زبان تخصصی مهندسی مکانیک

قسمت دهم

۳-۴- پیچش (*Torsion*)

۳-۴-۱- مقدمه (*Introduction*)

In this chapter structural members and machine parts that are in torsion will be considered.

More specifically, you will analyze the stresses and strains in members of circular cross section subjected to twisting couples, or torques, T and T'.

These couples have a common magnitude T, and opposite senses. They are vector quantities and can be represented either by curved or by couple vectors.

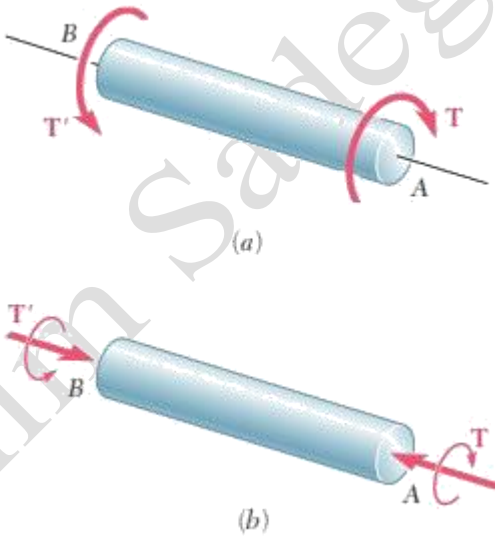

Figure 3 – 10 : shaft subjected to torsion

کلمه	معنی	کلمه	معنی
twist	پیچیدن	specific	خاص
common	مشترک	torque	گشتاور
magnitude	مقدار	opposite	مخالف
quantity	کمیت	vector	بردار
		curve	منحنی

Members in torsion are encountered in many engineering applications. The most common application is provided by transmission shafts, which are used to transmit power from one point to another.

For example, the shaft shown in Photo is used to transmit power from the engine to the rear wheels of an automobile.

کلمه	معنی	کلمه	معنی
applications	کاربرد، ابزار	encounter	مواجه شدن، روبرو شدن
shaft	محور	transmit	انتقال دادن
rear	عقب	power	توان

Figure 3–11: In the automotive power train shown, the shaft transmits power from the engine to the rear wheels.

These shafts can be either solid,or hollow.

Consider the system shown, which consists of a steam turbine *A* and an electric generator *B* connected by a transmission shaft *AB*. By breaking the system into its three component parts, you can see that the turbine exerts a twisting couple or torque *T* on the shaft and that the shaft exerts an

equal torque on the generator. The generator reacts by exerting the equal and opposite torque T' on the shaft, and the shaft by exerting the torque T' on the turbine.

کلمه	معنی	کلمه	معنی
hollow	تو خالی	solid	تو پر
steam	بخار	consists of	شامل شدن
generator	ژنراتور، مولد برق	turbine	توربین

You will first analyze the stresses and deformations that take place in circular shafts. In first section, an important property of circular shafts is demonstrated: When a circular shaft is subjected to torsion, every cross section remains plane and undistorted. In other words, while the various cross sections along the shaft rotate through different angles, each cross section rotates as a solid rigid slab. This property will enable you to determine the distribution of shearing strains in a circular shaft and to conclude that the shearing strain varies linearly with the distance from the axis of the shaft.

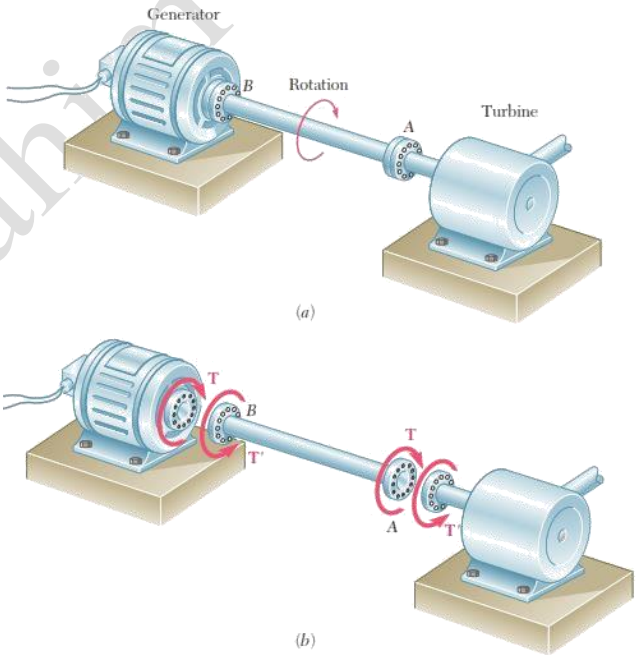

Figure 3–12: Transmission shaft

Considering deformations in the elastic range and using Hooke's law for shearing stress and strain, you will determine the distribution of shearing stresses in a circular shaft and derive the elastic torsion formulas and you will learn how to find the angle of twist of a circular shaft subjected to a given torque, assuming again elastic deformations. Then the solution of problems involving statically indeterminate shafts is considered.

کلمه	معنی	کلمه	معنی
hollow	تو خالی	solid	تو پر
steam	بخار	consists of	شامل شدن
generator	ژنراتور، مولد برق	turbine	توربین
distort	کج کردن، اعواج دادن	plane	صاف، مسطح
conclude	نتیجه گرفتن، استنتاج کردن	slab	تکه، قطعه
solution	راه حل	enable	قادر ساختن

you will study the design of transmission shafts. In order to accomplish the design, you will learn to determine the required physical characteristics of a shaft in terms of its speed of rotation and the power to be transmitted.

The torsion formulas cannot be used to determine stresses near sections where the loading couples are applied or near a section where an abrupt change in the diameter of the shaft occurs. Moreover, these formulas apply only within the elastic range of the material.

۳-۴-۲- تغییر شکل های یک محور دایره ای (DEFORMATIONS IN A CIRCULAR SHAFT)

Consider a circular shaft that is attached to a fixed support at one end. If a torque T is applied to the other end, the shaft will twist, with its free end rotating through an angle ϕ called the angle of twist.

کلمه	معنی	کلمه	معنی
require	نیاز داشتن	accomplish	انجام دادن
abrupt	تند، ناگهانی	term	عبارت

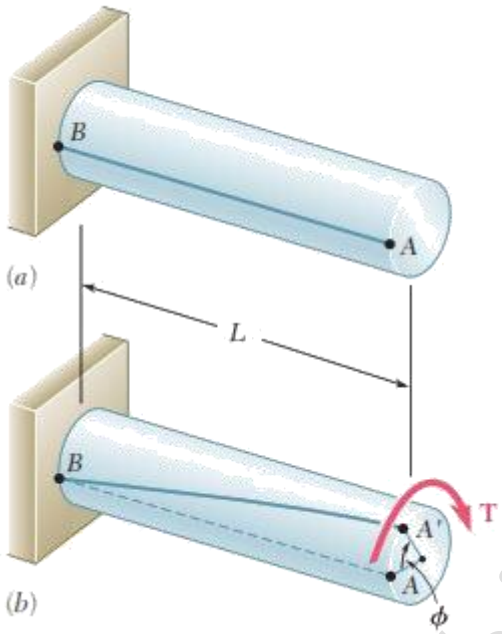

Figure 3–13: Shaft with fixed support

Observation shows that, within a certain range of values of *T*, the angle of twist ϕ is proportional to *T*. It also shows that ϕ is proportional to the length *L* of the shaft.

In other words, the angle of twist for a shaft of the same material and same cross section, but twice as long, will be twice as large under the same torque T. One purpose of our analysis will be to find the specific relation existing among ϕ, L and T ; another purpose will be to determine the distribution of shearing stresses in the shaft, which we were unable to obtain in the preceding section on the basis of statics alone.

معنی	کلمه	معنی	کلمه
متناسب	proportional		