeasible method to use and was quickly scarped in favour of a new bridge.

The main challenge of the bridge is the fact that it has to be as strong and rigid as possible to be able to carry trains and a considerable number of heavy carriages accordingly. The construction of two long iron tubes is feasible and can easily be carried out in any shipyard. There is an argument whether the bridge should be made out wrought iron or steel but the latter is certainly much stronger to serve this purpose.

The next challenge is whether to suspend the tubular bridge tunnels from suspended cables through openings at the top of the two bridge towers. Engineering calculations have revealed that there is no real need for such suspension cables since the towers are strong enough if built from suitable materials to be able to carry the weight of the trains on their own.

The bridge stonework can easily be quarried from Welsh limestone with the stone from Pennon being ideal for such a purpose. Other materials such as sandstone are also ideal for the inner construction of the towers. The tubes which make up the bridge can be constructed on site and easily fit into place although a considerable number of men need to be used to actually fit the tubes into their final position.

Again the mian challenge from an engineering perspective with regard to the bridge is raising the 1500 ton tubes into position. When compared to the Menai Strait Bridge, the task is far more difficult although in the original scenario, luck was on Stephenson’s side and he prevailed. The use of hydraulic pumps was important to raise the tubes but today this difficult task can easily be done using tower cranes.

One of the most interesting aspects of the bridge is the carving of the four stone lions. These were made by John Thomas, a true master carver and sculptor who also did the carving on the Houses of parliament as well as Buckingham Palace. These lions are 4 metres in height and sit on huge plinths that are just as tall.

One can also compare the bridge with its original appearance after its reconstruction which followed the 1970 fire. It has been rebuilt chiefly using pre stressed concrete and thus the concept of a tubular bridge has unfortunately gone out of the window. The incredible strebgth of the old bridge was revealed by the fact that it did not fall down after being almost completely destroyed by fire although its structural safety was severely compromised. This is a tribute to George Stephenson and his fellow engineers who undoubtedly worked extremely hard to ensure the total safety of the bridge.

Analysing the suggestions made to replace the bridge after its destruction by fire, one may note that a particularly interesting one was to combine two bridges into one. The proposal was that the bridge would be rebuilt as a two way bridge carrying both trains as well as nominal vehicular traffic. However this proposal never went through and the original structure of a railway bridge was retained.

The bridge is no longer a tubular bridge since it is now supported by arches with one railway track carrying trains to and from Holyhead. On top of this bridge is another roadway which carries traffic on the A5. An unfortunate consequence of the bridge’s destruction are the lions which now sit abandoned below the road, prime examples of superb sculpture left to rot.

Other architectural examples

Industrial products should serve a purpose and it is important that the design which is used is actually attractive and that this fits in with the norms and expectations of society accordingly. The design of a specific product also means that it must fit in with the design features which are conversant with this day and age. A typical example is a clock which has a number of functions but whose design is important for aesthetic and tasteful considerations. It is also important to note that the more intense the use of the product, the more design will come into the mix so it is crucial for the workings of the clock to be top notch and its design attractive since attention will be drawn to it most of the time.

The same could be said for buildings and architecture since functionality is of paramount importance when designing a building. The way natural light has to be filtered is very important for a building to be properly assessed and to carry out its functions accordingly and without hiccups. Omitting the unimportant is a crucial part of making a building functional yet at the same time attractive to the eye.

Some classic buildings involving architectural and design originalities

The Villa Lante

The Villa Lante demonstrates an incredible understanding of topography and how this affects the intrinsic design of any villa accordingly. One can appreciate certain features such as the Fountain, the River Gods and the Water Chain which demonstrate the capabilities of the architectural designer who also brought about considerable change in what he managed to achieve. The whole complex as regards the Villa Lante demonstrates that everything can be achieved with some imagination and this is most definitely the case here.

The architectural features which are prominently described include a whole stretch of designs such as Fountain Candles, the Fountain of Moors as well as Casini on either side of the gardens. On the right, there is a hunting park, Pegasus, other fountains in woods, maze, whole complex is the Villa Lante- recognized as quintessential form of using golden section and iconography, underling predicate, proportioning system not part of golden section 1: 2, 2: 3, Ren-square, circle pure forms, golden rectangle, doesn't show up in overtly triangles. The Villa Lante is an excellent example of design which is functional yet also very beautiful as it brings out the main characteristics of the building but also provides ample space for roaming about in its wide and extensive gardens.

The second example is the Tower of Alhambra in Madrid

This is a fortified palace which was completely rebuilt by Charles X and is the last remaining extant Islamic structure/garden in Spain and is very much popular with visitors. It is situated on roughly 35 acres of hilltop and was initially conceived by Calif Muhammed and there are several famous sections in it dating from 1248 or roughly the middle of the 13th century

Amongst the most famous aspects of this topographical design is the Court of myrtles, reception area, step, reflection pool-layers, bilaterally symmetrical, alternating layers of dark and light, with mirador, beautiful surface texture, interior, caligraphic-script, poetry and other factors also permeate the view

One also should look out for Asaleiho, tile work, geometric or floral type motifs. Again this building is a striking example of classic design brought very much into the 21st century with its avante garde styles and reaching out to other cultures.

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