FEEDLOT DESIGN AND CONSTRUCTION

40. Machinery workshops

AUTHORS: Rod Davis and Ross Stafford

Introduction

Any feedlot needs a properly designed and equipped workshop for the repair and maintenance of machinery and for light engineering. Part of the building may also serve as a store for spare parts and consumables.

The workshop is generally a rectangular shed with an entrance at one end – either open or with doors which provide shelter from the elements. Its design and construction will depend on the size and location of the feedlot.

Design objectives

Machinery workshops should be designed, constructed and maintained to

- have sufficient space for undercover accommodation of feedlot machinery during maintenance and repairs
- have functional space for maintenance and repair activities
- have well lit and well ventilated space for maintenance and repair activities
- have sufficient space for spare parts for the repair and maintenance of on-site machinery
- be compliant with respective state building codes and relevant Australian standards
- provide a safe working environment.

Mandatory requirements

The building elements such as concrete footings, floor slabs and steel structures should meet the structural provisions of the Building Code of Australia (BCA) and local building regulations, and be designed in accordance with the relevant Australian standards.

Machinery workshop at large feedlot with drive through design and external storage area for steel.

Design choices

Site selection

Site selection is often difficult when planning a workshop, but the site should be well drained to allow access to the shed at all times and be accessible to vehicles and other items of plant. Topography and soil type will impact on earthworks and the design of foundations; on some clay soils, road base may be needed to ensure access in wet weather.

Accessibility, proximity to the feedlot and on-site traffic management are also considerations when selecting a suitable workshop site. See *Section 2 – Feedlot site layout* for overall site layout.

Sufficient distance should be allowed from other existing buildings to allow for future expansion, reduce fire hazard and allow room for machinery manoeuvring and parking.

The workshop should be orientated so that the main entrance is away from prevailing weather. Where possible, locate large doors in end walls so that roof water does not fall inside the shed, or provide adequate gutters.

Floor plan

A workshop area may be added to an existing machinery storage building or a separate building constructed. An attached workshop may increase the fire potential of the machinery storage area, but having both areas combined in one building or close to each other is more convenient.

The workshop area required will depend on the size of the feedlot, the equipment to be maintained and repaired and the type of equipment to be used. Machines should be able to be moved easily into and out of the workshop.

The workshop should be able to accommodate the largest machine on the site with space to manoeuvre equipment inside the building if required. Service space around the perimeter of the machine should be at least two metres wide for manoeuvring lifting equipment (e.g. forklifts).

One or more work benches and a machinery area 1–1.2 m wide will be needed along the walls, along with room for storage of equipment, tools, spare parts and consumables (e.g. nuts and bolts) and some additional space for new tools and equipment.

The interior layout should be planned to provide maximum convenience for doing maintenance and repair work. For example, welding units (gas and electric) located immediately inside the access doors will allow their use inside or outside the building.

Location of personnel access doors will depend upon the choice of floor plan and on the type of construction.

A large machinery workshop with double sliding doors and entry from both ends

A large machinery workshop with an open side offering good access, good ventilation and natural lighting – but little protection from the weather.

Steel or timber construction

Australia is well serviced by companies that design and construct all types of farm buildings. Cost will depend on geographic location, source of supply, span and length of the building and the way in which the project is undertaken.

The shed frame may be made from steel, timber or a combination of these two materials. Timber may need to be protected from termite attack while poor construction or inadequate maintenance may lead to corrosion problems with steel. Galvanised steel sheeting is the most common and most economical form of cladding.

Steel framed sheds may use three types of construction – portal frame, structural steel frame and stud frame. The cladding and flashings are common to all types.

Portal frame

The basic principle is that all the purlins (both rafters and columns) consist of cold-rolled C section joined by fabricated brackets that bolt each assembly together. The main structure is called the portal frame (Figure 1). The roof and wall members are added once all the portal frames have been stood.

The span width of portal frame sheds can be limited by the length of roof cladding. Steel roof cladding is usually limited to 12 m lengths, which is the length that can be transported on a semi-trailer. Wider spans would require multiple roof sheets or roll forming on site.

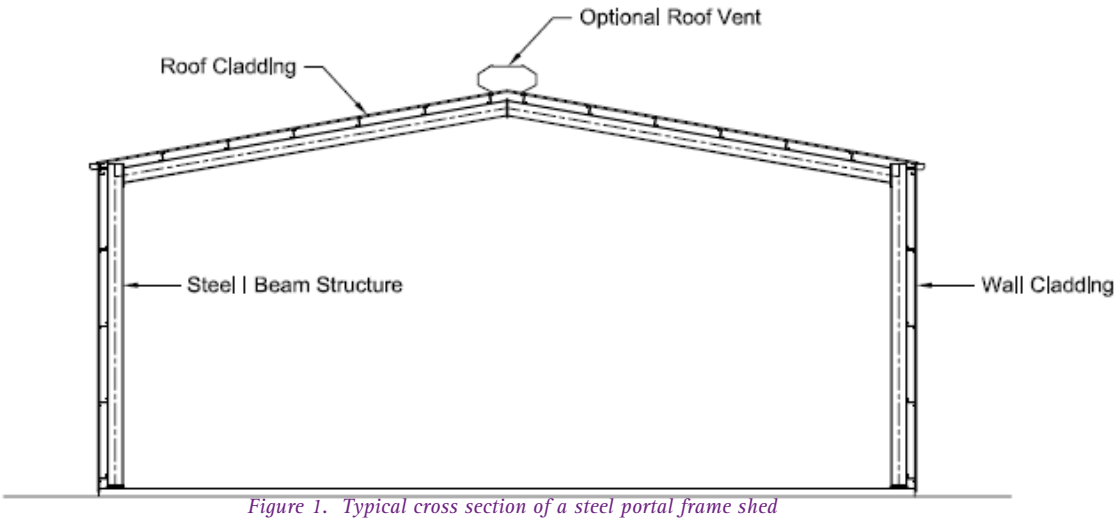

Figure 1. Typical cross section of a steel portal frame shed

Structural steel frame

With the structural steel frame, all the columns and rafters are from hot-rolled section such as H section, I beam, or C channels with welded cleats and joiners on all ends. The roof and wall members are normally the same as the portal frame (see Figure 2). The advantage of this type of design is that it allows larger spans, normally over 18 metres in width. The structural steel is heavy to transport but does allow faster erection and has an extremely high strength joining system.

As with portal frame sheds, the span width of structural steel sheds can be limited by the length of roof cladding. Spans greater than 12 m require multiple roof sheets or roll forming on site. Also a floor area greater than 500 m^2 requires additional services to comply with BCA requirements.

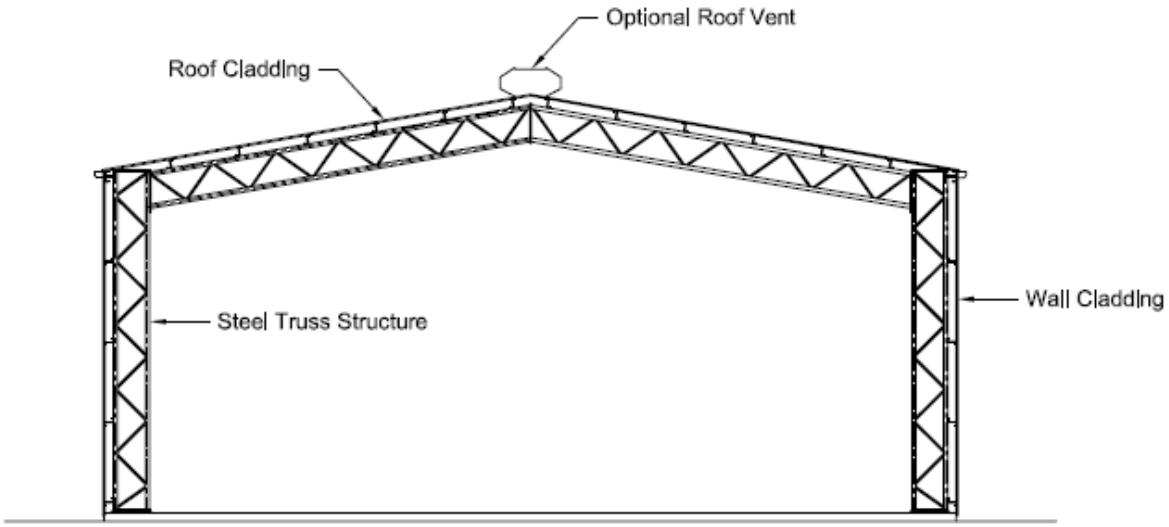

Figure 2. Typical cross section of a structural steel frame shed

Steel stud frame

This is identical to the steel stud framing used in housing and results in a very strong overall construction. The walls and trusses are all prefabricated in sections and simply stood on site and then clad. The advantage of this system is the ease of finishing the sheeting internally.

Structural design

Most shed companies provide a holistic design, structural design and manufacture service. Alternatively, structural design requirements may be obtained from a consulting structural engineer.

The structural design requirements include

- selection of appropriate member sizes and joint details
- erection of steelwork or concrete frameworks
- temporary fragility or instability of structure
- load-bearing requirements for overhead cranes
- stability and integrity of structure
- foundations/footing design for columns
- design of slab.

The design of the footings for a shed should take into account the bearing capacity of the soil and movement of soil due to wetting and drying.

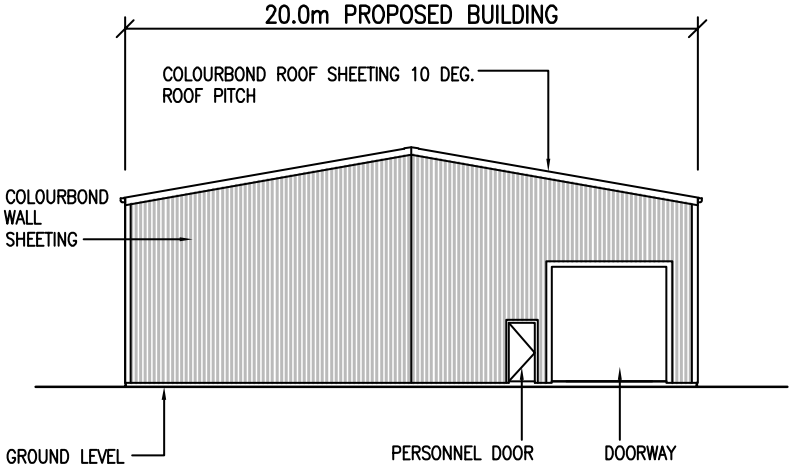

Figure 3. Typical cross section of a colourbond steel sheeted shed

Flooring

The floor of the workshop should be elevated at least 100–300 mm above the natural outside grade to provide good drainage and to stop water entering. The ground around the shed should be graded to channel water away.

A concrete floor in the workshop area will promote cleanliness, withstand the weight of machinery and provide a durable working surface. The floor should be sloped at a grade of 1% (1 mm per 100 mm) to the access doors for drainage.

Concrete shed floors are usually laid over a gravel-based subgrade before the shed frame is put up. Typically, the minimum thickness is 170 mm on a medium to good subgrade (200 mm on a poor subgrade) and is reinforced with square mesh.

Workshop with space for vehicle and machinery repairs, and with fluorescent and halogen strips for good lighting. Note the wall mounted swing-away jib boom for welder on the left.

Doors

The height and width of access doors should be 600 mm wider and 150 mm higher than the largest machine on the site.

Where practical, large access doors should be located on the end walls. One machinery access door may be adequate, but having doors in both the front and back will offer drive through ease in handling large machines.

There are various arrangements for workshop doors. These include sliding (bypass, bi-parting, single) hinged or roller. Each arrangement has its own advantages and disadvantages. The key considerations are space utilisation and cost.

Overhead roller type doors take less space and are easier to open than sliding doors, but are more costly.

Sliding and hinged doors require space to the sides of the opening and may limit access to the sides of the building. They are durable and cheaper.

At least one personnel door must be provided for safety and in accordance with relevant building codes.

Services

Electrical

Electric power will be required for various activities and services with generally single phase 10A and 15A outlets and 32A 3-phase outlets. The electrical service should have some reserve capacity for future expansion.

Electrical installation must comply with the current electrical standards including all subsequent amendments, and all applicable regulations and bylaws of statutory authorities. Work not covered by the requirements of statutory authorities must comply with the latest edition of the appropriate publication from the Standards Australia.

Lighting

It is impractical to install enough windows to provide sufficient light for working. Clear polycarbonate sheeting may be installed on the roof but degrades over time and is prone to damage from hail. Irrespective of windows, the primary source of light should be artificial.

The positioning and illumination level should be sufficient to eliminate shadowing and allow activities to be completed safely.

The following Australian Standards provide guidance on minimum illumination levels.

- AS1680.1-2006, ‘Interior and workplace lighting – general principles and recommendations’
- AS/NZS 1680.2 series, ‘Interior and workplace lighting – specific applications’

Ventilation

Workshops should be naturally or artificially ventilated. Gases and fumes from various activities need to be removed from a safety perspective. Exhaust fans may be installed for rapid air removal. Windows provide some natural ventilation and entrance of fresh air when exhaust fans are operating.

Essential safety measures

The Building Code of Australia (BCA) outlines the essential safety measures that apply to the various classes of buildings defined by the BCA. Refer to *Section 26 – Office and amenities.*

Machinery buildings would be classed as Class 10a (a non-habitable building or shed) according to the BCA. The essential safety requirements are stipulated in the Building Code of Australia, respective State Building Fire Safety Regulations and the relevant Australian Standards.

For example, a fire hydrant system or fire hose reels are not required in a building having a total floor area of less than 500 m^2. For Class 10 buildings, no point on the workshop floor must be more than 20 m from an exit, or a point from which travel in different directions to two exits is available, in which case the maximum distance to one of those exits must not exceed 40 m.

Hence, a workshop of 20 m by 24 m (Figure 4) complies with the BCA requirements for floor area and travel distance and no fire hydrant and hose reel system is required.

Portable fire extinguishers and electrical isolation of machinery are the bare minimum provision for a machinery workshop.

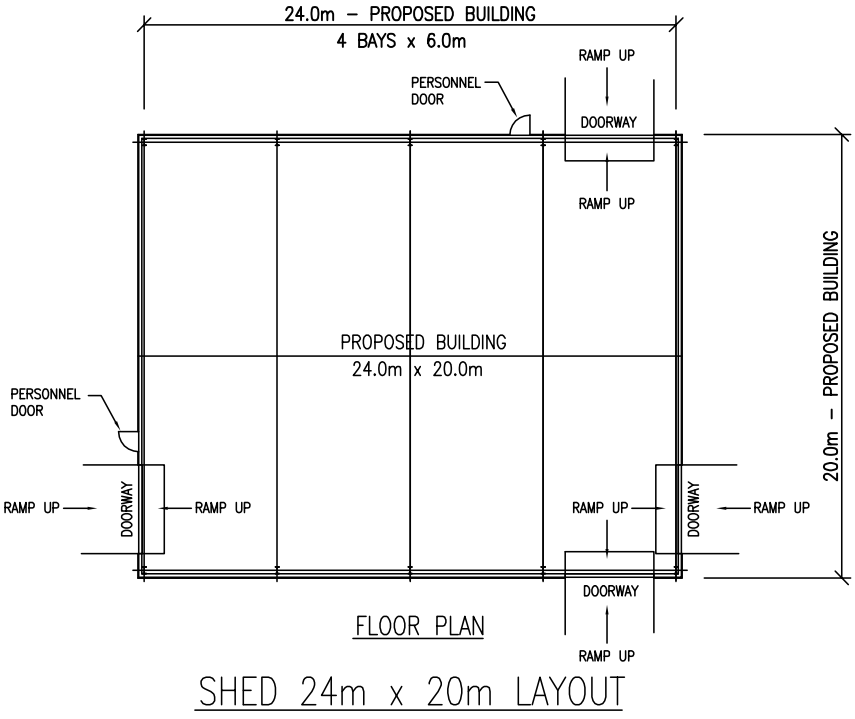

Figure 4. Class 10 buildings have a floor area of less than 500 m^2

Australian Standard AS4084–2012 sets out the minimum requirements for steel storage and pallet racking systems.

Hoists

A hoist should never be attached to the roof trusses since this would place an unsafe concentrated load on that portion of the building. A chain hoist should be attached to a portable beam supported at both ends with A-frames on casters. Alternatively it could be attached to a steel beam across the width of the workshop with the beam separately supported at each wall as a permanent part of the building. A permanent steel beam support is less versatile than a mobile A-frame unit.

Vehicle lift hoists

Vehicle lift hoists are an alternative to inspection pits for inspecting the undercarriage of vehicles, but they do need constant maintenance. With lift hoists, it is easier to walk to other parts of the workshop for tools but work cannot also be done above the vehicle when it is raised. Hoists are safer for servicing petrol vehicles because of fumes and the ability to escape in the event of fire.

In a feedlot workshop, a heavy truck lift needed to service the size of vehicles operating (trucks, tractors, earthmoving machinery) would be extremely expensive. As the number of vehicles to be serviced is low, an inspection pit offers a more practical and cost effective solution.

Inspection pit with stairs for access. Pit should have temporary fencing when not in use.

Inspection pits

Inspection pits are commonly used to inspect the underside and suspension of vehicles, to replace oil and filters and for servicing and minor repairs.

From a safety perspective, inspection pits are preferred for servicing diesel vehicles and vehicles with air bag suspension but not for petrol vehicles.

Inspection pits require safe means of entry and exit, usually stairways. At least one fixed entry/exit point should be provided with a separate means of escape where a risk assessment identifies the need e.g. where escape from the pit may be blocked by the parked vehicle or long pits. The surface around the inspection pit should be slip-resistant.

Access to pits should comply with the relevant WHS requirements, with fixed handrails.

Typically inspection pits are along the workshop bay. The depth of the inspection pit is optional but its width depends on the vehicles to be serviced. The width is about 150–200 mm on each side less that the width between the vehicle tyres.

Inspection pits provide a safe working environment but they do present particular hazards. They are a common cause of accidents, not only to those unfamiliar with the premises but also to staff who momentarily forget the presence of an unfenced pit, or who slip or trip into them. Inspection pit edges should be painted so that the pit opening can be clearly seen. Temporary fencing needs to be provided when the pit is not in use, or a steel or wooden cover put in place.

Prefabricated steel inspection pits are also available.

Signage

Machinery workshops should have appropriate signage, including

- Personal protection equipment to be worn – eye or hearing protection and footwear
- Evacuation procedure
- Emergency assembly point
- Emergency contact details
- No smoking
- Flammable gas
- First Aid station

Waste management

Wastes generated at machinery workshops include regulated wastes (hydrocarbon waste such as oils and tyres, solvents and batteries), general waste (damaged parts, air filters, hydraulic hoses, rags, cardboard and paper) and scrap steel. Some paint solvents are highly flammable.

The appropriate management and storage of all wastes, in particular regulated wastes, will prevent potential on site and off site environmental harm to livestock, land, surface water or groundwater.

Workshops should have the provision for storage, handling and spill containment equipment and materials for each category of waste generated.

A cluttered workshop with insufficient bench space for small repairs.

Workshops should have signage and portable fire extinguishers.

Waste management – large oil drip trays (above) and aggregation tank (below)

Clear area for small vehicle repairs, but poor type of drip trays under the oil drums.

Quick tips

- Sufficient distance should be allowed from existing buildings to allow for future expansion, to reduce fire hazard and allow room for manoeuvring and parking machinery.
- Consider space for manoeuvring repair equipment around the perimeter of the machine when sizing the workshop floor area.
- The correct structural design of a workshop should be carried out by a reputable manufacturer or by a structural engineer.
- Dimensions, member sizes or construction details must never be changed without the approval of appropriate authorities.
- Keep records of building approvals for future reference.
- Ensure adequate safety and fire protection measures.

Further reading

Local Authority Planning Scheme for local requirements for buildings.

Australian Building Codes Board (ABCB), 2013, Volumes One and Two of the National Construction Code of Australia.

Standards Australia (1998). Steel structures, AS 4100-1998, Sydney, NSW, Standards Australia.

Standards Australia (2002). Dead and live load combinations, AS/NZS 1170.1-2002, Sydney, NSW, Standards Australia.

Standards Australia (2005). Cold formed steel structures, AS/NZS 4600-2005, Sydney, NSW, Standards Australia.

Standards Australia (2005). Emergency Escape Lighting and Exit Signs for Building – Inspection and Maintenance, (AS 2293.2-2005), Sydney, NSW, Standards Australia.

Standards Australia (2009). Concrete construction (including reinforced and prestressed concrete), AS 3600-2009, Sydney, NSW, Standards Australia.

Standards Australia (2011). Masonry (including masonry-veneer, unreinforced masonry and reinforced masonry), AS 3700-2011, Sydney, NSW, Standards Australia.

Standards Australia (2011). Wind Loads, AS 1170.2-2011, Sydney, NSW, Standards Australia.

Standards Australia (2012). Routine service of fire protection systems and equipment, AS 1851-2012, Sydney, NSW, Standards Australia.

Standards Australia (2012), Steel Storage Racking, AS4084-2012 – Sydney, NSW, Standards Australia.

Standards Australia (2004), Cranes, hoists and winches – Guided storing and retrieving appliances, AS1418.6-2012 – Sydney, NSW, Standards Australia.