Turning Effect of Force

Consider the following examples:

- opening or closing a tap
- opening or closing a door
- loosening or tightening a nut with a spanner or a screwdriver (see diagram)
- steering wheel of a car
- seesaw

In all of the above, the force applied is producing a turning effect or rotation. Let us look at the turning effect produced by a force on a spanner or a wrench more closely.

In the above diagram we see a force applied on the handle will cause the spanner to turn or rotate in the anti-clockwise direction. The rotation is about a fixed point called the pivot.

You must have noticed this from practical experience that if you apply the force farther away from the pivot, the easier it is to turn the screw.

The same force applied at B produces greater turning affect than that applied at A.

Conclusion:
The turning effect of a force depends on:
1. Force - greater the force greater the turning effect.
2. Distance - greater the distance from the pivot greater the turning effect.

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Moment of Force (Torque)

The turning effect of a force, also called torque is defined as

\[ T = F \times d \]

where, \( T = \) torque (or moment of force)  
\( F = \) force  
\( d = \) perpendicular distance of the line of action of force from the axis of rotation.

Note: if you draw an imaginary line in the direction of the force, that is your line of action of force.

Example 1

Example 2

Unit of Torque

Since \( F \) is in Newton (N) and \( d \) is in meters (m), the SI unit of \( T \) which is \( Fd \) is in Nm.

The SI unit of Torque or Moment of Force is Newton-metre (Nm).

Revision

1. Define torque or moment of force.
   Ans: Torque is the product of force and its perpendicular distance of its line of action from the axis of rotation. \( T = F \times d \).

2. State the SI unit of torque.
   Nm

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3. A nut is tightened by a force of 180N using a 8 cm spanner. What is the torque generated?

\[ T = F \times d \]

\[ T = 180 \times \frac{8}{100} \]

\[ T = 14.4 \text{Nm} \]

4. If we want to loosen the above nut by applying 150N force, what length of the spanner should be used?

\[ T = F \times d \]

\[ d = \frac{T}{F} = \frac{14.4}{150} = 0.096 \text{m} = 0.096 \times 100 = 9.6 \text{cm} \]

Assignments

1. Define moment of force or torque.
2. State the SI unit of momentum of force.
3. Which would you prefer to use, a spanner with a long or a short handle. Explain.
4. With the help of a simple diagram show the turning affect of force when opening or closing a door. In the diagram show the following - force, axis of rotation, perpendicular distance from the line of action of force to the axis of rotation.
5. If you require 100N force to tighten a nut using a 15cm spanner, how much force should you apply to loosen the same nut with a 12 cm spanner?