**Simple bending equation derivation**

# Simple bending equation derivation

Derive the equation for simple theory of bending. Choose the correct assumption made in the derivation of simple bending equation.

Now we are going on to start a new topic namely the derivation of the flexion formula or the flexion equation for pure flexion in the strength of the material with the help of this post. We go on step by step to make it easier to understand, however if there are any problems we can discuss them in the comments box provided below. We consider a structural element like the beam with rectangular cross section, we can select any type of cross section for the beam but here we have considered that the next beam has rectangular cross section. First we will find here the expression for the bending stress in a pure bending layer of the beam and after we understand the concept of the resistance moment and once we have these two pieces of information, we can easily fix the bending equation or bending formula for beams. expression for stress bending acting on a layer of the beam subjected to pure bending. Suppose the following PQ is horizontal and supported at its two ends, i.e. the P end and the Q end, so we can say that here we have considered the condition of the simply supported beam. Once the load W is applied to the PQ of the horizontal beam simply supported as shown above, the PQ beam will bend as a curve and we tried to show the bending condition of the PQ of the beam due to the load W in the figure above. Let us now consider a small portion of the PQ of the beam, which is subjected to a simple bending, as shown here in the following figure. Consider two sections AB and CD as shown in the following figure. Now we have the following information from the above figure. AB and CD: Two vertical sections in a portion of the beam considered N.A: Neutral axis shown in the figure above EF: Layer on neutral axis dx = Beam length between sections AB and CD Consider a GH layer at a distance y below the neutral EF. Here we can see that the length of the neutral layer and the length of the layer GH will be equal and will be dx. Original Length of Neutral Layer EF = Original Length of Layer GH = dx Now we will analyze here the condition of the assumed part of the beam and the section of the beam after the bending action and we have shown here in the following figure.Ã¨ As we can see here that the part of the beam will bend as a curve due to the bending action of flex and then we will have followed information from the above figure. Section AB and CD will now be Section AâB' and CâD' Similarly, the GH layer will now be GâH' and we can see here that the length of the GH layer will now increase and will now be GâH' The neutral EF layer will now be EâF', but as we discussed during the study of Assumptions made in the theory of simple folding, the length of the neutral EF layer will not be changed. Neutral Layer Length EF = EâF' = dx AâB' and CâD' meet at the center O as shown in the previous figure Neutral Layer Radius EâF' is R as shown in the previous figure The angle made by A’B' and C’D' to the center O is Î¸ as shown in the figure above The distance of layer G’H' from neutral layer E’F' is y as shown in the figure above Length of neutral layer E’F' = R x Î¸ Original length of layer GH = Length of neutral layer EF = Length of the neutral layer E’F = R x Î¸ Length of the layer G' Change of the length of the layer GH = Length of the layer G’H'- original length of the layer GH Change of the length of the layer GH = (R + y) x Î¸ – R x Î¸ Change of the length of the layer GH = y x Î¸ Strain in Layer Length GH = Variation of Layer Length GH/ Original Layer Length GH in Layer Length As we can see here that the tension will be proportional in direction to the distance, i.e. the distance of the layer from neutral layer or neutral axis and so how we will go towards the lateral layer bottom of the beam or towards the top layer of the beam, there will be more tension in the beam layer. At the neutral axis, the value of y will be zero and so there will be no tension in the neutral axis beam layer. Recall the concept of Hook Law According to Hook Law, within the elastic limit, the stress applied on an elastic material will be proportionally in a directional way to the strain produced because of the external load and mathematically we can write over the law as said here. Where and is the Younger’s Module of Material Elasticity Let’s consider the above equation and putting the safe stress value above, we will have following equation as mentioned here. Therefore, the bending stress on the level will be given by the following formula as shown here We can conclude from the top equation that the stress acting on the beam layer will be proportional to the distance y of the layer from the neutral axis. As we have discussed that when a beam is subjected to pure bending, layers above the neutral axis will be subjected to compressive stresses and layers below the neutral axis will be subjected to thunder stresses. Therefore, there will be force acting on the layers of the rays because of these stresses and thus there will be the moment of these forces on the neutral axis also. The total moment of these forces on the neutral axis for a section will be defined as the moment of resistance of that section. As we already thought we are working here with a beam with rectangular cross section and consider the cross section of the beam as shown here in the following figure. Let’s assume a strip of thickness dy and area dA at a distance y from the neutral axis as shown in the figure above. We need to determine the force that acts.layer due to the stress of bending and we will have the following equation We decide the moment of this layer on the neutral axis, dM as mentioned here Total moment of forces on the beam section around the neutral axis, also defined as moment of resistance, could be assured by integrating the equation above and we will have Let consider the above equation of resistance and equation moment that we fixed to bend the stress in action; we will have followed the equation that is defined as bending bending bending or flexible equation. We will discuss another topic in the material strength category in our next post. Strength of the material, from R. K. Bansal HomeMechanical SolidsSimple Bending Theory-Bending Equation-Flexural Formula-Derivation Simple bending or pure bending is defined as the phenomenon of development of stresses throughout the beam length due to the bending action of the moment exclusively. The development of stresses along the entire length of the beam is called as bending stress. In this article, we will discuss the simple theory of bending, the assumptions in the theory followed by derivation to determine bending stress or Bending equation. Beam Construction; Image Courtesy: Molin Precast Products The simple bending can be explained by the beam below and by the load layout. As shown in the figure, from the BM diagram of the corresponding beam layout have constant Bending moment along the AB beam length and the SF has nothing to contribute to that length. Fig. Explanation Theory Simple Bending This section of the AB beam is said to be in condition of simple bending or pure bending. The flexorale formula is given by the report: The assumptions in the simple theory of bending are: The beam material is homogeneous and isotropic The cross section of the beam remains the plan before and after bending. The value of the youth module is the same in tension and compression The beam is initially straight and all longitudinal filaments bend into circular arches with a common curvature center The bending radius is large compared to the size of the cross section. Each layer of the beam is free to expand or contract independent from the underlying layer. The theory of simple bending can be explained following the consideration of the beam element, as shown in figure-2 below. As shown in the above figure, consider a section of the ABCD small beam with a length of dx. The N-N forms the neutral axis of the beam element. Section AB and CD are perpendicular to the N-N neutral axis. The element of the beam under the bending action is deformed as shown in figure-2(b). The layers of the beam before the curvature do not remain the same after the bending. The AC and BD layer deformedto A’C' and B’D. The layer shortens at the top and expands into the bottom layer. The beam layer does not undergo any change to the neutral layer. This means, NN = dx = N’N' The layers above the neutral axis are are then subjected to a compression force. the layer under the neutral axis is elongated and then tractioned. Therefore, the compression effort is maximum in the upper layer and the traction effort is maximum in the lower layer. While we move from the lower level to the neutral level, the length of the layers decreases. Therefore, the increase or decrease in the length of the layer depends on its distance from the neutral axis. this theory of bending is called the theory of simple bending. as shown in Figure 2, letter a,) consider an ef level starting from a ‘y’ distance from the neutral axis. After bending, ef is deformed in E’F’ as shown in point 2 (b.) given: the radius of the neutral layer = r The angle subdued by A’B’ and C’D’ a o = î¸ then, variation of the deformation along the depth of the original beam length of the layer = ef = dx;¸le = nn = N'N' = dx from the figure, N'N' = r x î¸ = dx E'F' = (r + y)¸ deformation in the ef layer = increase in the length of the ef / (original length) = (E'F' – ef) /ef = (r +y) î¸ – (rx¸ This report shows the variation of deformation along the depth of the beam. the variation of deformation is linear. â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â€o â

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