METAL FATIGUE AN OVERLOADED TERM IN BLAME OVER INJURIES

A recent incident saw a guard, 43, die hours after a metal gate fell on her at a Yau Ma Tei health center early last week.

Nuts and bolts

Edmund Leung

In recent injury incidents involving broken metal frames or snapped wires, a term often used is metal fatigue.

Many people confuse metal fatigue with aging and excessive loads, but it actually involves quite a different mode of failure.

A failure to note signs of excessive stress and to distinguish among these modes may lead to a sudden failure of critical components, resulting in fatalities.

The aging of materials is often the result of corrosion causing deterioration and leading to a weakening of the structure, and eventually it can no longer support the weight or provide the designed strength to resist the forces imposed on it.

It can happen with plastic, wood or composite materials. Typical are wooden chairs in parks subjected to sun and rain collapsing under their own weight.

Metal objects can withstand heavy loads and remain elastic and return to their original shape once the loads are gone, but they can suffer fatigue or breakage.

Metal fatigue is a complicated phenomenon.

When a piece of metal is subjected to repeated loading and unloading, though within the designed limit of tensile stress, hairline cracks may occur.

This happens in loading cycles of hundreds of thousands or even millions.

Once cracks occur, they will continue to grow until they are large enough to cause a weakening, leading to total failure.

A simplistic way to illustrate this mode of failure is to keep bending a paper clip. After about 10 cycles, it breaks.

But this is an inaccurate way to explain cyclic loading, ignoring the basic principle of fatigue failure.

A true case of metal fatigue is the cyclic load from forces lower than the yield point, when a piece of metal retains its elastic properties.

In the case of the paper clip, the forces imposed on the wire far exceeds that and therefore it breaks after only a few cycles.

Actual cases of failures involving metal fatigue sometimes happen on reciprocating machine parts, such as those in car engines.

Parts in racing cars often suffer metal fatigue due to high rotation speeds.

But for everyday applications such as with lifting equipment, the number of cycles normally does not reach that level that causes fatigue failure.

Breakages due to overloading are the more likely cause of failures on a slow moving machine. When excessive loads are applied to it, it will invariably break.

If the forces are fractionally larger than a design load, a component may not break immediately, but it goes through a stage of plastic elongation, commonly known as yielding.

As forces overcome the elastic phase of that piece of metal, it will fail to return to its original length or shape after the load has been released.

The structure is already weak but the piece is still partially intact and can still withstand certain loads, until, that is, the next heavy load occurs.

Most industrial and construction industry failures are due to excessive loads, mainly because they very seldom reach the number of repeated cycles (hundreds instead of hundreds of thousands) to cause fatigue, but more likely, they can be susceptible to sudden excessive loads due to the varied nature of the forces imposed.

Experienced engineers will be able to analyze the mode of a failure, be it due to aging, metal fatigue or excessive loads.

They should be able inspect components to ensure they work to design intents and stay safe for use by workers and technicians who may not understand the intricacies of these different modes of failures.

Veteran engineer Edmund Leung Kwong-ho casts an expert eye over features of modern life