CHAPTER XVI.

The first Suspension Bridge—The Railway Suspension Bridge—Extraordinary vibration given to the Railway Bridge by the fall of a mass of rock—De Veaux College—The Lewiston Suspension Bridge—The Suspension Bridge at the Falls.

ON the partial completion of the Hydraulic Canal, the principal stockholders, with a number of invited guests, celebrated the event on July 4, 1857, by an excursion from Buffalo in the *Cygnet*, the first steamer that ever landed within the limits of the village of Niagara. The same route is followed during the season of navigation by tugs towing canal-boats and rafts out and in. No passenger boat, however, has been placed on the route, although the sail on the river is a charming one.

Mr. Charles Ellet, in 1840, built the first suspension bridge over the chasm. He offered a reward of five dollars to any one who would get a string across it. The next windy day all the boys in the neighborhood were kiting, and before night a youth landed his kite in Canada and received the reward. The first iron successor of the string was a small wire cable, seven-eighths of an inch in diameter. To this was suspended a wire basket in which two persons could cross the chasm. The basket was attached to an endless rope, worked by a windlass on each bank. At an entertainment given on the occasion of the completion of the bridge, the good people of the embryo village at the bridge, elated with their new acquisition, were inclined to regard their neighbors at the Falls with patronizing sympathy. One of the latter said to Mr. Ellet, "This bridge is a very clever affair, and you only need the Falls here to build up a respectable village." "Well," he replied, "give me money enough and I will put them here." He had great faith in dollar-power.

This bridge was an excellent auxiliary in the construction of the present Railway Suspension Bridge, built by Mr. John A. Roebling. It was begun in 1852, and the first locomotive crossed it in March, 1855. It is one of the most brilliant examples of modern engineering, and stands unrivaled for its grace, beauty, and strength. Seizing at once upon the natural advantages of the location, the engineer resolved to combine the tubular system with that of the suspension bridge. The carriage way was placed level with the banks of the river at the edges of the chasm. The railway track was placed eighteen feet above, on a level with the top of the secondary banks across which the two railroads were to approach it. The plan was perfect, and perfectly and faithfully executed in all its details. It is practically a skeleton tube. As the traveler passes over it in a carriage or a railway car, from the almost total absence of any vibratory motion he feels at once that he is on a safe basis, and his sense of security is complete.

One feature of the construction of the bridge may be noticed as having a bearing on the question of its durability. It is well known that when wrought-iron is

exposed to long continued or oft repeated and rapid concussions, its fibers after a time become granulated, whereby its strength is greatly impaired and finally exhausted. It is also known that the effect of rhythmical or regular vibrations is more destructive than the effect of those which are inharmonious or irregular. Because of this, a body of men is never allowed to march to music across a bridge, nor is a large number of cattle ever driven across at one time, lest they should, by accident, fall into a common step and so overstrain or break down the bridge. It is the difference between a single heavy blow and an irregular succession of light ones. Hence, when harmonious, regular vibrations can be broken up, the destructive influence is greatly modified and retarded.

The bridge is supported by two large cables on each side, one pair above the other, the lower pair being nearer together horizontally than the upper pair, so that a cross section of the skeleton tube would be shaped somewhat like the keystone of an arch. Each of these large cables is ten inches in diameter, and is composed of seven smaller ones, called strands. These smaller strands are made of number nine wire, and each one contains five hundred and twenty wires. Each of these wires was boiled three several times in linseed oil, giving it an oleaginous coating of considerable thickness and great adhesive power. Each wire was carried across the river separately, from tower to tower, by a contrivance of the engineers, the chief feature of which was a light iron pulley about twenty inches in diameter, suspended on what might be called a wire cord. This apparatus was called a traveler, and curious and interesting was its performance as seen from below. It looked like a huge spider weaving an iron web.

Six of the seven strands forming each of the cables were laid around the seventh as a center, and when all were properly placed they were again saturated with oil and paint. After this, by another contrivance of the engineers, they were wound or wrapped with wire, like winding a rope cable with marlin, and thus the whole cable was made into a thoroughly compact, huge, round, iron rope. This was covered with numerous coats of paint to prevent the oxidation of the inner wires. The oleaginous coating of the wires, together with the small triangular spaces between them, would seem to reduce the destructive power of the vibrations to zero. But the vibrations are very greatly reduced and the stiffness of the structure is greatly increased by the use of a series of triangular stays, the triangle being the only geometrical figure whose angles cannot be shifted. There are sixty-four of these triangles. Their hypothenuses are formed by over-floor stays of wire rope reaching from the tops of the towers to different points in the lower floor, this latter, of course, forming their common base and the towers their altitude. The stays are fastened to the suspenders so as to form straight lines. As the towers and the floor are rigid and solid in the direction of the lines they represent, it follows that the intersections of the hypothenuses with the common base form so many stationary points in the latter. These stationary points present a powerful resistance to vibrations. The side trusses, with their system of diamond-work braces and the weight

of the railway track on the upper bridge, also help to stiffen the structure. There are likewise fifty-six under stays or guys of wire rope fastened to the rocks below, designed to prevent upward and lateral vibrations. A heavy locomotive with twenty loaded cars produced a depression of the upward curvature of the track of nearly ten inches. The ordinary loads make a depression of only five inches.

In Part II., attention was directed to a point on the American side of the river, just below this bridge, where the disintegration of the shale and abrasion of the superposed rock is strikingly exhibited. A singular phenomenon was witnessed here in 1863. A mass of rock and shale, about fifty feet long, twenty feet wide, and sixty feet deep, fell with a great crash. Directly following the fall a remarkable motion was developed in the bridge itself. A strong wave of motion passed through the whole structure from the American side to the opposite shore, and returned again to the same side.

Some twelve or fifteen mechanics, who were at work on the upper or railway track, were so alarmed that they fled with all speed to the shore. The motion imparted to the bridge was incalculably greater than, and of a different character from, any motion imparted by the crossing of the heaviest trains. The rocky mass which fell was forty rods below the bridge, and the hard floor on which it struck was more than two hundred and thirty feet beneath it. The mass itself fell about sixty feet average distance, and might have weighed five thousand tons. The extraordinary motion imparted to the bridge by the concussion must have been transmitted along the bed-rock to the anchorages on the American side, thence through the cables and the bridge across to the anchorages on the Canadian side, whence it returned to the American side.

Mr. Donald McKenzie, master carpenter and superintendent of repairs, who has been connected with the bridge constantly since its erection, and all the men under him at the time, confirm this statement, and declare it is impossible to exaggerate or describe the wave-like motion which they experienced while escaping to the shore.

Half a mile further down is De Veaux College, a noble charity endowed by the late Mr. Samuel De Veaux. He was for many years an active business man at Niagara, and by his integrity, industry, and wise enterprise accumulated a handsome fortune. His death occurred in 1852, and by his will he left nearly the whole of his estate to certain trustees to establish an institution for the care, training, and education of orphan boys. In addition to these, other pupils are received who pay a fixed price for their tuition, board, and incidentals. The institution has gained a high reputation for the thoroughness of its instruction and the excellence of its discipline. One of its sources of income is the amount received annually for admissions to the Whirlpool. Every visitor to that interesting locality will cheerfully pay the fee charged when he understands this fact.

The suspension bridge below the mountain near Lewiston, spanning the river where the water emerges from the fearful abyss through which it dashes for five miles, was built in 1856, by Mr. T. E. Serrel. The guys designed to protect it from the effect of the wind were fastened in the rocks on either side at the water's edge.

The great ice jam of 1866 tore from their fastenings, or broke off, many of these guys. Before they were replaced a terrific gale in the following autumn broke up the roadway, severed some of the suspenders, and left the structure a melancholy wreck dangling in the air.

The New Suspension Bridge, as it is called, just below the ferry at the Falls, was built in 1868. It is a light, graceful structure, standing one hundred and ninety feet above the water. Its length is twelve hundred feet, after the Brooklyn bridge the longest structure of the kind in the world, and it is the narrowest of those designed for carriage travel. To its narrowness it probably owed its safety from destruction during a fierce gale which occurred in the fall of 1869. The fastenings or dowels of several of the guys on the Canadian side were torn out, and the bridge at its center deflected downstream more than its width, so that the surface of its road-way could not be seen half its length. Then its undulations from end to end—like a stair-carpet being shaken between two persons—were frightful, and for a time it was feared that either cables or towers must give way. After the gale subsided the old guys were made fast again, new ones were added, and two two-inch steel wire cables were stretched from bank to bank, and connected with the bridge by wire stays. Wrought-iron beams were afterward placed on the bottom stringers, and channel irons on the top beams of the side trestles, all of which were strongly bolted together. These improvements added much to the strength of the whole structure, and greatly increased its ability to resist horizontal deflection.