Strength of material 2

The fundamental aspect of structural engineering is to define spaces within roofs, floors and walls. In even the most complex of buildings the there are two underlying sub substructures; and firstly horizontal structures like beams and secondly vertical substructures the like columns and struts. A key rule that structural engineers must adhere to is that the resistance of every structural element as well as the structure as a whole such be greater than the maximum load that the structure will be exposed to over its lifetime, along with a built in safety factor (Wai-Fah Chen and E. M. Lui, 2005).

Beams: Beams are often classified according to their ideal support conditions as either simply supported beams or cantilever beams. Beams are subject to bending stresses when loads are applied and experience compressive, shear and tensile forces. A simply supported beam is fixed on two ends. When loading the maximum tensile stress occurs at the midpoint of the bottom edge of the beam and the maximum compressive stress occurs at the midpoint of the top edge. A cantilever beam is supported on one end only and must be built into the wall that supports it. Two forces act on cantilever beams – firstly, a vertical upward force which supports the weight of the beam and any downward loads and secondly ‘ the fixing moment’ which prevents the unsupported beam from falling (Eric William Nelson et all, 1997). A beam may be strong enough to resist bending moments set up by its load and yet may sag without collapsing. This is called deflection and is dictated by the elasticity and strength of the material used to build it.

Columns and Struts: Columns, also known as stanchions support compressional loads along their longitudinal axes. The effective of excessive loading on a column is that the column could cause it buckle or crush like a wall coming down. A ‘ short column’ is one whose height is small relative to

its thickness is small relative to its thickness. Whether or not the column will remain stable under increasing axial load will depend on the strength of the material that constitutes the column. A ‘ long’ or ‘ slender’ column has a greater height relative to its thickness. A long column becomes unstable and buckles at a load much smaller than which would crush a short column of the same cross-section and material. This is called the ‘ critical load’. Unlike beams, the loading capacity of a column depends less upon the strength of the material of which it is made than upon its stiffness and this decreases with a decrease in column width. (Jack Stroud Foster and Roger Greeno, 2007).

Like columns, struts also carry loads primarily in compression along their length. Struts provide outward facing support in their lengthwise direction which can be used to keep two other structural components separate. In mechanical engineering, struts can be used as passive braces to reinforce the chassis or body of an automobile, while in civil engineering they form integral parts of trusses, space frames and suspensions (www. corusconstruction. com and Wikipedia)

Safety Factors in Structural Engineering:

Allowable stress design (ASD), ultimate stress design (USD) and the Load and resistance factor design (LRFD) are three approaches to safety engineering. The ASD approach stipulates that the allowable stresses should be greater than the unfactored nominal loads or load combinations that the beam or column will encounter during its lifetime. A safety factor is introduced in predicting resistance and loads set at nominal values, ignoring the uncertainties in their prediction. The USD concept involves the use of load safety factors, but no specific safety factors for resistance. The LRFD

(also known as reliability-based design concept) removes the shortfalls of the ASD and USD systems and introduces conservatism with the use of safety factors for both loads and resistance determination, under the constraint on an underlying risk. (Wai-Fah Chen and E. M. Lui, 2005)

References

(1) Eric William Nelson, Charles L. Best, William G. McLean. 1997. Schaum's Outline of Theory and Problems in Engineering Mechanics. New York: McGraw-Hill.

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(3) Wai-Fah Chen and E. M. Lui. 2005. Handbook of Structural Engineering. CRC Press.

(4) http://www. corusconstruction. com/en/reference/teaching_resources/architectural_studio_reference/ elements/design_of_columns_and_struts/introduction/

(5) ' Struts' - http://en. wikipedia. org/wiki/Strut