FEEDLOT DESIGN AND CONSTRUCTION

31. Commodity storage

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Introduction

Dry and wet feed commodities may include dry grains, processed grains, high moisture grains, roughages and by-products from feed or food processing operations, fermented feeds, liquid feeds and wet or dry vitamin or mineral supplements.

This section focuses on the storage of bulk feed commodities that are typically by-products from processes that extract, convert or separate compounds in various segments of the food or feed industry.

Examples include hulls and meals from oilseed extraction, distillers grains from beverage or fuel ethanol production, brans, grain germs and chaff from various grain milling operations, fermented sugars, starches and bran from sweetener production and pulps from sweetener or juice production.

Ethanol production has increased the availability of dry and wet distiller grains for feedlot cattle feed. Dried distiller grains are relatively easy to handle and store, but wet distiller grains present challenges for storage, handling and preservation.

Another class of feed commodities includes various industrial food wastes, such as potato wastes, snack food waste (e.g. corn and potato chips), fruit and vegetable cannery waste and bakery wastes (e.g. bread).

For bulk storage and handling of these feed commodities, factors that need to be considered include storage volumes, shelf life of the product, any further processing required, delivery systems, loading systems, labour, capital investment and maintenance of the facilities and equipment.

Design objectives

Commodity storage facilities should be designed and constructed to

- Provide a functional space for the storage of a range of feed commodities.
- Provide separate areas to store each feed commodity.
- Provide adequate storage space for a given volume of each feed commodity, considering the shelf life and seasonal supply.
- Provide enough storage to meet the daily demands of the feedlot.
- Provide moisture protection for dry feed commodities.
- Provide adequate access and flexibility for various types of vehicles for delivery and handling of feed commodities.
- Minimise wastage and spoilage of feed commodities.

Mandatory requirements

The building elements, such as concrete footings, floor slabs and steel structures, are required to 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.

Design choices

Major considerations when designing a commodity storage facility include

- Flexibility – the system should allow easy changes in feeding practices or ration ingredients.
- Physical characteristics of the feedstuffs– these will affect the handling and storage requirements.
- Site location – a single site versus multiple sites.
- Storage options – silos, slabs or flat-bottomed storage sheds.
- Ease of operation – for convenient movement of machinery to feed out the commodities.
- Economy – lowest cost combination of components, with effective performance and minimal wastage.
- Maintenance – provision for alternative methods to keep feeding, even when a part or component is out of service.
- Dependability – dependability from simplicity, as more mechanisation increases the potential for breakdowns and costs to repair.
- Safety – minimise hazards and risks to personnel and animals.
- Plan for expansion – allow for possible increase in capacity.

Physical characteristics

The physical characteristics (e.g. bulk density, angle of repose and particle dimensions) of feed commodities vary. The bulk density (weight/unit volume - or kg/m^3), or specific volume (volume/unit weight - or m^3/kg), of a feed commodity can be used to determine the volume needed for storage.

Table 1. Bulk density for common feed commodities.

Feed commodity	Bulk density kg/m^3	Specific volume m^3/kg
Dry brewers grain	240	0.004
Wet brewers grain	800	0.001
Canola	620	0.002
Cottonseed, hulls	192	0.005
Cottonseed, meal	593	0.002
Hominy meal	449	0.002
Linseed, whole	753	0.001
Linseed, meal	513	0.002
Lupins	770	0.001
Peanuts, shelled	641	0.002
Peanuts, not shelled	272	0.004
Soymeal	650	0.002
Sunflower meal	416	0.002
Rice hulls	288	0.003
White fluffy cottonseed	401	0.002

Sufficient space for easy access and tipping for large trucks and semi-trailers.

Locating the commodity storage facility adjacent to the feed mill allows processed grain to be discharged directly into a storage bay.

Tub grinder sited adjacent to, but outside, commodity shed.

Other physical characteristics, such as high moisture content, increase the likelihood of feed quality losses, deterioration or spoilage. The physical properties of hay play a role when these are used in grinder or mixing systems.

Single or multiple site

A single site for storage of all feeds is preferred, as it allows feed transport vehicles from both on and off the feedlot and feed mixing and delivery vehicles to be contained in a designated area. The person responsible for feeding can load the feed truck or mixer with a minimal amount of travel distance to ingredients, making mixing and feeding more efficient and effective.

The feed out loader is also readily available to move bulk commodity deliveries if required. See *Section 2 – Feedlot site layout* for design considerations for the overall site layout.

Matching storage and equipment

Sufficient storage space should be provided for equipment such as feed mixers, tub grinders, tractors and loaders that are used for processing, delivering feed commodities, filling storage bays and feed trucks.

This storage may be in an adjacent machinery storage area, a section of the commodity storage building or another building. Sufficient space is needed for easy access and tipping for large trucks and semi-trailers that deliver feed commodities.

Space may be available, or may be adapted from other buildings already on the site.

Location

The location of the commodity storage facility is integral to the efficiency of the feed preparation, storage and delivery system. An ideal location will provide easy access for delivery of purchased feed commodities, easy filling of grain silos and/or storage bays, convenient movement between silos, bulk storage and efficient loading of feed trucks or mixers.

In feedlots with an on site feed mill, the commodity storage facility should always be located adjacent to the feed mill so that processed grain can be discharged directly into one or more storage bays.

Site considerations are discussed in *Section 28 – Feed preparation and storage* and *Section 2 – Feedlot site layout.*

Delivery vehicles should be able to enter, unload and leave with minimal manoeuvring. Delivery of feedstuffs into the commodity shed should not interfere with the ration mixing and delivery process. Roadways and aisles should be wide enough to allow for unhindered movement of feed system vehicles.

Rodent control

Rodents cannot be completely eliminated, but some steps can be taken to limit the appeal of the commodity storage facility. A narrow trench, about 30cm deep and filled with medium sized gravel, placed around building foundations and slabs will discourage rodents from burrowing.

Typical daily 'house keeping' should keep the facility relatively clean, and the area surrounding it should be regularly mowed/tidied. Safe rodent baits will help to limit habitat.

Bird problems can be reduced by limiting the available roosting area, such as open trusses and knee braces. Small bird wire netting can be used to screen off these areas.

Storage options

The chosen option will depend on the type of feed commodity to be stored. Storage options include silos, covered flat bottom storage bays and tanks for liquid feedstuffs.

Most dry feed commodities are available in loose (e.g. meal, shreds or cake) or pelleted forms. All require closed, or covered, structures to keep out rain.

Wet feed commodities are typically available in a loose shred, or meal, form. Some, such as brewer grains and citrus pulp shreds, are now available partially dried or dewatered (e.g. squeezed/pressed) to reduce freight costs and enhance handling and storage characteristics.

Silos allow gravity unloading of stored feed commodities such as grain, but liquid feedstuffs will need tank storage. These storage structures are discussed further in *Section 30 – Grain storage and handling* and *Section 34 – Liquid feeds*.

Flat-bottom storages are usually concrete bottom bays with wooden (e.g. timber sleepers), steel or concrete (e.g. pre-cast or cast in-situ) walls. Without a concrete floor, feed can be contaminated with stones and dirt. Front end, or telescopic, loaders used to load the feed truck or mixer need direct access for fast and efficient operation.

Several storage bays may be located next to each other in a special open-sided or open-ended covered building that is often referred to as a commodity shed. Bays may also be incorporated in other on site buildings.

Commodity sheds usually incorporate multiple feed commodity storage bays. The number of bays will depend on the number of different ingredients, or commodities, likely to be used in the ration mixes. Large bays allow for the purchase of large quantities of bulk feed commodities. Extra bays can minimise waste and spoilage by allowing each bay to be emptied before taking delivery of another load, while also allowing extra stored feed commodities for emergencies.

Flat storage commodity sheds are especially useful for by-product ingredients that do not flow, cannot be moved with augers or cannot be stored in conventional silos where gravity flow is required. An example is brewer grains, which may have inconsistent and unpredictable handling characteristics.

Layout

Factors that affect the design and layout of a flat bottom storage system include

- Size and type of vehicles that will deliver materials and method of unloading.
- Size and type of vehicles that will access the bay for filling or retrieving feed commodities.

Storage structures for dry feed commodities should be closed or covered to protect the contents from the weather.

Any storage facility may be adapted to store feed commodities. The side wall from this machinery shed has been removed and storage bays constructed.

A purpose-built, stand-alone commodity storage shed. The high roof allows direct loading of storage bays from a tipping-trailer truck. A large concrete apron in the front of the bays allows easy vehicle manoeuvring.

Filling commodity bays by loader can be time consuming and can interrupt loading of feed trucks.

A cross conveyor can transfer grain into one or more bays. Highly visible bollards protect structural members and walls from damage by machinery.

Concrete placed around structural members offers little protection, as the impact is transferred directly to the steel member.

- Preferred location for loading the feed truck or mixer.
- Location and layout of grain processing and handling equipment – extra bay or bays for processed grain.
- The number and amount of ingredients to be stored.
- Filling and retrieving preference – drive in, reverse out or push-through.

Flat bottom storage configurations include

- Open-front buildings with a single row of separate storage bays – with push-through bays or closed end bays.
- Enclosed buildings with two rows of separate storage bays and a central aisle – with push-through bays or closed end bays.

Flat bottom storage commodity sheds are typically concrete base bays with timber, steel or concrete side walls. Front end or articulated loaders are generally used for both loading and unloading feed from the storage bays to the feed truck or mixer and need convenient access. For single-row, open-front buildings, a concrete apron in front of the bays allows manoeuvring by delivery vehicles and equipment.

The next delivery can be placed in extra bays so that older material does not become buried in the back of a closed storage bay with drive in, reverse out systems. Alternatively, a push-through bay design may be used.

Where possible, the bays should be designed and located to allow the delivery vehicle to unload the material directly into the appropriate bay to minimise double handling.

A high roof clearance and ability to back straight into the bay is needed if feed commodities are unloaded from tipping trailers directly into the bay. Many commodity sheds have a steep monoslope roof with ample open space in front.

Other unloading techniques include a walking floor in the delivery trailer and hopper-bottom type trailers, which need direct access to the bays but require less height clearance.

An alternative strategy is to unload the truck on to a large paved area in front of the storage bays and then push the feed into the bay with a front end loader. However, as material will spread out as it falls from the delivery vehicle, the clean paved area must be large enough to prevent contamination with adjacent feed commodities, dirt or debris.

This method can be used to reduce the clearance needed for both manoeuvring and unloading and may allow material to be piled higher in the bay.

Construction techniques can also vary. Pre-cast or poured-in-place concrete walls can be used and then a roof built on top of the walls. Alternatively, a post frame building can be built and the bays constructed on the base as independent structures.

Whatever the roof design or wall type, the bays must be able to withstand the load of the product and the loads caused by vehicles pushing into the walls.

Reinforced concrete walls are expensive, but provide the best protection and will also better withstand corner blows with loader buckets or truck tailgates. These walls and any exposed shed supports can be protected from damage by strong concrete filled steel bollards.

Commodity sheds are often used to store other items, such as machinery and/or fertiliser. If this is a planned management practice, additional room and bays will need to be designed into the system.

Hay processing equipment may be sited adjacent to the commodity shed (see *Section 33 – Hay storage and processing*).

Figure 1 provides an example of a large commodity shed layout with push-through bays on one side, closed-end bays on the other side and a batch box loadout. Bays can be configured to various widths depending on the storage volume required. A cross section through the commodity shed is shown in Figure 2. The roof line is angled to accommodate tipping trailers.

Differing heights between the commodity storage area and the feed vehicle loading bay allow ease of operation and safety.

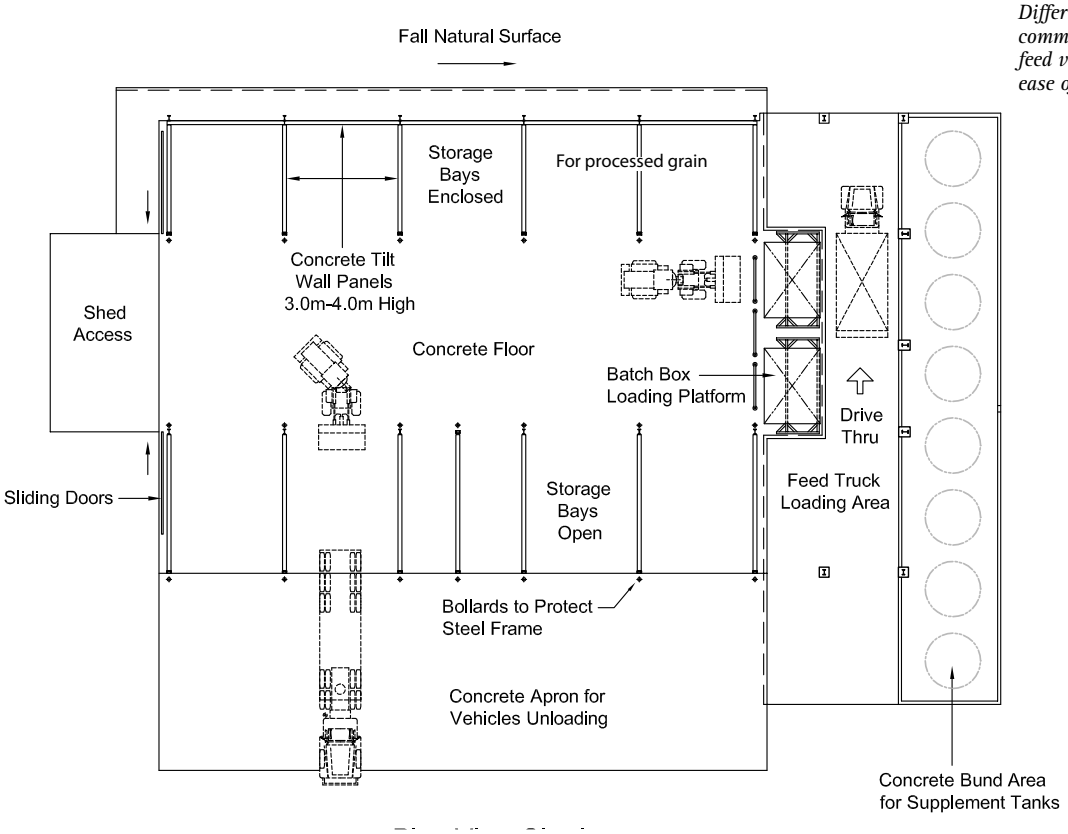

Figure 1. Example of large commodity shed plan view (with batch boxes)

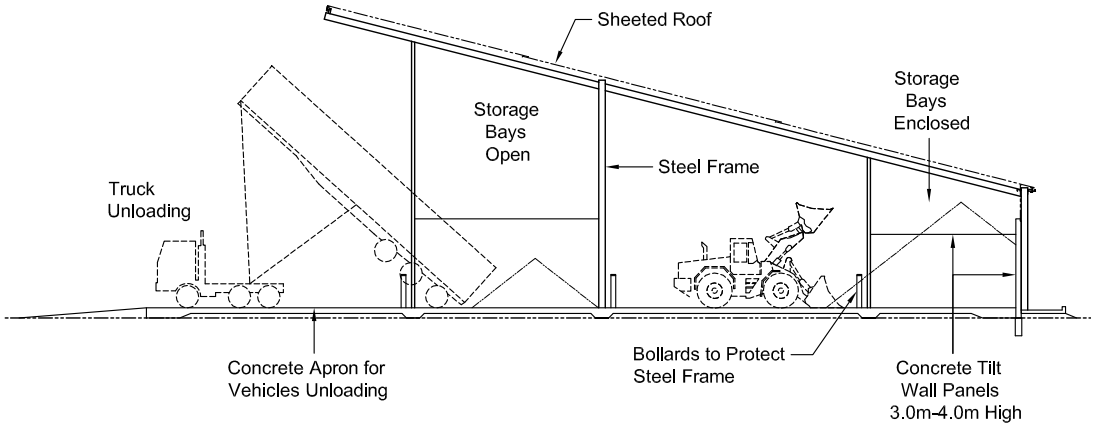

Figure 2. Cross section through commodity shed (Figure 1).

Figure 3 provides an example of a medium sized commodity shed layout with push-through bays on one side, closed end bays on the other side and a batch box loadout. The shed has a pitched roof and an external truck unloading area. This design requires the front end loader to push the unloaded feed commodities into the storage bays. A cross section through the commodity shed is shown in Figure 4.

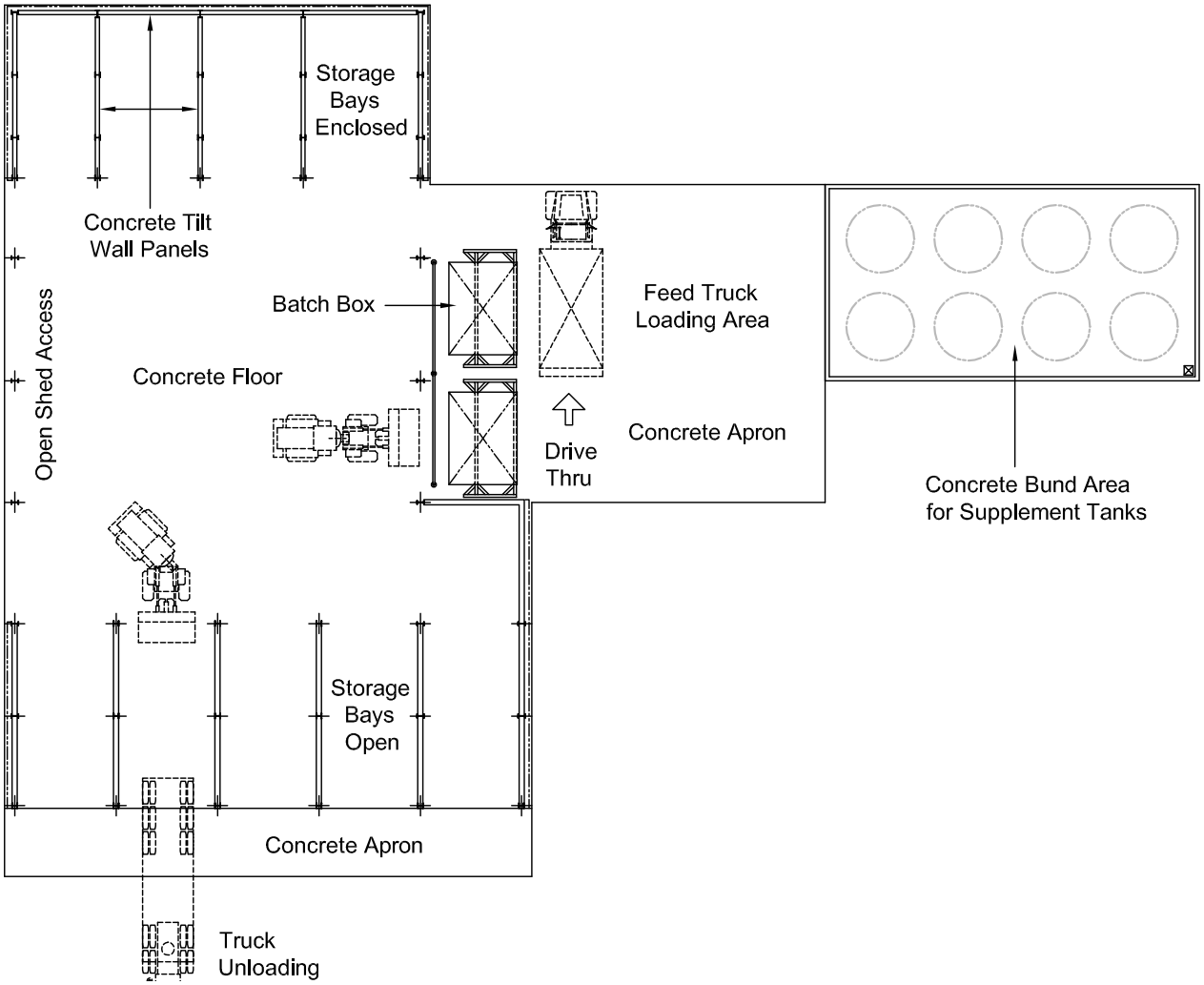

Figure 3. Example of a medium-sized commodity shed plan view (with batch boxes).

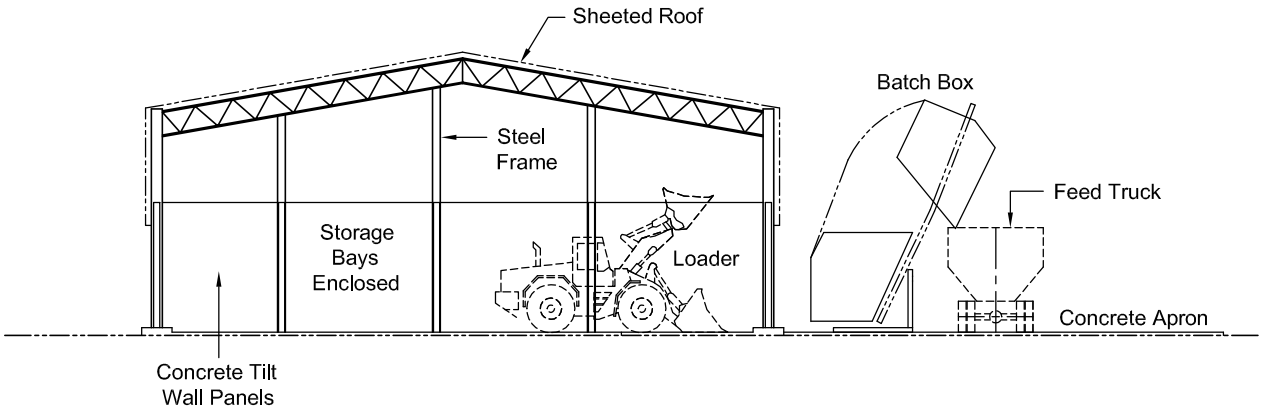

Figure 4. Cross section through medium-sized commodity shed (Figure 3)

Figure 5 shows an example of a small-sized commodity shed layout with one row of enclosed bays, a sloped roof and external loading area. A cross section through the commodity shed is shown in Figure 6.

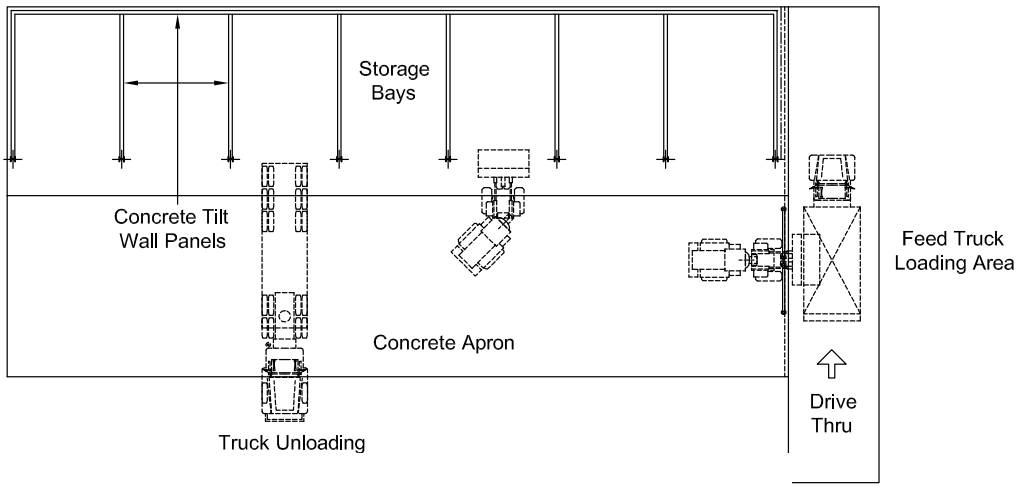

Figure 5. Example of single row open-side commodity shed plan view

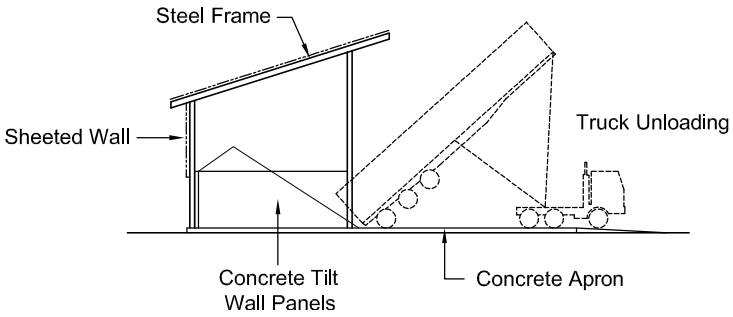

Figure 6. Cross section through single row open-side commodity shed (Figure 5).

Size

The size of the commodity storage facility will depend on the number and volume of feed commodities to be stored.

The total volume required can be calculated as the amount of space occupied by the feed commodity for the amount of time required to use the feed commodity. Feed commodity usage rates should match the acceptable shelf life window of each commodity.

The amount of storage needed for a particular feed commodity will be a multiple of the unit truck capacity plus a cushion of 25–50%, depending on the purchasing and transportation arrangements and whether replacement material will be unloaded in the same bin that is being fed out.

A semi-trailer has a capacity of about 24t. For dense products, such as cottonseed meal, soybean meal and pelleted ingredients, one truck load will almost equal the semi-trailer weight capacity.

Length and width of individual bays and height of divider walls should be designed to match the volume of material to be stored. Grains with a flatter angle of repose will form flatter piles.

Large push-through bays allow fresh material to be accessible over time.

The volume of individual bays should be designed to cater for the volume of delivery vehicles so that all material can be stored under cover.

For less dense products, such as brans, hulls, brewers and distiller grain, truck volume is the limiting factor. The equivalent load size will contain about 20–22t of material. For maximum flexibility, the bay should be designed to hold the maximum truck load capacity that is expected to be received in a single delivery.

Once the volume is known, the size of the storage bay can be determined. In addition to holding the appropriate volume and weight of material, it must be sized and located to accommodate delivery vehicles with a minimum width to allow easy loading and unloading of the bays. This is usually determined by the size of the vehicles to be used (e.g. front end loader). Clearance will be needed alongside the delivery trucks to safely open tailgates or end doors.

If material is to be pushed up with a loader, the maximum depth is limited by the reach of the loader and the skill of the loader operator. Reinforced walls will need to be higher and strong enough to support the additional loads imposed by the loader and the deeper pile of material.

Most operators find it convenient to have more bays than the number of feed commodities that are fed. Two additional bays are generally sufficient. This allows room for storing a pre-mix, an extra load of a feed commodity at a good price, a reserve in case of plant or road closures or taking fresh load while using the remainder of an older load.

The base of the bays and any concrete apron should be sloped away from the storage bay to prevent water flowing into the bay.

The orientation of the commodity shed should ensure adequate protection against the prevailing wind so that commodities are not exposed to blowing rainfall during storms.

Supplement storage

The quantities of dry supplement ingredients, such as enzymes, minerals, urea and salts, may not be large enough for bulk storage. However, they may still constitute a considerable number of bags/bulk bags/pallets that need to be stored out of the weather and close to the commodity shed. A common solution is to use one bay of a commodity shed, or a small shed with a gravel floor, for items on pallets.

Quick tips

- A commodity storage facility should be situated so all feed commodity and delivery vehicles, from both on and off the feedlot, are contained in a designated area and adequate room is available for any future expansion.
- Provide sufficient room to deliver feedstuffs into the commodity storage facility without interfering with the daily feeding process.
- A one-way traffic flow, with vehicles primarily moving in a similar direction, is best.
- Allow adequate room for expansion and flexibility in the commodity storage facility design.
- The physical characteristics of a feed commodity (e.g. bulk density, angle of repose and particle dimensions) will affect the storage space and design.
- Concreting the floor of a flat-bottomed storage facility will prevent feed being contaminated with dirt or stones.
- Storage bays can be constructed with pre-cast concrete walls, cast in-situ concrete, timber sleepers or large concrete blocks. Allow adequate room for manoeuvring front end loaders between mirrored bays and have a concrete area in front of the bays for truck unloading.
- Provide extra bays, or use a push-through design, to prevent older feed material being buried in the back of a storage bay.

Further reading

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