Torque diagram of a stepped shaft

Example 5.1.1 Under certain conditions: Shaft step (polar moment of inertia J1, J2) made of two materials (shear of module G1, G2). The shaft is fixed (without rotation) on top. The torque is applied along the shaft axis: 3T (counterclockwise around the +y axis at Pt.B) and T (about the +y axis at Pt. E). I'm not going to be a Sol'n: Step 1. Equilibrium: Decide on the response to Pt. A: R = 2T (clockwise around + y-axis, negative torque). Step 2. Twist/Torque of Elements: Break the bar into lengths on which all values (torque, cross-section and module) are constant. The upper shaft length, AB, has length, a, Polar moment of inertia, J1, module, G1, and brings torque 2T (negative torque on the positive side of AB). With cross-section (Section) Fixed, the rotation of Section B in relation to Section A is: Taking each of the other lengths with constant torque, cross-section and module: Step 3. Compatibility: The total rotation is: Free shaft carociphs. Angular deviation of a step shaft. 2 » 5.1 Torsion members • Thin-walled torsion member • Hard/thick-walled torsion members • Discreetly different torsion members • Ever-changing torsion members • Power - Examples modules/tools/tables • Polar moment of Momentum (J) » Problems in practice • Problem 5-1 • Problem 5-2 Page 3 » Discreet and constantly varying shafts To solve problems, including discreetly different shafts, breaking the shaft into lengths by which all the force values, area and module are constant. The total angle of rotation can be obtained by treating each part of the bar as a member of a uniform torsion torsion: qtotal = qi = TiLi JiGi Similarly, for problems involving constantly changing shafts, the angle of rotation can be determined by integrating along the length of the element: qtotal = L DQ = L T(x) dx DX J(x) G(x) G X) foot shaft, curve and twisting hardness -Join shafts -Fixed and simply supported shaftsShaft: Shafts are the machine elements that are used to transmit energy into machines. Twisting moment: The twisting torque for each section along the shaft/shaft is defined as an algebraic sum of the moments of the applied pairs lying on one side of the section. The choice of the country in any case is, of course, arbitrary. Grinding strain: if generator?? (b) is marked on the surface of the unladen bar and then, after the moment of rotation T, this line is moved to i.e. the ??? measured in radians, between the extreme and initial positions of the generators is defined as a shear on the surface of the rod or shaft. The same definition will take place at any point in the interior of the bar. Shear elasticity module: The ratio of shear stress to the shear strain is called a shear module (c) shear or hardness module and in the symbol Angle of rotation: If an L-length shaft is subjected to a constant twisting torque T along its length, from the angle? through which one end of the tape will rotate relative to the other is known is the angle of rotation. Despite the differences in load forms, we see that there are a number of similarities between bending and sludge, including, for example, a linear variation of voltages and voltage with position. In the ustizia, members are subjected to moments (pairs) in planes that are normal for their wasps. In order to disguise a circular shaft in order to withstand a given torque, we need to develop an equation that gives the ratio between the twisting torque, the resulting maximum shear voltage and the amount representing the size and shape of the cross-sectional section of the shaft. Not all uteria problems involve rotating machines, but for example, some types of vehicle suspension systems use resistive springs. In fact, even the coiled springs are really curved members in nitrite, as shown in the figure. Many of the engineering elements of torque are cylindrical. Examples include drive shafts, bolts and screws. Simple torsion theory or development of torsion formula : Here we are mainly interested in getting an equation between the corresponding parametersConnection in torsion: 1st Term: Refers to applied loading of advertising property of a section that in this case is polar second moment of zone.2 nd Term: This refers to stress, and stress increases as the distance from the axis increases.3 rd Term : it refers to the deformation and contains the terms hardness module " &&, combined term (??? l), which is equivalent to a strain for designing a circular shaft with a torque stand, we need to develop an equation that gives the relationship between the reverse moments max m shear, produced and quantity representing the size and shape of the waist?? shaft cross-section. Above, reference shall be made to the figure where the same circular shaft is subjected to torque, each part of the shaft being subjected to a state of pure shear, the resistance torque developed by the shear voltages being equal to the amplitude and vice versa in the sense of the torque applied. In order to obtain a simple theory of describing the behavior of shafts subjected to torque, it is necessary to make the following basic assumptions. Admission: (i) The material is homogeneous, that is, with the same elastic properties, exists throughout the material. (ii) The material is elastic, follows Hook's law, with pressure proportional to the shear strain. (iii) The voltage does not exceed the elastic limit. (iv) The round part remains a circular(v)cross-section remaining a plane. (vi) Cross-section as solid, i.e. each diameter rotates through the same angle. Now that the solid circular shaft with radius R is subjected to torque T at one end and the other end is fixed under this torque, the radial line at the free end of the shaft is rotated through an angle, point A is moved to B and AB is angled within the fixed end. This is the angle of curvature of the shaft, that is, the shear strain. Since the angle in radius = arc / Radiusarc AB = R? [since L and? also represents arc AB] So? = R? / L (1)From the definition of the hardness module or the shear elasticity module: Let's consider a small strip with radius r and thickness Dr. who is under stress shear t'. The force created on each element = stress x area = t' . 2 p. r = 2 p t' . R2. e. T of the section's torque T will be the sum of all contributions. Since t' is a function of r, because it varies with the radius, so recording t' in relation to r of the equation (1). This force will result in torque or torque around the central shaft axis. The total torque T of the section will be the sum of all contributions. Because it is a function of r, because it varies with the radius so recorded?' in terms of r of the equation (1). whereT = applied external torque which is constant above the length L;J = Polar moment of inertia [D = Outer diameter; d = internal diameter]G = Modules with hardness (or shear elasticity module)q= The angle of rotation in radians on length L. Tension hardness: the hardness of the tensioner k is defined as torque of the shear radius.e.d. k = T /q = GJ / LProblem 1A stepped solid circular shaft is built at its ends and is subjected to externally applied torque. T0 in the shoulder, as shown in the figure. Determine the angle of rotation?0 of the shoulder section where T0 is applied? Solution: This is a static unspecified system because the shaft is built in at both ends. All we can find from the statics is that the sum of two reactive torque TA and TB in the built?? at the ends of the shafts must be equal to the torque applied T0Thus TA+ TB = T0 ------ (1)[of static principles]Where TA, TB are the reactive torque at the end A and B. wheeras T0 is the applied torqueFrom viewing a sequential deformation, we see that the angle of rotation in each part of the shaft should be the same.i.e Qa = q b = q 0using the angle of turn N.B: Assuming that the hardness module G is the same for both partsSo the ratio of TA and TBSo by solving (1) & (2) we get non-uniform torsion: Clean torso refers to twisting the prismatic tape, which is subjected to torques, acting only at the ends. While non-homogeneous torsion differs from pure comfort in the sense that the bar/shaft does not need to be prismatic and the torque applied can be The shaft consists of two different segments of different diameters and with torques applied on several cross-segments. Each section of the strap between the applied loads between the cross-section is in pure comfort, so the formula obtained earlier can be applied. Then form the internal torque, the maximum shear voltage and rotation angle for each area can be calculated from the ratio The total angle for turning one end of the tape in relation to the other is obtained by summing using the formula If the torque or cross-section changes continuously along the axis of the tape, then ? (summation can be replaced by an integral sign ( ). . After examining the differential element, we can write Replace expressions for Tx and Jx at a distance of x from the end of the tape, and then the integration between the boundaries from 0 to L, the value of the angle of rotation can be determined. Application to spiral springs with near-rolled spirals, warmed by spiral springs subjected to axle loads: Definition: the spring can be defined as an elastic element, the main function of which is to deflect or bleed under the applied load; it restores its original shape when releasing load.orSprings are energy absorbent units whose function is to store energy and restore it slowly or quickly depending on the specific application. Important types of springs are: There are different types of springs such as(i) spiral spring: They are made of wire rolled up in spiral form, applying the load to spiral axies. In this type of springs, the main loads are the stress of twisting due to twisting. They are also used for tension and compression. (ii) Spiral springs: They are made of a flat strip of metal rolled up in the form of a spiral and loaded into torsion. In this, the main voltages are tensile and compression due to bending. iv) Leaf springs: composed of flat rods of different lengths, tightening together so as to obtai greater efficiency. Leaf springs can be full elliptical, semi-elliptical or cantilever species, in these types o springs the large voltages that enter the picture are stretched & gt; Compression. This type of springs are used in the car suspension system. Use of springs :(a)In order to apply the forces and adjust the movements of both brakes and connectors. (b) Measure the forces as in the spring balance. c) Store energy as in the clock. (d) Reducing the effect of impact or impact load, as with a file. (e) Change the vibrating characteristics of a member as inflexible engine installation. Formula derivative: To obtain the necessary formula that regulates spring behaviour, consider the closed cat spring subjected to axial W.LetW = average coil diameter = spring wire diameter n = number of active coilsC = spring index = D/ d For wires l = spring wire lengthG = hardness module x = spring deformation q = rotation angle when the spring is subjected to axial load on the spring wire is twisted like a shaft. If q is the total angle of rotation along the wire and x is the spring deflection under the action of load W on the coil axis, so = D / 2 . again l = D n [consider half turn of a near-rolled spiral spring] Maximum shear voltage in spring section, including the Wahl FactorWahl FactorAlity factor: (1) The bending and shear effects can be ignored(2) For the purpose of obtaining a formula, the angle of the spiral side is considered so small that it can be ignored. Any coil of such a spring will be assumed to lie in a plane that is almost p to the axis of the spring. This requires the adjacent coils to be close to each other. With this limitation, a section taken perpendicular to the axis the spring rod becomes almost vertical. Therefore, in order to maintain the equilibrium of a spring segment, each X cross-section requires only shear force V = F and torque T = F. r. Using the diligent formula i.e. page 2 SPRING DEFLECTIONSpring striffring: Hardness is defined as deformation of the load of the WAHL'S FACTOR unit: To take into account the effect of direct shear and the change in coil curvature, a stress factor that is known as the Wahl factor is determined. K = wahl's factor and is defined aswhere C = spring index = D/dif we take into account the Wahl factor from the shear stress formula becomingStrain Energy: Voltage energy is defined as the energy stored in material when the work is done on the material. In the case of a spring, the voltage energy will be due to bending and the energy voltage due to bending is given by the extensionDive springs of the spiral coil under axial loadsDeflection of springsExample: A close-winded spiral is to carry out a load of 5000N with a deformation of 50 mm and a maximum shear voltage of 400 N/mm2., if the number of active turns or active coils is 8.Read the following: (i) wire diameter (ii) average diameter of the coil(iii) of the spring. Let's say G = 83,000 N/mm2; = 7700 kg/m3 :(i) for the wire diameter if W is the axial load, thenTeer,D = .0314 x (13.317)3 mm = 74.15 mm = 74.15 mmSwising spiral springsPromising springs in series: If two springs of different hardness are joined and carry a total load W, they bind sequentially and the combined hardness and deformation are given by the following equation. In parallel with the If the two springs are joined in the a way that they have a common deformation x; then they are shared between the two springs and total load W = W1 + W2stresses in spiral springs under torsion loadsString under twistingHeart stress in a shaftWhen a shaft is subjected to torque or twisting, pressure shear is obtained in the shaft. The shear voltage varies from zero in the axis to a maximum on the outer shaft surface. The shear voltage in a solid circular shaft in a given position can be expressed as: s = T r/ip (1), where = shear voltage (MA, psi) T = twisting moment (Nmm, in lb) r = distance from centre to stressed surface in a given position (mm) Ip = polar moment of cross-sectional inertia (mm4, in4)the polar moment of inertia is a measure of the object's ability to withstand a torso. The circular shaft and the maximum moment MomentMaximum in a circular shaft can be expressed as: Tmax = smax Ip / R (2)WhereTmax = maximum twisting torque (Nmm, in lb) smax = maximum shear voltage (MPa, psi)R = shaft radius (mm, c)Combining (2) and (3) for solid shaftTmax = (p/16) smax D3 (2b)Combining (2) and (3b) for hollow shaftTmax = (p/16) smax (D4 - d4) / D (2c)circular shaft and polar moment of inertiaPolar moment of inertia of a circular solid shaft can be expressed asIp = p R4/2 = p D4/32 (3)D = outer shaft diameter (mm, c)The polar moment of a circular hollow shaft can be expressed as a p = p (D4 - d4) /32 (3b)) where = internal shaft diameter (mm Hard shaft diameter Diometer can be calculated using the formulaD = 1.72 (Tmax/smax)1/3 (4)The uscore deflection of the shaft Ttafort deflection of the torsion shaft can be expressed as? = L T / Ip G (5)where? = angular shaft deflection (radians) L = shaft length (mm, in)G = hardness module (Mpa, psi)The angular deformation of the rigid twisting can be expressed as? = 32 T / (G p D4) (5a)Angular deformation of a hollow shaft of torsion can be expressed as? = 32 L T / (G p (D4-d4)) (5b)The angle in degrees can be achieved by multiplying the angle? in radians with 180/p Solid shaft (p removable)?degrees °584 L T / (G D4) (6a)Hollow shaft (p replaced) ?degrees °584 L / (D4-d4) (6b) Page 3 TORSIA 1. What are the assumptions made in the precipitation equation? The shaft material is uniform, for rotation is uniform along the shaft and the voltage does not exceed the limit of proportionality 2. Write down the power expression transmitted by a shaft. Power, P = 2pNT/ 60 where, T – Torque in kN.m N –Speed in r.p.m. P – Power in 3. Determine the polar This is the relationship between the polar moment of inertia and the radius of the shaft. 4. Indicate the differences between closed and open coils with spiral springs. Closed rolled spiral springs Adjacent coils are very close to each other It can carry only tensile load. Angle of helix is insignificant Open rolled spiral springs Large spilled between adjacent coils It can carry both tensile and compression loads. The angle of filament is a significant 5.Find the torque that the shaft with a diameter of 50 mm can transmit safely if the permissible shear voltage in 75 N/mm2? T = p/ 16 x fsx d3 T = p/ 16 x 75 x (50)3 T = 1,840 kN.m 6. What does stiffness mean? The hardness of the spring is defined as the load required for the deformation of the unit of the product. 7.Classification of spring types. Torsion spring and bending 8.What is meant by spring? The spring is a device that is used to absorb energy, taking very large changes in shape without permanent deformation and then releasing them when necessary. 9.Determine torsion. When a pair of forces of the same size, but in the opposite direction, acting on the body, it tends to twist the body. It is known as a twisting torque or simply as torque. 10.What do you mean by the torsion spring? A spring that is subjected to torsion or twisting is only known as a torsion spring. 11. What is the ratio of the maximum shear voltage to the average shear voltage in the case of a rigid circular section? Qmax is 4/3 times Qavg. 12. What is the value of the distribution of the flange shear voltage part of the I-section? Where, D- depth y- Distance from neutral axis 13. Where is the maximum shear tension for a triangular section? In the case of a triangular section, the shear voltage is not max. The shear voltage is maximum height h/2 14. Definition: Mohr'sTheorem for slope The change of inclination between two points of the laden beam is equal to the area of bmd between two points divided into EI. 15. Definition: Mohr'sTheorem for deviation The deviation of a point in relation to the tangent at point two is equal to the first moment of the area of the BMD between two points around the first point divided into the EI. Page 4 1.A metal band with a diameter of 10 mm, when subjected to a pull of 23.55KN give and elongate 0,3 mm to a gauge length of 200 mm. You're deceasing Tasson. Solution: To give diad = 10 mm pulling P = 23.55KN extension SL = 0.3 mm Device length = 200 mm torsion test (or) = 40.71 N/mm2 Diameter = 500 mm rotation angle = 0o21' length = 3 0' length 0 mm Asked problem-2: A diameter ratio of the hollow shaft 3/5 is required for transmission of 450Kw at 1200pm, the shear voltage in the shaft should not exceed 60N/mm2 and the 2.5m turnback should not exceed 1o. The minimum external external shaft is calculated. Take, C=8,0KN/mm2. Problem-3: What should be the length of aluminum wine of 5 mm, so that it can be twisted through 1 complete revolution without exceeding a shear of 42N/mm2. Take, G= 27 GPO. Problem-4: The rigid steel shaft must transmit 75KW of power in 200 hours. By accepting a permissible shear voltage of 70Mpo. Find suitable shaft diagnoses with the maximum torque transmitted at each speed exceeds by an average of 30% 1.3 times. Means.