

RESEARCH

An Foras Taluntais

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GRAVITY FLOW CHANNEL

Gravity Flow Channel as a facility in farmyard area

A Gravity flow channel or overflow slurry channel as it is sometimes called is a facility which can give flexibility in farmyard planning in both new buildings and where existing structures are being converted to meet new requirements in livestock housing. Accordingly the concept should be of interest to farmers wishing to erect new buildings or to convert buildings to meet changed future needs.

Flow characteristics of cattle manure

The flow of liquid in a channel is influenced by factors such as:

- length of channel
- slope of channel
- viscosity of liquid
- frictional resistance of channel surfaces
- cross-sectional area of flowing liquid
- length of channel perimeter in contact with liquid

Cattle manure flowing in a channel is influenced by the same parameters. However, cattle manure is not homogenous and at best can only be considered as a complex mixture of solids and liquids with flow characteristics which vary with time, temperature, type of animal, diet, quantity of water in the diet and quantity of water added to the manure. This mixture is further complicated by the fact that the solids fraction in cattle manure contains carbohydrates which ferment and cause gases to be released within the solids. This changes the buoyancy of the solids and causes them to rise to the surface and float as a crust. In static conditions this crust tends to adhere to the side walls and in particular cases it requires considerable force to overcome this adhesion. However, in spite of all these complications if a channel is correctly designed, cattle manure will flow without the application of any external force. This fact can be used to advantage where, for example, cattle manure is required to be taken to a manure store or a loading point without having to be pushed over large concrete areas.

Design for gravity flow channel

Water content is sometimes used to differentiate between animal manures resulting from different diets or different amounts of added water. The flow characteristics of manure from cattle in some European countries which have been fed mostly on meals can be quite different to those from cattle in Ireland fed mostly on grass silage. Accordingly, research work on gravity flow channels for cattle manure may require interpretation. In a farming context, a system must be safe before it can be recommended for application on the farm. To avoid having to dilute the manure with water, it is best to design channels for manure of the lowest water content in the knowledge that by so doing, manure of a higher water content will not present any flow problems.

A gravity flow channel must be designed to operate successfully for every possible set of conditions which may arise. Apart from the water content of the slurry there are other considerations which should be allowed for, such as:

- Rate at which slurry may be scraped into channel.
- Amounts of hay, straw, or other material of a high dry matter content which may be pushed into channel.
- Degree to which separation of liquids and solids has taken place in channel.
- High frictional resistance of freshly voided manure in a newly constructed channel.

Accordingly, in the design the following basic parameters should be adhered to:

- (i) Floor of channel should be horizontal i.e. perfectly level.
- (ii) Minimum width of channel should be one metre.
- (iii) Height of lip (weir at end of channel) should be 0.15 metres.
- (iv) Surface slope of flowing slurry should be assumed at 1 in 33 (3%).
- (v) Surface finish on channel should be smooth.
- (vi) Freeboard (clear distance between underside of roof and highest point of manure) should be 0.25 metres.

If the length of the gravity flow channel is known then the required depth can be calculated using the above surface slope. Where slope of ground is adequate a gravity flow channel can be designed in stepped sections with a lip or weir at end of each section (see Fig. 1). The purpose of the lip is to retain a layer of material to act as a lubricant thus reducing the frictional resistance of the floor.

Shallow tanks under slats as gravity flow channels

There are four situations where gravity flow channels (shallow tanks) under slatted accommodation for cattle can be used:-

- (i) Conversion of existing structures to slatted accommodation.
- (ii) Locations where rock levels are close to ground level.
- (iii) Locations where water table levels are close to ground level and where they cannot be lowered.
- (iv) Where adequate manure storage capacity is already available outside the structures to be converted.

The use of a propeller agitator to improve flow characteristics of cattle manure

In the design of long shallow tanks under slats, the depth required may be excessive or the channels may have constrictions or other impediments to flow. To overcome these problems a propeller agitator can be incorporated in a circuit for the purpose of improving the flow characteristics of the manure and of providing a homogenous manure suitable for direct land-spreading (see Figure 2). If cattle manure is allowed to remain in a tank for a long period, a solid crust may form which is difficult to break up by use of a propeller agitator. The best approach to successful agitation may be:

- (1) Release enough liquid fraction to lower the crust thereby breaking the adhesion between crust and wall.
- (2) Break up the crust upstream of propeller and any constrictions in the circuit.

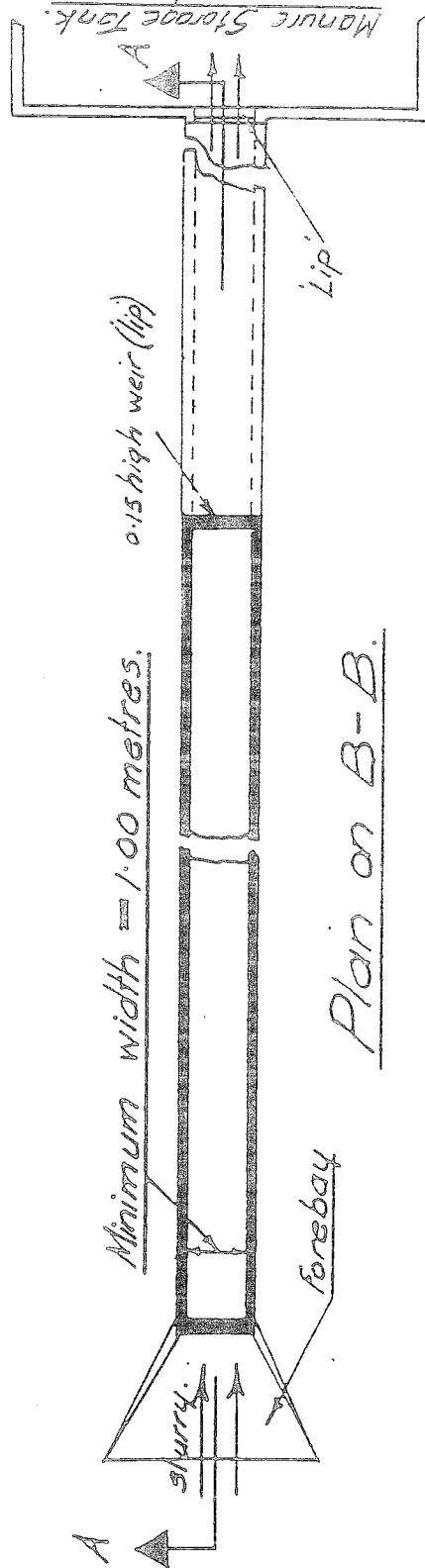
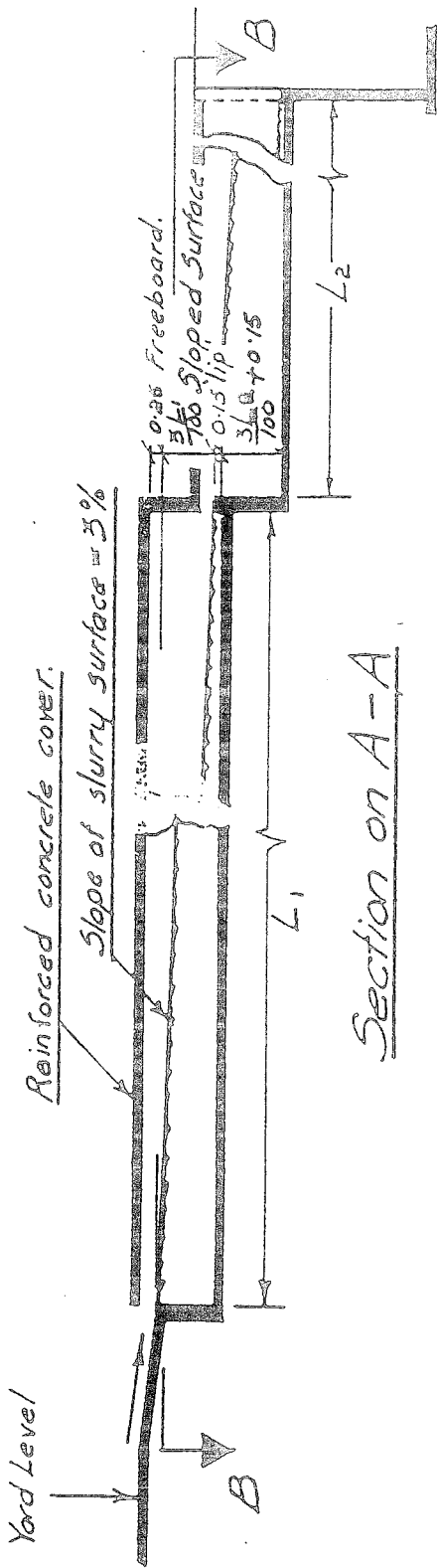


Figure 1 : Diagrammatic representation of 'Stepped gravity flow channel for transport' of cattle slurry.

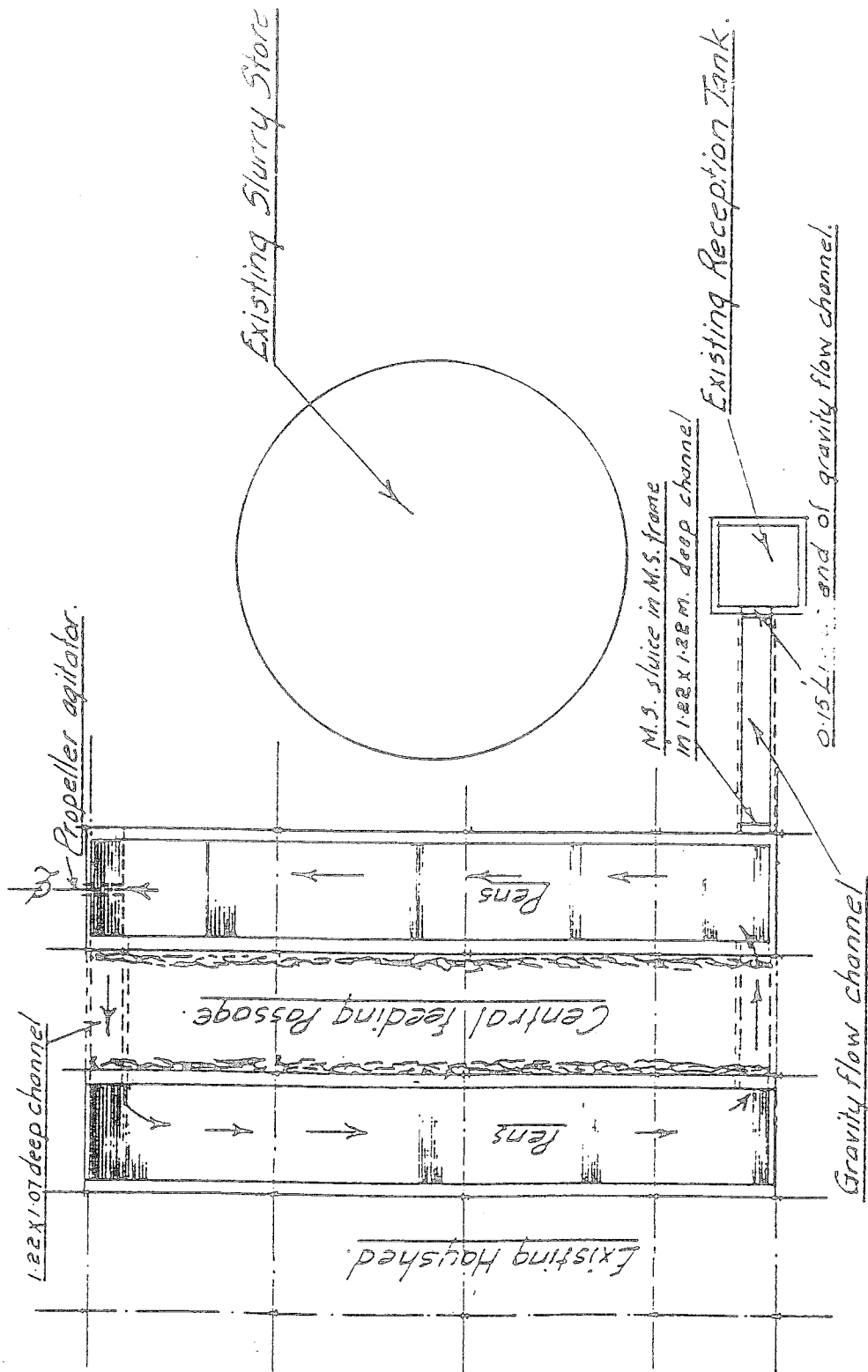


Figure 2. Diagrammatic representation of slotted accommodation for cattle arranged in existing hayshed using shallow tanks (1.07 m. deep) with propeller agitator.

- (3) Use the propeller agitator to suck back the manure towards the driving shaft. This will facilitate efficient pumping by ensuring close contact at seating for agitator.

When these recommendations are followed the manure in shallow tanks as indicated in Figure 2, can be homogenised in about one hour from start of propeller agitator. The surface slope or hydraulic gradient for such homogenised cattle manure, for cattle fed on grass silage, should be as low as 1/100: hence the advantage of incorporating a propeller agitator facility in long shallow tanks.

Lethal gases released from manure during agitation

It must be emphasised that during agitation of manure, gases are released which are lethal to animals and humans. Accordingly, when such agitation is being carried out animals should be removed from contiguous areas and all doors and ventilators should be opened fully. As an additional precaution manure agitation should not be carried out during calm weather if animals are housed in the vicinity.

Roof over gravity flow channel

To avoid accidents to persons and/or animals it is essential to have channels roofed or properly fenced. It is also important to realise that any roofing placed over a channel must be strong enough to carry the greatest wheel loads that can pass over the channel.

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