Technical English
Unit 30
professional english
Load, Stress and strain

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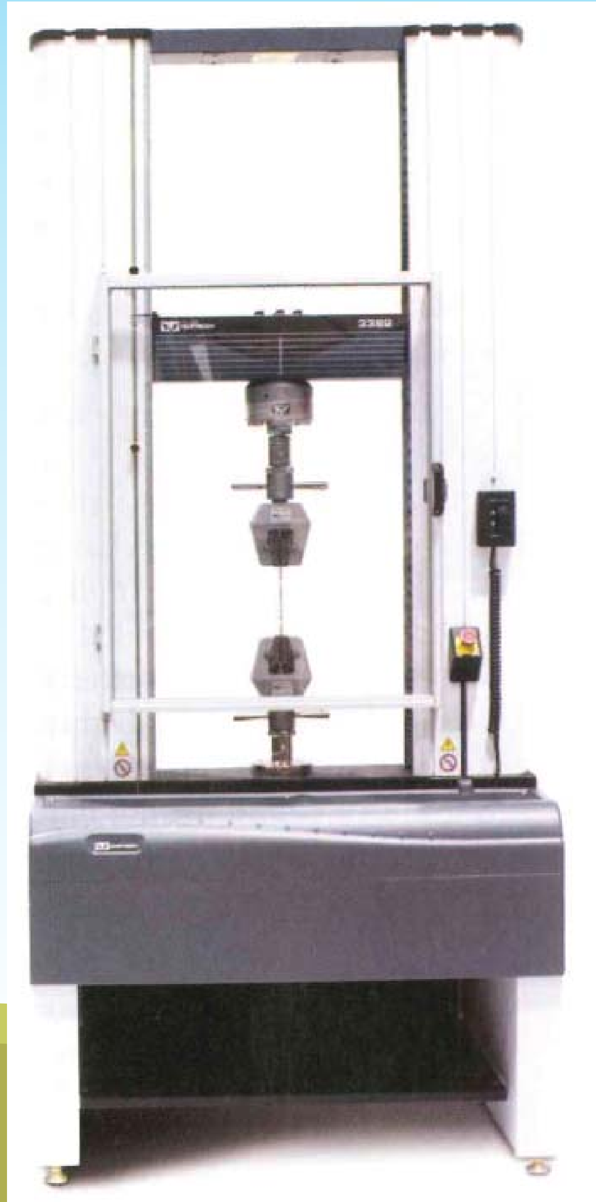
Contentes

A. Load

- When engineers design a machine or structure, they need to know what forces will be **exerted on** it (put pressure on it). In engineering, forces are called **loads**. Usually, several different loads will **act on** - apply force to - the components in a machine, or the **members** (parts) of a structure. A component or member which is designed **to carry (or bear) a load** is called a **load-bearing** component or member.

- To predict what will happen when components are **loaded**, engineers calculate the **magnitude** (size) of each load, and also work out the direction of the load -for example, vertically downwards. Load is therefore a vector **quantity (or vector**)- that is, a measurement with both a magnitude and a direction. This is different to a **scalar quantity**, which has a magnitude only.



B. Stress and Strain

The extract below is from an engineering textbook.

- In a test, a thick cable is used to pick up a heavy object. The cable stretches slightly, but lifts the weight. A second test is done using a thinner cable- one with only half the cross-sectional area of the thick cable. This time, the cable stretches, then breaks.
- Why did the thinner cable **fail**? Not due to a higher load, as the weight was the same. The **failure** was due to **stress**. Stress is force per unit of area, and is measured in newtons per square metre, or Pascals (1 N/m2 = 1 Pa). The thinner cable was therefore **stressed** twice as much as the thick cable, as the same load was **concentrated** into a cross-sectional area that was 50% smaller.

- Why did the thick cable stretch but not break? When objects are stressed, they **deform** -that is, they change size (if only slightly). In the tests, the cable **extended**- it increased in length. **Extension** can be measured as a change in an object's length compared with its **original length** before stress was applied. This measurement is called **strain.**
- According to a law called Young's Modulus of Elasticity, stress is **proportional to** strain. In other words, a percentage increase in stress will cause the same percentage increase in strain. However, this is only true up to a point called the **limit of proportionality**. If a material is **overstressed** beyond this limit - it will start to become strained by a higher proportion. Stress and strain will therefore become **disproportional**.

30.1 Replace the underlined words and expressions with alternative words and expressions from A opposite and Appendix V on page 106.

- If you look at the objects around you, it's difficult to find something that couldn't be smashed with a hammer. But if you laid a hammer down carefully on any of those objects, the (1) force which it (2) put on them wouldn't be sufficient to cause even the slightest damage. This comparison illustrates the difference between:
  - a (3) moving force, which combines mass and movement to apply (4) a shock
  - a (5) still force, which consists only of an object's (6) own mass.
- Between the two situations, the (7) size of the load (8) placed on the surface is dramaticallv different.

30.1

1 load	5 static load	9 loaded
2 exerted/imposed on	6 self-weight	10 uniformly distributed load
3 dynamic load	7 magnitude	11 concentrated
4 an impulse	8 exerted/imposed on	12 point load

The above comparison illustrates another difference in the way surfaces are (9) pressured. When a hammer is laid horizontally on a surface, its weight is spread over a relatively large area. It therefore applies a (10) spread out force. By contrast, when a hammer hits something, only the edge of the hammer head comes into contact with the surface. The force is therefore (11) focused in a small area, applying a (12) localized pressure.

30.1

1 load
2 exerted/imposed on
3 dynamic load
4 an impulse
5 static load
6 self-weight
7 magnitude
8 exerted/imposed on
9 loaded
10 uniformly distributed load
11 concentrated
12 point load

30.2 Complete the technical checklist (1-7) based on the questions (a-g), using words from A and B opposite and Appendix V on page 106.

a. Which components need to carry load?

b. What types of load will be carried by each part? Which loads will remain constant, and which will differ depending on use and circumstances?

c. What amount of load will be exerted, in Newtons?

d. In what directions will the loads act?

e. For the materials used, how concentrated can maximum loads be without putting the component under too much pressure?

f. How much deformation can be expected?

g. If something breaks, will the assembly collapse dangerously, or in a controlled, relatively safe way?

1 Determine which components are ......load-bearing........ .

2 Analyze the types of load that will .... on each part. Assess .... loads and .... loads.

3 Calculate the .... of loads as .... quantities.

4 Evaluate loads as .... quantities.

5 Determine the maximum level of .... that can be carried by materials without causing them to be ....

6 Calculate percentages of ....

7 Assess the consequences if a component .... , determining the potential dangers of the ....

30.2

1 load-bearing
2 act, dead, live
3 magnitude, scalar
4 vector
5 stress, overstressed
6 strain
7 fails, failure

Common structural elements

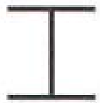
The table below lists the structural elements commonly found in large structures, in:

- the **substructure** – elements situated below **ground level** (below the ground)
- the **superstructure** – elements situated above ground level.

Element	Description
foundation	an element in the ground, usually made of concrete, which transmits loads from a structure to the soil or rocks in the ground below it
pad foundation	a square foundation – usually supports a column
strip foundation	a long, narrow foundation – usually supports a wall
raft foundation	a large rectangular foundation which covers the entire area of the building that it supports – effectively a thick slab which acts as a foundation
pile	a vertical column of concrete below the ground which provides a strong foundation – may be cast in-situ by pouring concrete into a hole that has been **bored** (drilled), or may be precast and **driven** (hammered) into the ground
pile cap	a block of concrete, at ground level, built directly on top of a pile or **pile cluster** (several piles close together) to provide a flat foundation – for a column, for example
ground beam	a concrete beam at ground level which connects two pile caps – pile foundations often consist of a network of ground beams connecting a number of pile caps

basement	one or more floors of a building situated below ground level, surrounded by walls
retaining wall	a wall which supports earth behind it, allowing the ground behind it to be at a higher level than the ground in front of it – the wall **retains** the earth (holds it back)
column	a vertical structural element with a relatively small cross-section – in large structures, often consists of reinforced concrete, a steel Universal Column (UC), or an **encased** UC – that is, a UC **encased in** (surrounded by) concrete
beam	a horizontal structural element with a relatively small cross-section – in large structures, often consists of reinforced concrete or a steel Universal Beam (UB) – frequently spans between two columns
slab	an area of concrete generally with a constant thickness, most often a **floor slab** (a slab for a floor) – called a **suspended slab** if it spans between supporting beams, including ground beams
dam	a wall which holds back water behind it – for example, across a valley to **dam** a river and create a **reservoir** (a manmade lake)

Structural sections

universal beam (UB) an I-section with a depth greater than its width	
universal column (UC) an I-section whose outside dimensions are roughly square	
rolled steel joist (RSJ) a term sometimes used to refer to I-sections generally	
rolled steel channel (RSC) a C-section	
rolled steel angle (RSA) an L-section	

structural tee a T-section	
circular hollow section (CHS) a circular tube	
rectangular hollow section (RHS) a square or rectangular tube	

Types of load

Type of load	Description	Examples
dead load	a load that never changes, such as the **self-weight** of a structure (its own weight)	the weight of the concrete from which a bridge is built
live load	a load whose magnitude can be different at different times – usually **imposed on** (put on) a machine or structure by something that is not part of the machine or structure	cargo carried by a truck – different weights of cargo may be carried on different trips
static load	a load that remains still (does not move)	the dead load of a building, or a live load which remains still, such as snow lying on a roof
dynamic load	a moving load, such as one which produces a sudden shock but lasts for only a brief moment (an **impulse**)	aircraft wheels hitting the runway on landing

point load	a load which is **concentrated** – that is, one which acts on a small area	the end of a set screw pressing on a shaft (see Unit 27)
uniformly distributed load (UDL)	a load which is spread evenly over a reasonably large area	the weight of water acting on the bottom of a swimming pool

HW U30

Think about a machine or structure you're familiar with. Give examples of types of load which act on specific components or members. Say which components are stressed the most, and explain why.

1 N/m2 = 1 Pa

Any Questions