Foundation Preparation

Procedure Notes

Bulletin 57-06-22

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FOUNDATION PREPARATION

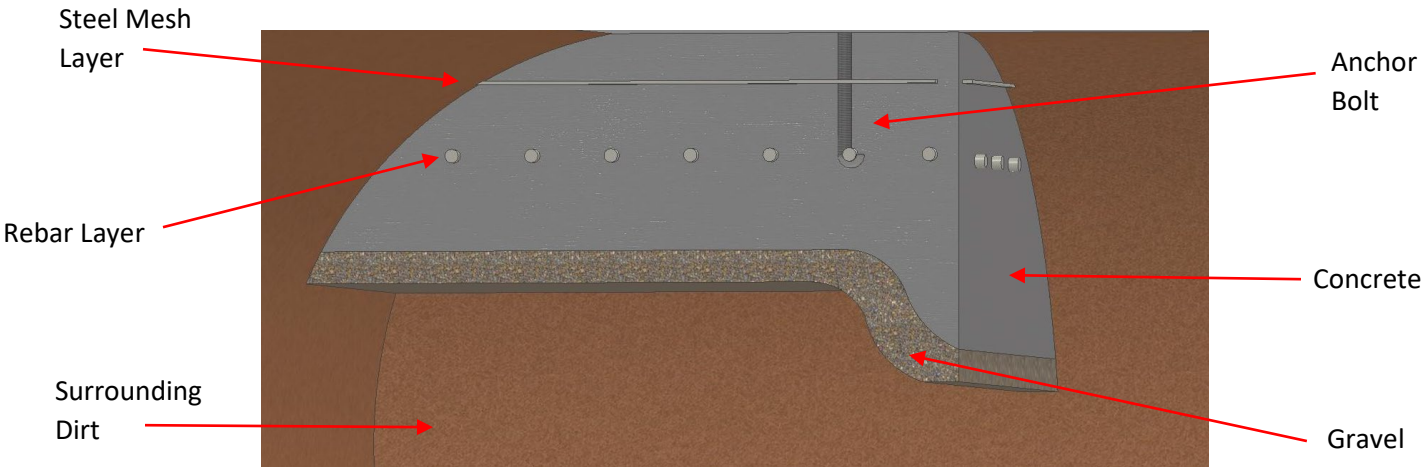

Figure 1: Slab-On-Grade Foundation (3D Cutaway View)

A reinforced concrete foundation is required for installation of Montgomery Hog units. **It is strongly recommended that the customer consult with a structural engineer to ensure their foundation is structurally sound and meets local codes.** The following guidelines are for reference only.

- ✓ The unit must be mounted on a reinforced concrete foundation which should extend at least 6” beyond the base plate of the unit on all sides.
- ✓ The foundation should be slab-on-grade, with a minimum thickness of 12”. Montgomery recommends a 12-18” thick slab, but **local codes and frost lines will determine the actual thickness required.**
- ✓ The concrete should have a strength of at least 4500 psi, with 5000 psi concrete being preferred. Adding fiber mesh to the concrete is strongly recommended.

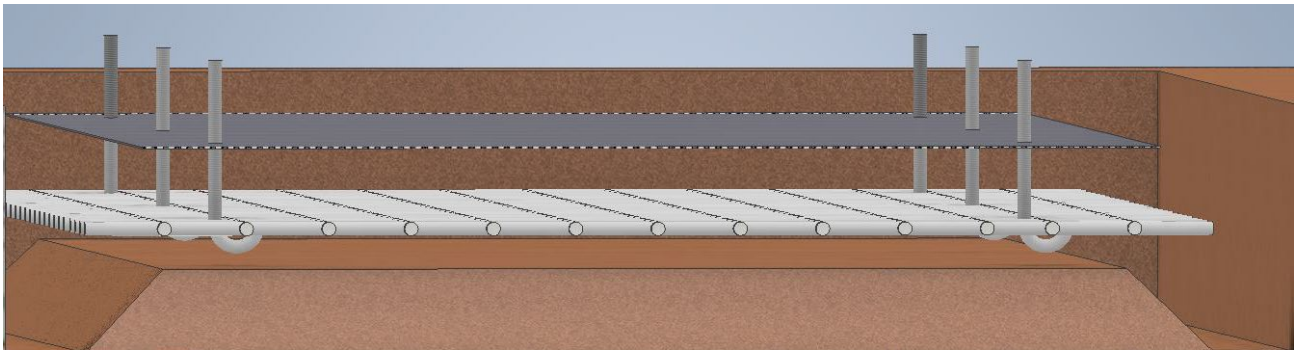

Figure 2: Rebar, Steel Mesh, and Anchor Bolt Placement

- ✓ #8 rebar should be placed on a 6” grid pattern in the lower third of the foundation for structural reinforcement. Additionally, a layer of steel mesh should be placed in the top

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third of the foundation for temperature and shrinkage reinforcement. Either Grade 40 or Grade 60 rebar is acceptable.

✓ Anchor bolts should be long enough to hook around the layer of rebar reinforcement. They should be 1” NC and a minimum of 12” long. 3” should extend above the top of reinforced concrete for mounting the unit.

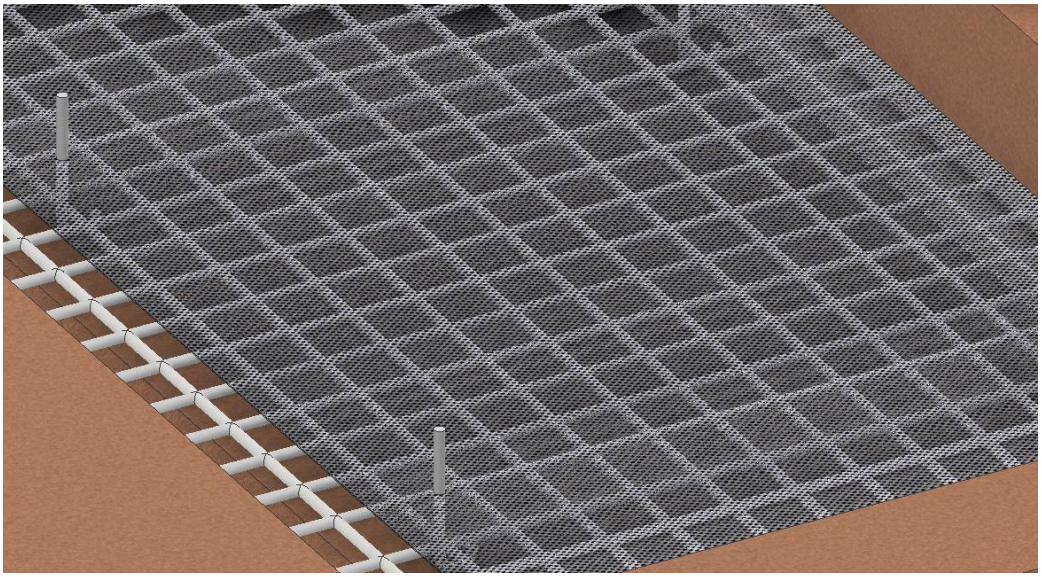

Figure 3: Reinforcements Prior to Concrete Pour

For further information on the Montgomery Hog foundation design, see Appendix A: *Bulletin 25-01-22: Reinforced Concrete Calculations*.

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Appendix A:

Reinforced Concrete Calculations

Supporting Documentation

Bulletin 25-01-22

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[Overview]

Montgomery Industries recommends pouring a reinforced concrete slab 12-18” thick extending at least 6” beyond the base plate of the unit on all sides. #8 rebar should be placed on 6” spacing in the bottom third of the slab for structural reinforcement. Additionally, it is recommended to place a steel mesh in the top third of the slab to prevent cracking. 5000 psi strength concrete is strongly recommended, but 4500 psi concrete is also permissible.

These values are provided as recommendations based on the nature of the equipment. They are not a substitute for structural engineering. It is the responsibility of the customer to ensure that their slab is structurally sound and meets local codes. It is strongly recommended that customers consult with a licensed structural engineer. The following document provides calculations and background information but is not comprehensive. It should be used for reference only.

[Information & Calculations]

The reinforced concrete suggestions were determined using several formulas and cross-referencing multiple sources. Montgomery Industries has historically recommended a 12-18” thick 5000 psi concrete slab with 1” thick rebar reinforcements. These variables were taken to be constant, with both the upper and lower end of the thickness range calculated.

First, the type of slab to be used in calculations was determined. The installation of a slab-on-grade foundation[1] (also commonly referred to as slab-on-ground with turned-down footings) was selected to remain consistent with what Montgomery Industries uses in their own facility. The 12-18” depth of the slab is deeper than the frost line in most areas, so the slab-on-grade foundation would not be at risk of frost damage.

In cases with more extreme weather, it is the responsibility of the customer to ensure that the foundation extends below the frost line or includes the proper insulation. Movement caused by the slab freezing and thawing may unbalance the hog, resulting in excess wear to components that may damage the machine.

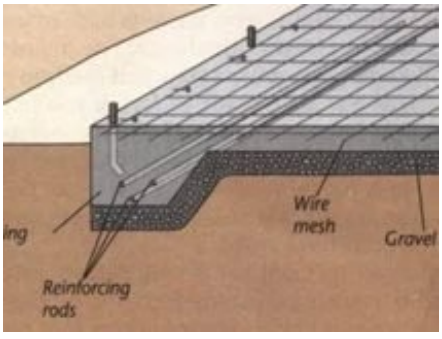

Figure 1: Slab-On-Grade Foundation[1]

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Next, the percentage of steel to concrete was calculated. Using the criteria for Reinforced Concrete Slabs-On-Grade Subjected to Heavy Loads, as defined by the Unified Facilities Criteria, it was determined that the minimum steel to concrete ratio required is 0.15% for 12" concrete slabs.[2] The value fell between 0.14% and 0.15% but was rounded up to err on the side of caution. Similarly, the minimum ratio for 18" slabs was determined to be 0.27%. Figure 5-4 from UFC 3-320-06A is included below for reference.

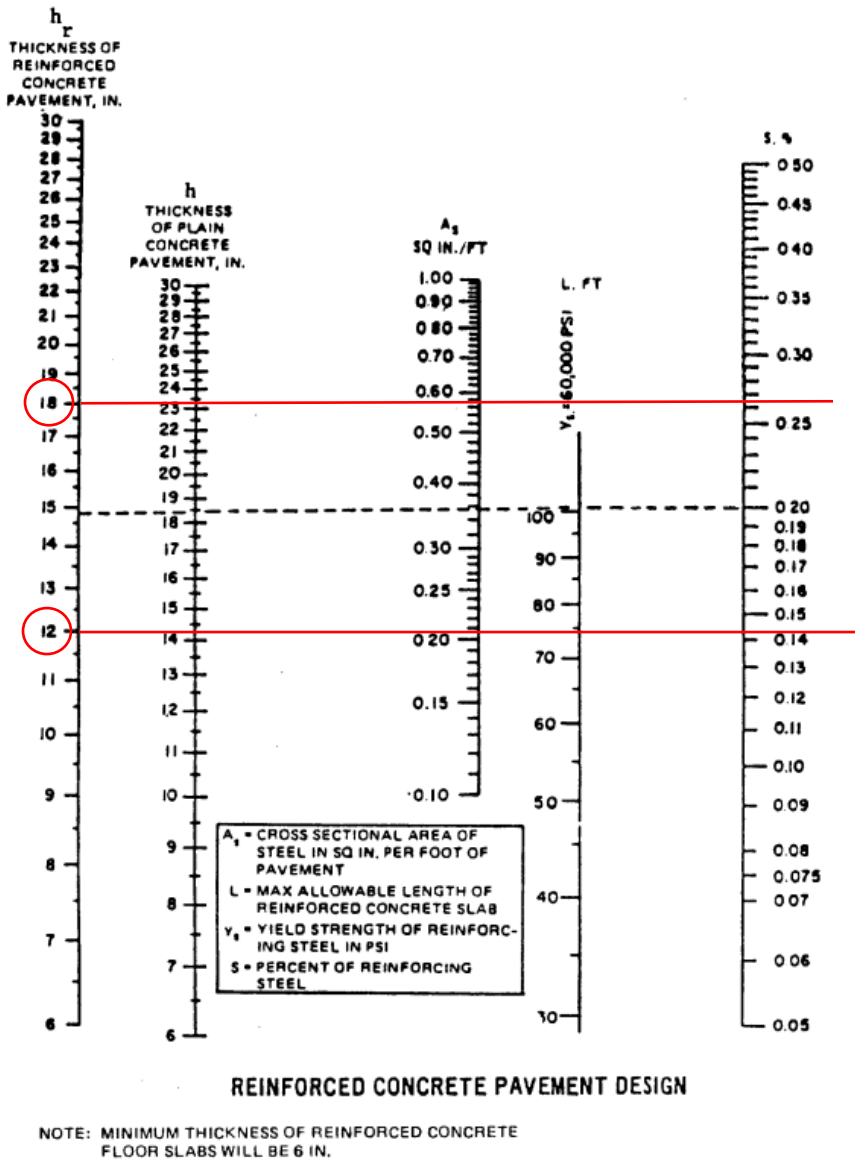

Figure 2: Reinforced Concrete Design Chart[2]

These values were then checked against the American Concrete Institute's standards, which define the minimum slab-on-ground reinforcement ratio as 0.10% (half of the minimum

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ratio for suspended slabs).[3] Since the found values of 0.15% and 0.27% exceeded that of the code, it was determined that these values would be safe to use moving forward.

The calculated percentages were then inputted into the rebar-to-spacing multiplier[4], which is defined below in Equation 1. Sample calculations are provided for the 12" thick option.

$$M = 0.9\sqrt{\rho t} \tag{1}$$

"M" represents the multiplier, "ρ" represents the percentage of steel required, and "t" represents the thickness of the slab in inches. Plugging in the 12" thickness and corresponding percentage, "M" was determined to be 1.207.

$$M = 0.9\sqrt{(0.15)(12)} = 1.207$$

Finally, the multiplier and the nominal rebar size were used to determine the minimum spacing.[4] In remaining consistent with past practices, #8 rebar was selected (1" diameter). These values were put into Equation 2, which is defined below.

$$n = M\sqrt{s} \tag{2}$$

"n" represents the nominal rebar size, "M" is the multiplier found from Equation 1, and "s" is the spacing in inches. Equation 2 was rearranged to solve for "s", which was determined to be 43.930 inches.

$$s = \left(\frac{n}{M}\right)^2 = \left(\frac{8}{1.207}\right)^2 = 43.930\ inches$$

Based on these calculations, the minimum rebar spacing required for a 12" slab-on-grade foundation with #8 rebar would be roughly 3.66 feet. By placing the rebar on 6" spacing, the recommended values from Montgomery Industries surpass the minimum requirements.

These calculations were repeated for a thickness of 18" and a reinforcement ratio of 0.27%. This yielded a minimum rebar spacing of 16.258 inches. Again, the recommended values from Montgomery Industries adhere to code and meet the minimum requirements.

To verify the recommended values further, Equations 1 and 2 were combined and reordered to find the actual reinforcement ratio of the foundation slabs. Equation 3 and the subsequent sample calculations find the ratio for the 12" slab.

$$\rho = \frac{1}{t}\left(\frac{n}{0.9\sqrt{s}}\right)^2 \tag{3}$$

$$\rho = \frac{1}{12}\left(\frac{8}{0.9\sqrt{6}}\right)^2 = 1.097\%$$

The calculated reinforcement ratio for the 12" slab was found to be 1.097%, and the calculated reinforcement ratio for the 18" slab was found to be 0.732%. Both values fall

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underneath the maximum reinforcement ratios, as defined by the American Concrete Institute.[3] Either Grade 40 or Grade 60 reinforcing rebar may be used; the ratios do not exceed the maximum ratios for both grades of rebar. Table 5.11.4.2 from ACI 314R-16 is included below for reference.

Table 5.11.4.2—Maximum flexural reinforcement ratio ρ_{max} for solid slabs

		f_y, psi (MPa)	
		40,000 (280)	60,000 (420)
f_c', psi (MPa)	3000 (21)	0.0190	0.0100
	3500 (25)	0.0220	0.0125
	4000 (28)	0.0250	0.0140
	4500 (32)	0.0270	0.0160
	5000 (36)	0.0290	0.0170

Note: Different values of f_y and f_c' can be interpolated.

Figure 3: Maximum Reinforcement Ratios[3]

By placing the rebar on 6” spacing, the recommended installation for a 12” thick slab has a factor of safety of 7.31. Similarly, for an 18” thick slab, the values recommended by Montgomery Industries have a factor of safety of 2.71. In the case of the hog becoming slightly unbalanced, the slab foundation should not lose structural integrity. Table 1 summarizes these results for both ends of the recommended thickness range.

Table 1: Calculation Results

Foundation Thickness	Minimum Reinforcement Ratio	Minimum Rebar Spacing	Calculated Reinforcement Ratio (6” Spacing)	Factor of Safety
12”	0.15%	43.930”	1.097%	7.31
18”	0.27%	16.258”	0.732%	2.71

Montgomery Industries adheres to a minimum factor of safety of 2.5 to account for dynamic loading. In the case that the hog becomes unbalanced, it is critical that damage to the machine or supporting equipment is minimal. Both of these factors of safety adhere to the company’s standards. This informed the decision to recommend #8 rebar on 6” spacing for hog foundations.

Following the American Concrete Institute’s standards, it was determined that shrinkage and temperature reinforcements be placed at approximately 1/3 of the slab thickness from the upper surface.[3] This informed the decision to recommend a layer of steel mesh. Additionally, the rebar placement was determined to be in the bottom third of the slab to maximize structural

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reinforcement.[5] The combination of a structural rebar layer and a crack-preventing steel mesh layer ensures the slab can withstand the dynamic loading of the hog.

These values are provided as recommendations based on the nature of the equipment. They are not a substitute for structural engineering. It is the responsibility of the customer to ensure that their slab is structurally sound and meets local codes. It is strongly recommended that customers consult with a licensed structural engineer.

[References]

1. https://www.concretenetwork.com/concrete/foundations.htm
2. https://d6s74no67skb0.cloudfront.net/course-material/ST702-Design-of-Heavy-Duty-Concrete-Floor-Slabs-on-Grade.pdf
3. https://herbycalvinpascal.files.wordpress.com/2019/05/aci_314r_16_guide_to_simplified.pdf
4. https://homesteady.com/13367457/how-to-determine-rebar-size-and-spacing-in-a-concrete-pad
5. https://www.forconstructionpros.com/concrete/equipment-products/rebar-accessories-equipment/article/10116892/how-to-reinforce-concrete-slab-on-ground-to-control-cracking

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