A Brief Account of the History of Strength of Materials

Strength of Materials is basically a subject, which has very old background dating back to the times of Egyptian, Greek and Roman civilizations. Gradual development of the subject then took place in the hands of giants stemming from the fields of natural science and mathematics. During the period of Renaissance, there was a great enthusiasm in the field of education, art, music, etc. At that time, the subject also received a good attention from persons like Leonardo da Vinci.

In the seventeenth century, the subject received contributions from Galileo in his book '*Discoursi e Dimostrazioni, Matematich intorno a due nuoue scienze*' or '*Two New Sciences*'. His early contributions were in the field of structural theory. Then came Robert Hooke who was famous for his experiments on strings and wires. He enunciated his famous law in Latin, in the form of an anagram, "*ut tensio sic vis*" from his studies on this experiment.

The next era experienced monumental mathematical contributions from giants like Jacob, John, Daniel Bernoulli, Leonard Euler and Euler's doctoral student Joseph Louis Lagrange. They contributed profusely on the theories of beams, columns, etc.

In the eighteenth century, persons like Charles-Augustin de Coulomb worked on the experiments on the tensile strength of sandstones, theory of structures, etc. He also developed the theory of torsion of circular shafts.

During the beginning of the nineteenth century, people like Claude-Louis Navier worked initially on the bridges and channels. He wrote a book on the strength of materials, which was published in 1826. Navier first attempted to develop the theories of torsion of non-circular shafts by following the development of Coulomb's theory. In fact, he was the first person to use the flexure equation to any general transverse loading on the beam where beam deflection is given by piece-wise continuous functions. The other persons who worked on this subject during this period were J.V. Poncelet, Thomas Young to name a few. After receiving important mathematical contributions, the subject took a new turn when mathematical theories of elasticity were gradually introduced. Before that, the knowledge of this subject was kept limited to finding the deflections and stresses in the beams. But it was time to establish a solid mathematical ground of this subject for which the works of Navier initially set the path again. Apart from him, Agustin Cauchy, Poisson, G. Lamé, Sophie Germain, etc., are to mention a few, who made remarkable impressions on the development of this subject.

In the latter part of the century, Saint Venant made important contributions on the theory of the beams. He also corrected the theories of torsion for non-circular shafts proposed by Navier earlier. The other great scientists who made significant contributions during this period were Jourawski, Clapeyron, Bresse, etc. Jourawski was famous for his theories on the shear stresses in the beams, while Clapeyron was the man who developed the mathematical analysis of continuous beams. On the other hand, J.A.C. Bresse was the first man who introduced the concept of core or kernel of any cross-section apart from his important contributions on design of the curved bars and arches. The German engineer, E. Winkler during this time developed the analysis of curved bars and beams.

The subject took a decisive turn with the advent of the steel industry, as the development of the subject took place in leaps and bounds. The concept of metal fatigue came into the being and A. Wöhler carried out his experiments on the rotating beam in his fatigue-testing machine. With the rapid advancement of the industrialisation, theories were required to be developed for the moving loads on the bridges. In the beginning of the twentieth century, the rigorous metal testing added another dimension to the development of this subject. J. Bauschinger contributed a lot in the experiments on the physical properties of steel. The theories of metal failure got a foothold on the experimental observations made possible on the materials. Otto Mohr was a person who developed the graphical representations of stresses inside the bodies. Castigliano at the same time enunciated his two important theorems on structural mechanics to determine the deflections of various structures from the consideration of the strain energy stored within the body. The other person who also made significant contribution in the structural mechanics was Engesser.

In the later part of this century, along with many other great personalities, Ludwig Prandtl, the mentor of other two big personalities of this subject, von-Karman and S.P. Timoshenko, also contributed heavily to the subject. Of particular importance is his theory of membrane analogy of the torsion of non-circular shafts. During this time, the world witnessed another great engineer, scientist and educator – S.P. Timoshenko. He was basically from Ukraine. Timsohenko taught the subject in Russia and then during the time of World War, ultimately left Russia and settled in USA. In Stanford, he was a professor of engineering mechanics. His significant contributions took place in the different corners of the subject. He corrected the beam theory and introduced shear deformation to consider beam deflection.

From his time onwards, that is, after later part of the twentieth century, the subject continues to grow in various dimensions. With the understanding of optics, electronics, electrical technologies, more experimental techniques have found their ways in the field of the experimental stress analysis. It greatly helps the development of the subject sometimes providing an alternative method of verifying some of the theories and the assumptions on which the related theories are built upon. Further, with the advancement of various numerical methods, with the help of finite-element modeling, people are analyzing more complicated stress situations, which are prevailing in various machine components and structural elements. Also, with the help of better understanding of material science, people are now able to solve the complicated inelastic stress analysis problems of non-Hookean materials. It is postulated that, with the rapid advancement of modern-period-cutting-age technology, the applications of such materials will evolve further and very soon we have to study the mechanics of such non-Hookean materials. All these greatly enhance the development of the subject. In short, we can only say that, the subject is still developing.