

Construction OS&H

General plant & equipment



Summary

Common hazards with general plant and equipment
General construction plant and equipment
Hand tools
Scaffolding materials and equipment
Temporary works for concrete and steel
Trench support and excavation equipment
Fire prevention and control equipment
Electricity

What are the common hazards with general plant and equipment?

Plant and equipment which are often used on construction projects should not give rise to any hazards.

Spend 10 minutes thinking about why hazards arise, and list six possible causes.

Some causes of hazards

Many of the hazards which do arise have the following causes:

- Poor mechanical design (breaks in use, not powerful enough, components fracture or malfunction)
- Poor functional design (not properly designed for the stated purpose)
- Misuse (not used as designed)
- Used in the wrong circumstances (e.g. ground collapses under a crane)
- Poor maintenance (breaks or emits noxious gases)

These cause the following hazards

- Falling machinery or parts of machinery
- Crushing due to impact of moving or toppling plant and equipment
- Falling from plant and equipment
- Limbs or bodies caught in machinery
- Physiological damage through vibration
- Poor ergonomics
- Physiological and psychological damage through repetitive work
- Stress caused by poor environment (noise, heat, poor ventilation, chemicals, noxious gases)

Other hazards

These are, of course, just some of the main hazards, there are many more which are specific to particular projects.

Each project must be assessed specifically and all hazards taken into account.

Example: The Pacific Highway Upgrade Program New South Wales (NSW) Australia (1)

“Occupational health and safety is a primary consideration in the planning and organisation of the project’s operations.

The project involves many different activities from earthworks to bridges and encompasses road users, workers and residents. By identifying the potential major hazards associated with the different activities on site, it is possible to reduce the risk of injury to employees, public and damage to equipment.”

Example: The Pacific Highway Upgrade Program NSW Australia (2)

Strategies include:

- To plan each stage of the project with safe working as one of the primary objectives.
- To ensure the appropriate equipment is used for each operation including the provision of protective clothing.
- To encourage everyone to work together in developing and maintaining safety.
- To provide adequate training and instruction.
- To ensure adequate supervision.
- To maintain adequate records and undertake full accident investigations.
- To provide full feedback information to all participants.

Example: The Pacific Highway Upgrade Program NSW Australia (3)

Hazards identified for the project include:

- Construction plant (large machines and continuous activity).
- Existing services (high voltage, fibre optic cable, etc.).
- Piling (large cranes, heavy materials).
- Bridge construction.
- Terrain (steep slopes).
- Adjacent traffic on public roads, including intersections.
- The mixing of construction plant and traffic.
- Working at heights.

Example: The Pacific Highway Upgrade Program NSW Australia (4)

“Risk management is integral to the project and its evaluation and assessment play a significant role. Detailed processes require each major activity and sub-activity associated with the works to be given a risk rating. This is the catalyst for the subsequent development of safe work procedures which are documented on job hazard analysis (JHA) worksheets. Regular training is provided to give work crews and supervisors help in the development and understanding of these worksheets and risk management.”

Operator protection and efficiency

Ilobwi Construction is about to purchase some new dumpers and excavator/loaders to be used for general site work.

Spend 10 minutes discussing (in groups of 3 or 4) and suggest the main factors that must be investigated when considering operator safety and efficiency.

Moving plant & equipment (1)

All vehicles and earth-moving or materials-handling equipment should:

- Be of good design and construction taking into account as far as possible ergonomic principles particularly with reference to the seat.
- Be maintained in good working order.



Moving plant & equipment (2)

Where appropriate, earth-moving or materials-handling equipment should be fitted with structures designed to protect the operator from being crushed, should the machine overturn, and from falling material.



Moving plant & equipment (3)

Roll Over Protection Systems (or ROPS) are designed and fitted to machinery which on overturning would reduce the possibility of an operator from being crushed, provided the operator was wearing a seat belt.

If the driver does not wear a seat belt there is a risk that the driver may be crushed by the ROPS bar as he or she is thrown from the vehicle.



Vehicles, earth-moving and materials-handling equipment (1)

Should be provided with a plate indicating:

- The gross laden weight.
- The maximum axle weight or, in the case of caterpillar equipment, ground pressure.
- The tare weight.

Moving vehicles, earth-moving and materials-handling equipment must have:

- An electrically operated acoustic signalling device
- Searchlights for forward and backward movement
- Power and hand brakes
- Tail lights
- Silencers
- Reversing alarm

Protection of operators (1)

Operators of vehicles and earth-moving or materials-handling equipment should be adequately protected against the weather or accidents due to impact, crushing or contact with a moving load by a cab which:

- Is designed and constructed in accordance with ergonomic principles and provides full protection from adverse weather conditions;
- Is fully enclosed where dusty conditions are likely to be encountered;
- Provides the driver with a clear and unrestricted view of the area of operation;
- Is equipped with a direction indicator and a rear-view mirror on both sides.

Protection of operators (2)

Cab should be at least 1m from a face being excavated.



Discussion on operator protection and efficiency: some considerations

- Ergonomic design; especially seat, controls and information displays
- Protection against crushing, and overturning, must have seat belts
- Protection from weather
- Protection from dust, fumes, etc
- Mirrors and direction indicators
- Signaling for changes of direction and reversing
- Warning alarms (reversing etc)
- Noise control
- Brakes with secondary safety mechanisms
- Ideally, devices to help with repetitive work

Inspection and maintenance (1)

On earth-moving and materials-handling equipment, motors, brakes, steering gear, chassis, blades, blade-holders, tracks, wire ropes, sheaves, hydraulic mechanisms, transmissions, bolts and other parts on which safety depends should be inspected daily.

Deck plates and steps of vehicles and equipment should be kept free from oil, grease, mud or other slippery substances.

Inspection and maintenance (2)

Brake pedals for all motions on power shovels should have two independent locking devices.

Power shovels should be equipped with an emergency quick-acting stop device independent of the controls.

Excavators that are also designed for lifting (1)

Should be provided with a plate in the cabin and on the boom bearing a clearly legible and durable text giving the maximum safe working load of the lifting gear fitted.



Excavators that are also designed for lifting (2)

Should be:

- Examined and tested in accordance with laws and regulations for mobile cranes.
- Fitted with an automatic safe working load indicator.



Excavators that are also designed for lifting (3)

Note that great care must be taken when using excavators as mobile cranes.

They have, generally, not been designed as cranes and have very different operating characteristics.

Under no circumstances should they be used for lifting people; their operating characteristics make this extremely dangerous.

Pavers are very complex items of machinery and require great skill to maintain safely. All those involved must be properly and thoroughly trained.

Health hazards may occur from breathing the fumes from the asphalt, to which operators are especially exposed because they sit over the hot asphalt. Their health should be monitored regularly and carefully

Pavers



Lifting appliances & gear

Every lifting appliance and every item of lifting gear should have instructions for use and with a test certificate stating:

The maximum safe working load

Safe working loads at different radii if the lifting appliance has a variable radius

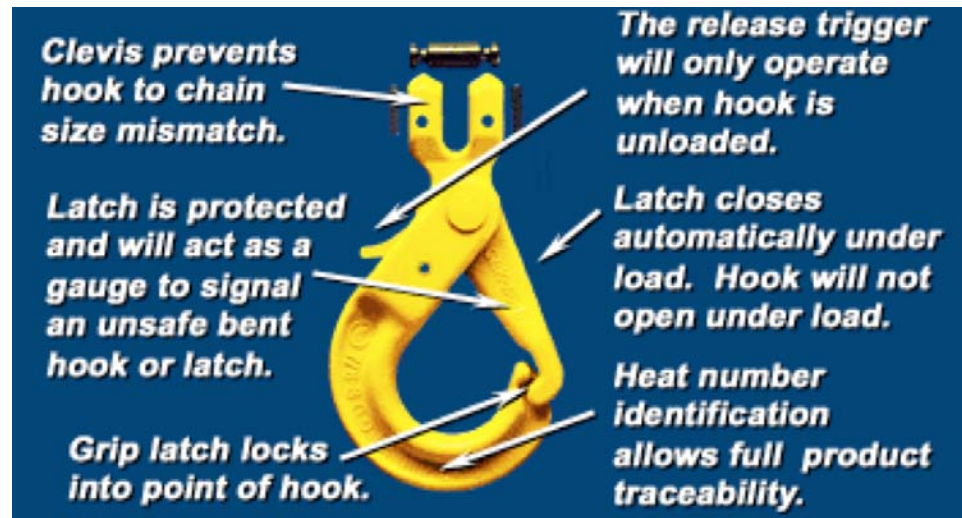
The conditions of use under which the maximum or variable safe working loads can be lifted or lowered



Safety hooks

All cranes should be fitted with a safety hook designed to prevent accidental dislodgement of the load if it fouls something or meets an obstruction during the lift.

There are many different designs, each with their own characteristics.



Variable load lifting appliances & gear

Every lifting appliance having a variable safe working load should be fitted with a load indicator or other effective means to indicate clearly to the driver each maximum safe working load and the conditions under which it is applicable.

Modern load sensors provide a very good and reliable means of informing the user of the weight about to be lifted and provide clear warning when the safe load is about to be exceeded. The most modern are wireless, so eliminating the work of wiring the indicators into the lifting appliance, and also eliminating subsequent risks of damage and corrosion. There is no excuse therefore for ‘accidents’ when lifting excessive loads.

Example of modern wireless safe load indicators

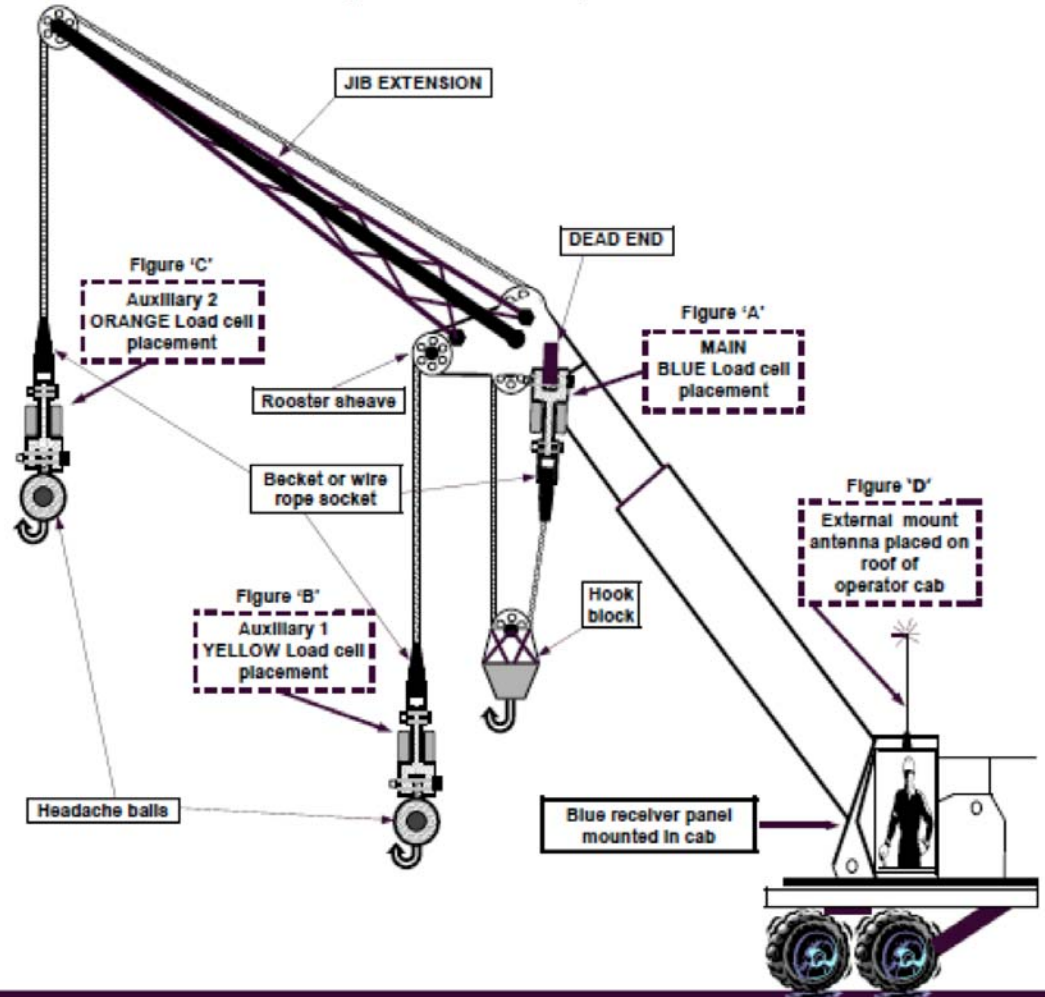
777 Multi-line load cell installation and placement guide for load cell links

Figure 'A' - Pin the **BLUE** load cell between the wire rope socket (becket) and the dead end on the main boom of the crane. >MAIN<

Figure 'B' - Pin the **YELLOW** load cell between the wire rope socket (becket) and the headache ball on the auxiliary sheave (rooster) on the cranes boom tip. >AUX 1< (Note: for two line load systems only)

Figure 'C' - Pin the **ORANGE** load cell between the wire rope socket (becket) and the headache ball on the jib extension. >AUX 2< (Note: for three line load systems only)

Figure 'D' - Location of external magnetic mount antenna on operator cab of crane.



Example of modern
wireless safe load
indicators:

Driver's information



Requirements for controls for lifting devices

Designed and constructed as far as possible in accordance with ergonomic principles;

Conveniently situated with ample room for operation and an unrestricted view for the operator;

Provided, where necessary, with a suitable locking device to prevent accidental movement or displacement;

In a position free from danger from the passage of the load;

Clearly marked to show their purpose and method of operation.

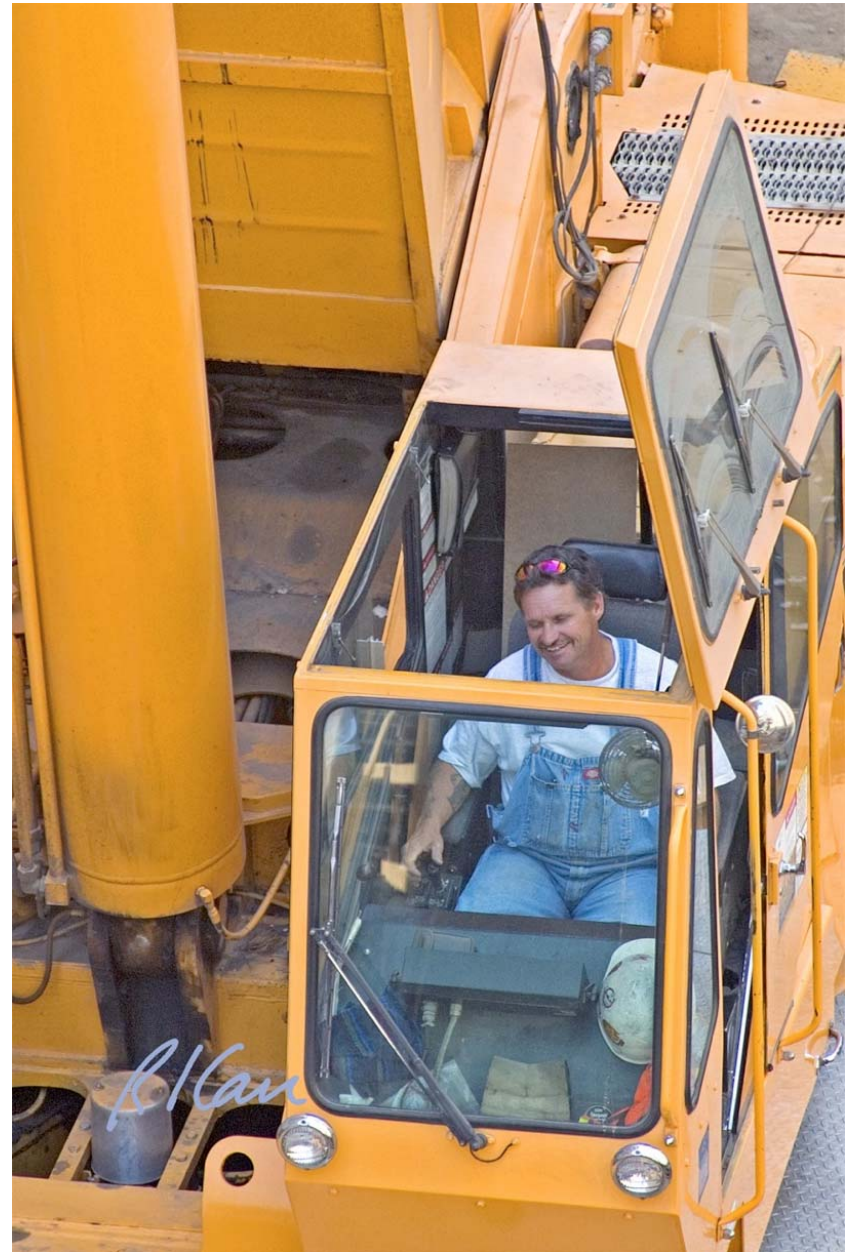
Operator requirements

A safe cabin with full protection from weather and adverse climatic conditions.

A cabin designed and constructed with ergonomic principles.

A clear and unrestricted view of the area of operation.

Safe access to and egress from the cabin.



Concrete equipment



Safety features of concrete plants

Concrete mixers should be protected by side railings to prevent workers from passing under the skip while it is raised.

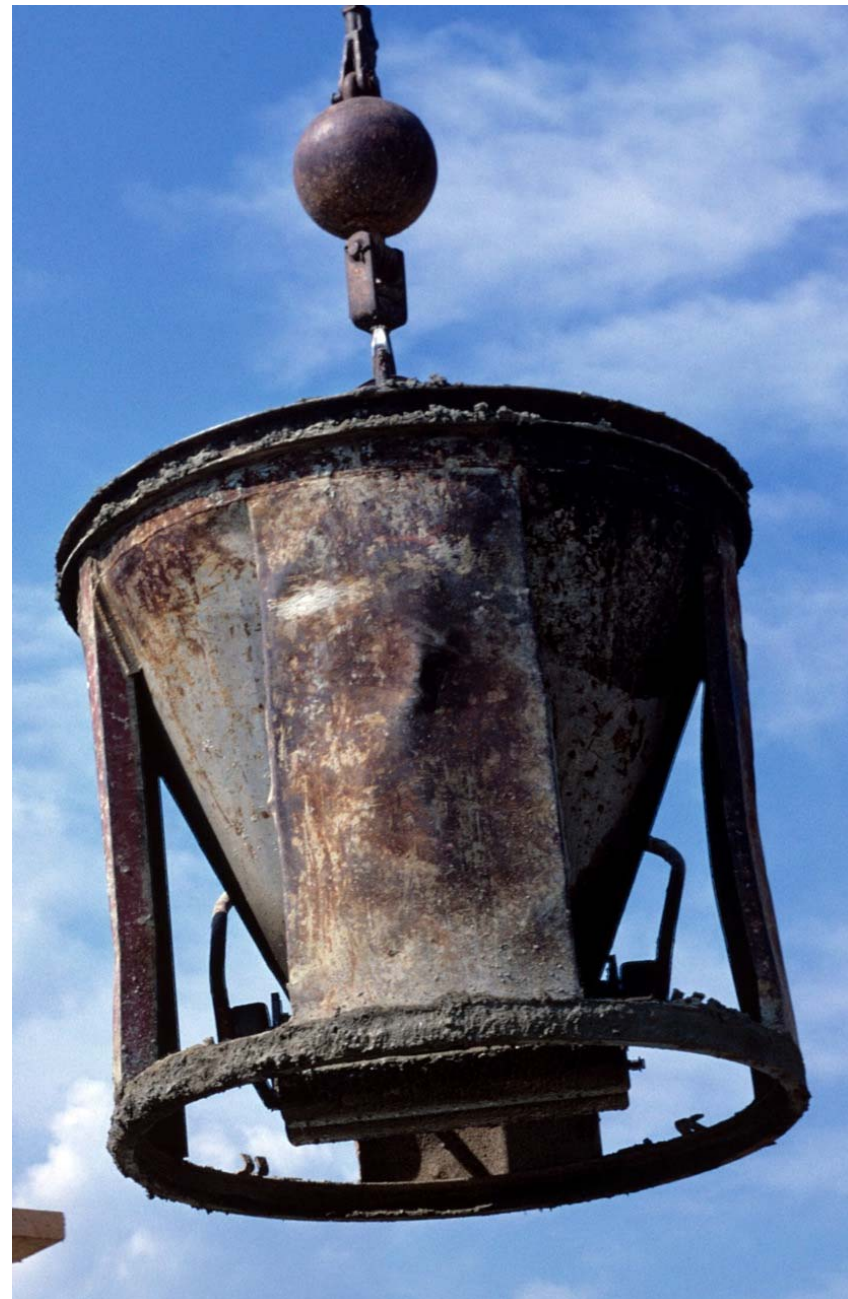
Hoppers into which a person could fall, and revolving blades of trough or batch-type mixers, should be adequately guarded by a grating.

In addition to the operating brake, skips of concrete mixers should be provided with a device or devices by which they can be securely blocked when raised.

While the drum of a concrete mixer is being cleaned, adequate precautions should be taken to protect the workers inside by locking switches open, removing fuses or otherwise cutting off the power.

Concrete skips or buckets

Concrete buckets for use with cranes and aerial cableways should be free as far as practicable from projections from which accumulations of concrete could fall



Concrete skips or buckets:
is this man in a safe workplace?



Concrete skips or buckets: is this man in a safe workplace?

No safe working
platform.

No guardrails or other
fall protection.

No easy means of
controlling the skip.

And more.....?



Pressure plant

“Workers are using respiratory protection. Exposure levels would be reduced if they were using jackhammers and compressors that reduced noise and silica dust levels.”



Hazards from high pressures

“Four Hurt in Air Compressor Explosion at Manhattan Construction Site

Three pedestrians and a construction worker were injured yesterday when an air compressor hose exploded at a construction site on the Avenue of the Americas, hurling debris into the street and starting a small fire.

New York City officials said the accident was the second one involving such a compressor in less than a month, and they ordered an immediate inspection of all similar machines in use throughout the city.

The trailer-like compressors, which power pneumatic tools through a network of air hoses, are typically parked at kerbside near city construction sites, placing them close to sidewalk crowds.”

Hazards from high pressures: quote from witness

“The rupture of the hose sent out a concussion wave that spread to the other side of the street, knocking down pedestrians," Mr. Smith said. "The hose itself was blown to pieces, and one of the fragments struck a pedestrian.”

Compressors

Pressure plant and equipment should be examined, tested and issued with a certificate by a competent person in cases and at times prescribed by national laws or regulations.

National laws or regulations should be laid down and enforced as regards the materials, design, construction, installation, inspection, testing, maintenance and operation of steam boilers and other pressure plant as necessary.

Hand tools: small tools

Hand tools and implements should be tempered, dressed and repaired by competent persons. The cutting edges of cutting tools should be kept sharp.

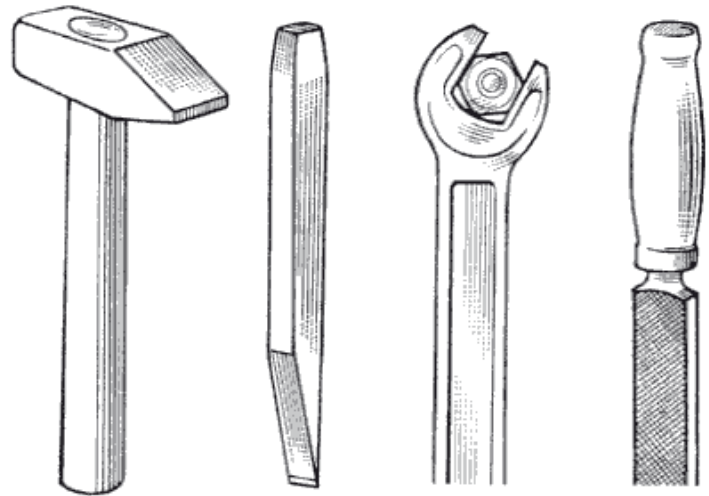
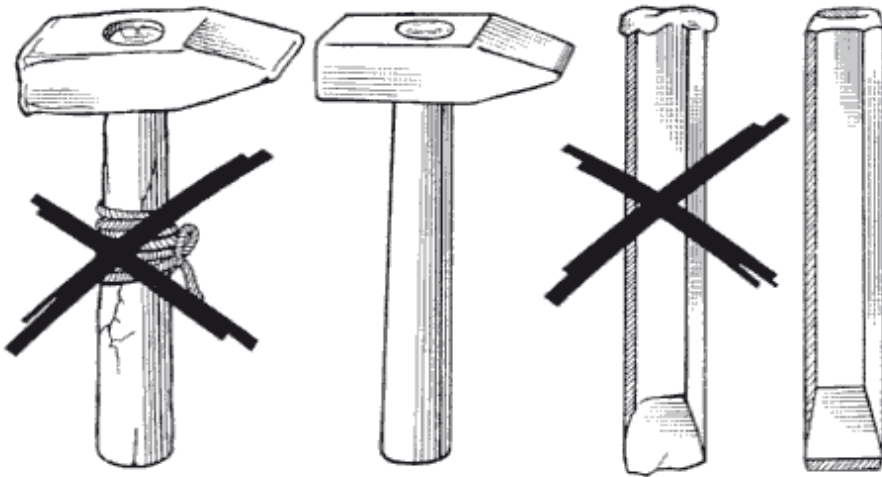
Heads of hammers and other shock tools should be dressed or ground to a suitable radius on the edge as soon as they begin to mushroom or crack.

When not in use and while being carried or transported sharp tools should be kept in sheaths, shields, chests or other suitable containers.

Only insulated or non-conducting tools should be used on or near live electrical installations if there is any risk of electrical shock.

Only non-sparking tools should be used near or in the presence of flammable or explosive dusts or vapours.

Hand tools



Pneumatic tools

Operating triggers on portable pneumatic tools should be:

- Placed as to minimise the risk of accidental starting of the machine
- Arranged as to close the air inlet valve automatically when the pressure of the operator's hand is removed

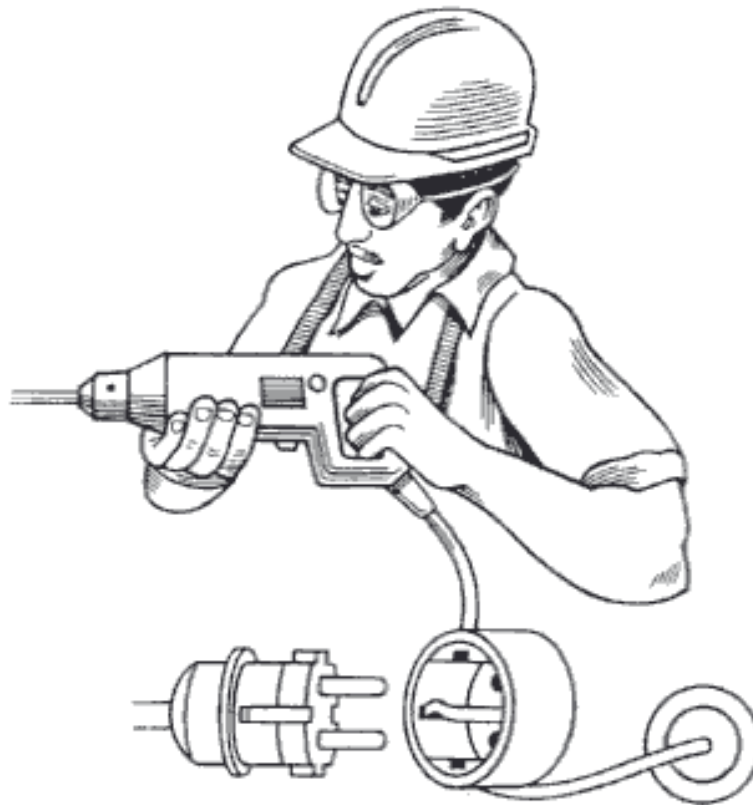
Hose and hose connections for compressed-air supply to portable pneumatic tools should be:

- Designed for the pressure and service for which they are intended
- Fastened securely to the pipe outlet and equipped with a safety chain, as appropriate

Pneumatic tools should be:

- Disconnected from power and the pressure in hose lines released before any adjustments or repairs are made.

Electrical tools (1)



Electrical tools (2)



Electrical tools (3)

Portable electrical tools should generally be used on reduced voltage to avoid as far as possible the risk of a lethal shock.

All electrical tools should be earthed, unless they are "all insulated" or "double insulated" tools which do not require an earth. Earthing should be incorporated in metallic cases, and as a safeguard against damaged cables where wires enter the tool.

All electrical tools should receive inspection and maintenance on a regular basis by a competent electrician, and complete records kept.

Scaffolding materials and equipment (1)

A patented system which can be erected more quickly and cheaply than conventional 'tube and fittings' when used in straightforward applications (such as rectangular scaffolds on firm and level foundations). The whole scaffold is enclosed in sheeting to protect the workforce from weather and the public from falling objects, dust and debris.



Scaffold materials & equipment (2)

Sufficient suitable and sound material should be provided and used in the construction of scaffolds.

Ladders, boards and planks used in scaffolds should not be painted so that any defects are visible.

Tubes should be free from cracks, splits and excessive corrosion and be straight to the eye, and tube ends cut cleanly square with the tube axis.

Alloy and steel tubing should not be intermixed on the same scaffold.

Scaffold materials & equipment (3)

The photo shows how the system is built up from yellow plastic base plates to prevent damage to the pavement surface. The screwed base members are necessary to adjust for irregularities in the level of the pavement because the joints in the uprights are at fixed intervals.



Scaffold materials & equipment (4)

Details of the system



Scaffold materials & equipment (5)



A beam is necessary over shop doorways and this is attached by conventional tube and fittings.



The uprights are encased in highly visible plastic foam to prevent damage to passing pedestrians.

Scaffold materials & equipment (6)

Where necessary, boards and planks used for scaffolds should be protected against splitting. Splits weaken the board and jagged ends can cause injury.



Useful guidance from the State of Montana, USA

Inspections and Testing of Planks

Wood scaffolds should not be proof tested. This may result in concealed or unrecognized damage that may cause failure later. Wood planks bear a mark, stamp, seal, or other indication of the referenced standard on usage.

Examine the plank for large knots, excessive grain slopes, shakes, decay, and other defects that may render it unfit.

Do not use a scaffold if the planks are bowing more than $1/60$ of their span.

Discard the plank upon visible or audible evidence of failure, or if it has an obvious defection.

Useful guidance from the State of Montana, USA

- Determine the safe load for a plank on its size and species.
- Do not use rusty or corroded scaffold equipment, its strength is unknown.
- Check for cracks around welds, joints, and circumference.
- Check castors for damaged brakes, axles, or stems.
- Check manufactured planking for missing hooks, locks, and rivets; bent side rails; and damaged walking surfaces.
- If the surface is plywood, check for rotten areas.

Shafts (1)

All shafts over 30m in depth should have an adequate head frame strong enough to withstand safely the maximum load that it will have to carry and preferably be of open steelwork construction.

All landings in shafts should be provided with gates that effectively close the opening to a height of at least 2m.

Shafts should be equipped with a signalling system that warns the hoisting engineer when a conveyance passes beyond the safe limit of travel.

Before tunnelling operations are begun from a shaft, two separate signalling or communications systems of different types should be installed.

The signal code should be posted in the hoisting machine room and at each landing.

Shafts (2)

Hoisting machines should be equipped with:

- An adequate brake that will automatically stop and hold the conveyance if the hoisting power fails.
- A reliable depth indicator.
- All hoisting machines should be inspected at least once a day by the hoisting engineer.
- Shafts exceeding 30m in depth should have an installation for conveying persons.

Shafts (3)

Cages or cars for conveying persons should be equipped with safety gear that automatically holds the cage or car when fully loaded if the suspension rope breaks or becomes slack.

There should be adequate means of blocking the cage or car at every landing.

Buckets used for conveying persons in shafts should:

- Have no projections on the outside that could catch in an obstruction
- Be not less than 1m deep
- Be provided with adequate means to prevent them from tipping and spinning
- Not be self-opening

Shafts (4)

Notices should be posted at conspicuous places stating the maximum:

- Speed for transporting persons in the shaft
- Number of persons and the maximum weight of material that may be safely carried in each conveyance

Hoisting operations in shafts should be governed by suitable signals.

Fire

Spend five minutes writing down everything you know about fire extinguishers.

[Yes, they are usually (but not always) red in colour and used to put out fires]

Fire extinguishers (1)

Pressurized water	Cools fuels rapidly – for fires in ordinary combustible building materials	Conducts electricity – not to be used for live electrical equipment or oil fires
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Carbon dioxide	Excludes oxygen	Displaces oxygen when used in confined spaces Re-ignition may occur in overheated liquids such as hot bitumen
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Fire extinguishers (2)

Dry chemical powder	Interferes with the combustion process	Use in confined areas may lead to a reduction in visibility Non-conductor of electricity and may be used on live electrical equipment Re-ignition may occur in overheated liquids
Foam	Excludes oxygen, limited cooling Forms blanket over flammable liquids	Conducts electricity — not to be used for live electrical components Gives better control over re-ignition than carbon dioxide and dry powder Better suited to extinguish fire in overheated liquids such as bitumen boilers and oil tanks

Typical fire extinguishers

Two types of extinguisher, guidance on their use and also actions to take in case of fire



Electricity

Electricity can be extremely dangerous if misused, so all electrical facilities must be designed and installed by qualified people.

General requirements are:

- All electrical equipment and installations should be constructed, installed and maintained by a competent person, and so used as to guard against danger.
- Before construction is commenced and during the progress thereof, adequate steps should be taken to ascertain the presence of and to guard against danger to workers from any live electrical cable or apparatus which is under, over or on the site.
- The laying and maintenance of electrical cables and apparatus on construction sites should be governed by national laws and regulations.

The worker is standing on the cab of a crawler crane and pushing an electric cable above the crane as it passes underneath

