Temporary Grain Storage

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The purpose of any grain storage facility is to prevent grain quality loss from weather, wind and moisture; rodents, birds and insects, and microorganisms.

Various techniques and facilities have been used to store grain temporarily. Generally, the more durable the facility, the longer grain can be stored without excess loss.

Manitoba agricultural engineers studied losses in different temporary grain storages of wheat, barley and oats. Losses in an uncovered outdoor pile were about 50%. Losses were 1-4% for temporary bins set on a plastic sheet and covered with a plastic sheet. Venting out moisture at the top of the covered grain pile may be needed. Grain piled in a smooth cone shape until it spills over the top edge of binwalls drained best. Spoilage occurred a few inches below the grain surface, so frequent checking by probing is important.

Grain going into temporary storage must be dry. Aeration cools the grain to enhance storability but is not adequate to remove moisture from grain.

Using Existing Buildings

Many types of buildings such as pole buildings used for machinery storage, empty barns, and stud framed shops or garages can be used for grain storage.

Make sure the building location is well drained. If the building does not have a concrete floor, place the grain on plastic to prevent moisture moving from the ground to the grain. Even with a concrete floor, it is advisable to cover the concrete with plastic, especially if the concrete is cracked. Moisture vapor will move through concrete and into the grain if the soil below the concrete is wet.

Most farm buildings are not built to withstand lateral loads other than those normally sustained from wind pressure, so they will need to be strengthened to support grain pressure .

Check with the building manufacturer about safe depth of grain to use in existing commercial buildings.

The pressure grain exerts per foot of depth is called the equivalent fluid density (EFD).

The lateral pressure pushing out at the bottom of a wall is calculated by multiplying the grain depth by the EFD of the grain. The EFD for some types of peaked grain are shown in Table 1. The force per square foot pushing out at the bottom of a 6 foot depth of wheat is 144 pounds per square foot; 24 x 6. The total force pushing on the wall is 432 pounds per linear foot of wall; 144 x 6 / 2. The EFD listed in Table 1 is for peaked grain. The EFD for level filled piles is about 80% of that of peaked grain. A comparison of needed building structural strength for different types of grain can be made by comparing the equivalent fluid density. The grain depth a wall can support is roughly related to the cube root of the ratio of the EFD.

Table 1. Approximate equivalent fluid density of some peaked grains.

Crop	Equivalent Fluid Density
	lb/cu. ft
Barley	20
Corn (shelled)	23
Oats	14
Grain Sorghum	22
Soybeans	21
Sunflower (non-oil)	9
Sunflower (oil)	12
Durum wheat	26
HRS wheat	24

Table 2 lists the safe depth of wheat, rye, shelled corn, grain sorghum, and beans for the stud sizes listed based on 1982 allowable stress values. The allowable bending stresses for lumber have been decreasing over time, so safe depths for new lumber would be less. For example, the allowable bending stress for #2 Southern Pine was 1,200 psi in 1982 and was reduced to 1,050 psi in 1991, according to the National Forest Products Association Design Values for Wood Construction. The design value for Douglas Fir-Larch was reduced from 1,250 psi to 875 psi. Spruce-Pine-Fir (South) #2 dimension lumber has a design stress value of 750 psi. Grain depths used should be adjusted based on the bending stress of the wood. For example, the allowable bending stress for Southern Pine was reduced from 1,200 in 1982 to 1,050 in 1991, so the depths should be reduced to 88% of the 1982 depth shown in the table; 1050/1200.

Table 2. Safe depth of wheat, rye, shelled corn, grain sorghum and beans for stud sizes listed.[1]

Stud Size			Grain Depth (feet) for Stud Spacing		
Nominal	**Dressed**	**Stud Length**	**24"**	**16"**	**12"**
- - - - - - inches - - - - - -		**(feet)**			
Old Lumber					
2 x 4	1 5/8 x 3 5/8	8	5	6	7 1/2
2 x 6	1 5/8 x 5 5/8	8	8	8	9
2 x 6	1 5/8 x 5 5/8	10	7	9	9
1982 Lumber					
2 x 4	1 1/2 x 3 1/2	8	4	4	5
2 x 6	1 1/2 x 5 1/2	8	6	7	8
2 x 8	1 1/2 x 7 1/4	8	7	8	8
2 x 10	1 1/2 x 9 1/4	8	8	8	8
2 x 4	1 1/2 x 3 1/2	10	4	4	5
2 x 6	1 1/2 x 5 1/2	10	5	6	7
2 x 8	1 1/2 x 7 1/4	10	7	8	10
2 x 10	1 1/2 x 9 1/4	10	9	10	10
2 x 12	1 1/4 x 11 1/4	10	10	10	10

[1] If large knots occur in any of the studs or if the lumber is soft and lightweight, use cross ties at 0.45 the depth of grain. Studs should be well fastened to the sill and top plates.

The maximum bending force on a grain wall is at approximately 0.5 times the grain depth. Therefore, the optimum location for tieing sidewalls together with a cable is at about 0.5 times the depth of grain above the floor.

Pole frame buildings are frequently used for grain storage. The maximum grain pile depth for various size poles in a building built before 1991 is shown in Table 3. The walls should be tied together at the eave by a cable if the truss has not been designed and connected to carry the grain load (Figure 1). To provide support for the poles, cables should be installed at about 0.5 times the grain depth above the floor.

Maximum grain depths for pole buildings built since 1991 are shown in Table 4.

Figure 1. Use a cable to tie post tops together or walls may pull apart from roof. (NRAES-1 Pole and Post Building Construction, 1977.) (10KB b&w Image)

Table 3. Maximum grain depth supported by Douglas Fir-Larch or Southern Pine posts and poles. Built before 1991.

		Oats & Sunflower			Corn, Wheat, Rye		
		4	6	8	4	6	8
POSTS		- - - - - - Post or Pole Spacing, Feet - - - - - -					
5.5 x 9.5		—	10.7	9.7	10.3	9.0	8.3
7.5 x 7.5		—	10.1	9.2	9.8	8.6	7.8
6.0 x 8.0		11.2	9.8	8.9	9.5	8.3	7.5
5.5 x 7.5		10.5	9.1	8.3	8.8	7.7	7.0
6.0 x 6.0		9.3	8.1	7.4	7.8	6.9	6.3
3.5 x 7.25		8.7	7.6	7.0	7.5	6.5	5.9
5.5 x 5.5		8.5	7.4	6.7	7.2	6.3	5.7
4.0 x 6.0		8.1	7.1	6.4	6.9	6.0	5.4
3.5 x 5.5		7.3	6.3	5.8	6.2	5.4	5.0
4.0 x 4.0		6.2	5.4	4.9	5.2	4.6	4.1
POLES							
Circum-ference	**Diameter**						
30	9.5			10.9		10.2	9.3
28	8.9		11.2	10.2	10.9	9.6	8.6
26	8.3		10.5	9.5	10.1	8.8	8.0
24	7.6	11.0	9.7	8.7	9.4	8.2	7.5
22	7.0	10.1	8.8	8.0	8.6	7.5	6.8
20	6.4	9.2	8.0	7.3	7.8	6.8	6.2
18	5.7	8.3	7.3	6.5	7.0	6.2	5.5

Note: Tie post tops together with properly designed truss or cable to keep walls from pulling apart from the roof. Do not overtighten cable or truss will buckle. Grain depths on the wall can be increased by 8% if the grain is not peaked. Modified from NRAES-1, 1997.

Table 4. Maximum depth of bulk products for selected post sizes and spacings (Southern Pine No. 2). Built since 1991.

	Corn, Wheat, Rye	Oats & Sunflower

Post Size	4	6	8	4	6	8
	- - - - - - - - - Post Spacing, feet - - - - - - - -					
4 x 6	4.3	3.8	3.4	5.2	4.5	4.1
6 x 6	5.0	4.4	4.0	6.1	5.2	4.8
6 x 8	6.2	5.4	4.9	7.4	6.5	5.9
6 x 10	7.3	6.3	5.7	8.7	7.6	6.9
8 x 8	6.8	6.0	5.4	8.3	7.2	6.5
8 x 10	8.0	7.0	6.3	9.6	8.5	7.6

Modified from NRAES-1 Post-Frame Building Handbook, 1997.

Nominal 2 inch (1.5") tongue and groove decking or center matched planks are often used to withstand high lateral pressures at the bottom of bulk storages. Table 5 lists the maximum uniform load for plywood and plank lining with supports spaced at 2, 4, 6 and 8 feet apart. Install plywood sheets or planks long enough to cover at least two spans (3 posts); pieces that only span between two posts may deflect excessively under load. To determine the maximum grain depth that the sheathing can support, divide the maximum uniform load from Table 5 by the equivalent fluid density from Table 1.

Table 5. Load-span for selected wood sheathing materials.

	Maximum uniform load in psf with supports spaced at:			
Sheathing Material	**2 ft.**	**4 ft.**	**6 ft.**	**8 ft.**
3/4" APA Structural I (unsanded, dry) Fb= 2000 psi	183	46	20	11
1 1/8" APA Structural I (unsanded, dry) Fb=2000 psi	388	97	43	24
2 x 10 Spruce-Pine-Fir planks (No. 2) Fb = 875 psi	506	126	56	32
2 x 10 Southern Pine planks (No. 2) Fb = 1051 psi	607	152	67	38

NRAES-1, 1997.

Figure 2 shows construction details for adding a 4 foot high wall between the posts to contain the grain. One option is to place the framing between the posts. Cut the sill and plate to fit between the posts. Attach the 2 x 6 sill and 2 x 6 plate to the 2 x 4 studs with two 16d nails at each end. Tip the frame into place. Fasten the sills and plates to the posts with framing anchors. Line the wall with 4 x 8 feet, 5/8 or 3/4 inch plywood sheets. Select plywood with a span rating of 42/20 Ext. To keep grain from falling between the grain wall and the building wall, add a baffle from the top of the grain wall to a wall girt.

> **Figure 2. Grain liner for post-frame buildings.** (21KB b&w Image)
> **Fasten plate and sill to 2 x 4 studs before installing framing in the wall. Drive two 16d nails through sill and plate into ends of each stud. Studs are flush with inside face of posts. Lumber is No. 2 or better, Southern Pine or equivalent.** (MWPS-13 Grain Drying, Handling and Storage Handbook, 1988.)

Another option is to move the new frame inside the posts. The sill and plate can be continuous across one or more posts; add a stud at each post to support the plywood. Anchor the sill to the floor with angle irons and anchor bolts or with anchor nails driven through the sill with a stud gun.

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