HOPPER BINS – FOUNDATION RECOMMENDATION

1. Engineering Recommendations

The hopper bin foundation must function as a structural unit in order to distribute the load safely from the steel hopper base to the subgrade. This can only be achieved if an engineered concrete foundation or engineered granular base foundation is placed on a properly draining subgrade. Recommendations for granular base foundation are covered in this document.

Removal of topsoil, organic material and very soft subgrade materials is critical to bin foundation performance. Upon excavation, the ground should be proof rolled and any material that experiences significant rutting or deformation should be removed. Bins should be based on a stiff subgrade.

Inadequate drainage is considered to be a major contributing factor to potential failures. Ideally, bins should be constructed on high ground where natural drainage carries rainfall away from the bin foundations. As a minimum, the base must be constructed above natural grade, not below. Prior to construction of the base, the site should be cross-graded or crowned to prevent future accumulation of rainfall in the foundation areas. Under no circumstances should bins be constructed in areas where the natural ground is below the seasonal water table (i.e. Sloughs).

Granular base course meeting the Saskatchewan Highways Specification 3505 is a suitable material. Preferably Type 33, or alternately Type 31 or 35 base course is appropriate. Each 6” lift of the base material should be uniformly compacted to be 98% Proctor (SPMDD). The minimum thickness of the granular pad varies with bin diameter.

The final surface of the compacted base must be very level in order to prevent eccentric loading of the steel hopper base. A maximum differential of ±1/4 inch is recommended under the steel hopper base. The base surface should be shaped until this condition is achieved.

Drawing HBF100 REV.B shows a schematic of the recommended installation guidelines.

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2. Guidelines for Installers

It is understood that the majority of these foundations will be constructed without engineering oversight. While Vale Industries is not liable for any damage which occurs due to insufficient engineering of the foundation, this section is intended to provide some practical suggestions that will help installers construct foundations within the spirit of the recommendations in the preceding section. Notwithstanding any recommendations contained herein, Vale recommends that any bin foundation should be inspected and approved by a qualified civil or geotechnical engineer.

2.1 Site Clearing

Removal of topsoil or organic material can be achieved using a dozer, bobcat or front end loader. If the soil underneath the topsoil is very wet or soft, such that the dozer, bobcat or front end loader causes significant rutting, then it may be necessary to over-excavate or to dry the native material. Drying can be achieved by discing or cultivating the area and then re-compacting it.

Visually check to ensure that surface water has a natural path to flow away from the bin pad area and then check that the cleared surface slopes gently towards the surface water outlet. It may be necessary to do some grading or ditching to achieve positive site drainage. This check can be accomplished using a straight piece of lumber and a carpenter's level.

2.2 Subgrade Proof Roll

Once the subgrade is shaped, it should be proof rolled to check for soft spots and weak materials. Use a loaded front end loader or moderately loaded grain truck and slowly drive back and forth across the subgrade area to detect soft areas. Remove any materials that rut or deflect more than 1 inch.

2.3 Base Course Selection

The quality of the base course is one of the main success factors for bin foundations. Any local gravel supplier who contracts to the provincial highway authority should recognize and be able to supply a suitable material. Request Type 33 base course and ask the suppliers for test results for this material. Pit run is not a suitable material and without test results, it is difficult to be confident the aggregate meets the base course specification.

2.4 Base Course Placement

A smooth drum packer with vibratory capability is the optimal equipment for base course compaction. Using loaded trucks or other farm machinery is a practice that has a history of unsatisfactory performance in terms of inadequate and non-uniform compaction. The following guidelines are recommended:

- The base course should not be so dry that it is dusty and not be so wet that it feels "greasy" or that there is free water. Add water if too dry or use a disc/cultivator to promote evaporation if too wet.
- It is not practical to compact thick granular layers. Place a maximum of 6" of material and compact. Repeat 6" lifts to minimum required thickness.
- Extend the base course 2' beyond the edge of the steel hopper base plus the height of the granular pad underneath. Ensure the end slopes follow the 2-to-1 ratio shown on the attached drawing.
    - For example, an 18' cone requires a 12" thick base, constructed in 2 separate 6" lifts.
    - The required width at the top of the pad is therefore 24'.
    - Considering the 2-to-1 end slope ratio, the required width increases 2' for every 6" lift. Therefore, start with a 28' compacted width, 26' width at the top of the first lift and a 24' width at the top where the bin will sit.
- For each lift, run the packing equipment across and back until the entire surface has had one pass. Avoid the concentrated compactive effort (i.e. More passes of the packer in one area compared to another), as this is potentially dangerous. Repeat with additional passes until the layer feels quite firms and does not deflect under load.
- Compaction to 98% Proctor is critical to foundation performance. It is difficult to assess this without quality assurance testing. Visual or empirical rules (i.e. Resistance to excavation, deflection under load) provide qualitative indications of compactive effort; however, these can be misleading depending on various environmental factors.

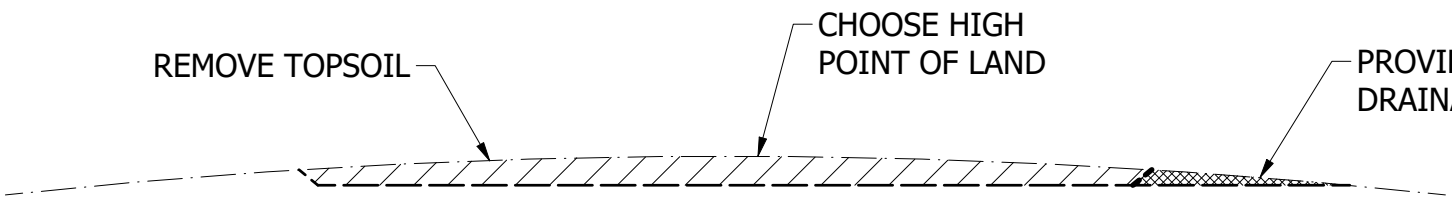
2.5 Level Check

Locate the centre of the proposed bin foundation. Use a straight piece of lumber which is about half as long as the bin diameter and a carpenter's level. Pivot the lumber from the centre and check the uniformity of the elevation under the foundation rings using the carpenter's level. Note the high and low spots and then raise the low spots with additional gravel. Compact as required.

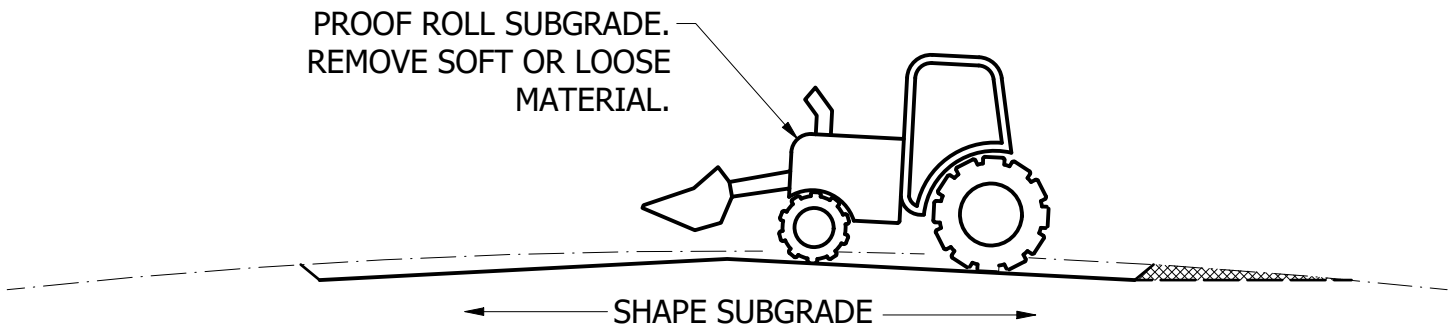
2.6 Site Grading

Ensure that the site is final graded to promote drainage away from the bin grade.

1. SITE CLEARING

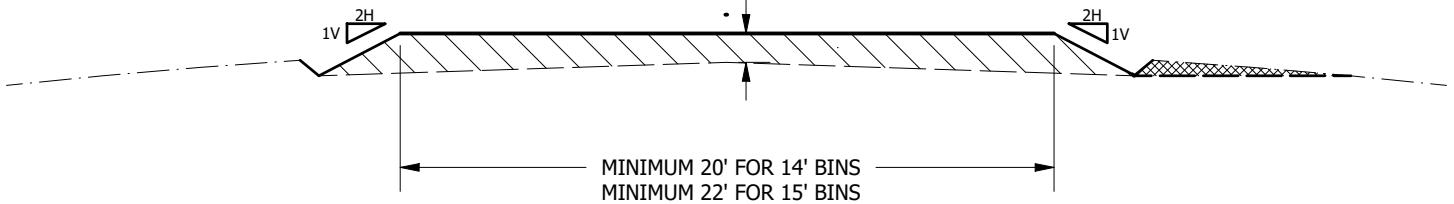


2. SUBGRADE PREPARE



3. BASE PREPARE

BASE COURSE:
8" MINIMUM FOR 14' BINS
12" MINIMUM FOR 18' BINS
14" MINIMUM FOR 15' BINS
18" MINIMUM FOR 19', 21', 24' AND 2706 BINS
30" MINIMUM FOR 2708 BINS



MINIMUM 20' FOR 14' BINS
MINIMUM 22' FOR 15' BINS
MINIMUM 24' FOR 18' BINS
MINIMUM 26' FOR 19' BINS
MINIMUM 28' FOR 21' BINS
MINIMUM 31' FOR 24' BINS
MINIMUM 34' FOR 2706 BINS
MINIMUM 36' FOR 2708 BINS

NOTES:
-BASE COURSE TO BE PLACED IN 6 INCH LIFTS AND UNIFORMLY COMPACTED TO 98% OF STANDARD PROCTOR.
-BASE COURSE MATERIAL TO MEET SASKATCHEWAN HIGHWAYS SPECIFICATION 3505 TYPE 33, ALTERNATIVE TYPE 31 OR 35.

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1. All dimensions in inches unless otherwise specified.
2. General tolerances
x/x = ± 1/16
.x = ± 0.010
.xx = ± 0.005
.xxx = ± 0.002
angles = 0.5
(UNLESS OTHERWISE NOTED)

TITLE: HOPPER BIN FOUNDATION PREPARATION

SIZE	SCALE	WEIGHT	DRAWING NUMBER	REV
A			HBF100	B