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Outrigger pad sizing results – know what you need and apply best practices recommendations.

Kris Koberg discusses essential steps in selecting the right size outrigger pad.

Outrigger pads and crane mats have a specific purpose: help spread the load and keep the crane level. According to Dave Duerr, P.E., 2DM and Associates Inc., “Crane mats must spread the load from the crane over a large enough area that the bearing pressure to the ground surface is acceptable... [They] must provide support that is stiff enough that the crane will not go out of level as the loads from the crane change during lifting operations.”

This is an important job, yet, historically, the crane industry has relied on rules of thumb to size outrigger pads/mats to try to accomplish this task. An evaluation of pad sizing rules of thumb for outrigger-enabled mobile cranes reveals a significant variance in results from method to method. Why? Because they fail to take into account ground conditions.

Pad area sizing results

Let's look at how the most common rules of thumb for sizing outrigger pads/mats generate different results for the same crane. A note of caution before beginning, anytime the ground bearing capacity is less than 5,000 psf, your outrigger reaction force and foundational support should be carefully evaluated.

EXAMPLES ARE BASED ON A GROVE RT890E MOBILE CRANE (See Chart 1, page 20, for this and other examples.): 90-ton lifting capacity, maximum outrigger reaction force = 125,000



THE AUTHOR

This article is the second part of two-part series excerpted from a presentation made by **Kris Koberg**, CEO of

DICA Outrigger Pads, at the 2015 SC&RA Crane & Rigging Workshop, in Denver, CO.



lb., outrigger float = 30.5" diameter, maximum standard boom length = 142'

■ 3 times the area of the outrigger float (pontoon).

- Float area (ft²) x 3 = area of matting
- Ex: 30.5" diameter float = float area ~ 5ft². 5ft² x 3 = 15ft² of matting, (pads)

■ Capacity of the crane (tons) divided by 5.

- Crane capacity (tons) / 5 = area of matting
- Ex: 90 ton crane. 90 / 5 = 18ft² of matting, (pads)

■ Capacity of the crane (tons) divided by 4.

- Crane capacity (tons) / 4 = area of matting
- Ex: 90 ton crane. 90 / 4 ~ 22ft² of matting, (pads)

■ Duerr Simple Method is capacity of the crane x 1100 divided by Ground Bearing Capacity (GBC) (David Duerr, P.E., 2DM Associates Inc.)

- (Crane capacity (tons) x 1,100) / Ground bearing capacity (psf) = area of matting, (pads)
- Ex: 90 ton Crane, GBC = 5,000 psf. (90 x 1,100)/5,000 ~ 20ft² of matting, (pads)

Each rule of thumb when applied to the same crane generates a different result. (See Chart 1.) In many cases results vary by more than 50 percent. One flaw in using a rule of thumb is not understanding the factors on which the method was devised. When a user arbitrarily selects a rule of thumb without understanding how or why those results are generated, it's difficult to know if it applies to your situation. Subject to the ground bearing capacity and the pressure imposed through the outrigger floats, any of these solutions *could* work, including

not using any outrigger pads at all. But is this a risk you are willing to take?

The formula to calculate the actual area required to distribute a force over a specified ground bearing capacity is Pad Area = Force (lb.) / Ground bearing capacity (lbs/ft²). DICA refers to this formula as the equalization method.

■ Equalization method. Outrigger force divided by ground bearing capacity

- In this example (Grove RT890E) the outrigger force to be fit for was specified as 93,750 lbs. (75% of the maximum outrigger reaction force)
- Two ground bearing capacity examples are shown to illustrate the difference. (5,000 psf and 2,500 psf)
- Equalization 1 = 93,750 lbs / 5,000 psf = 19 ft² of matting, (pads)
- Equalization 2 = 93,750 lbs / 2,500 psf = 38 ft² of matting, (pads)

The difference in area required between equalization results 1 & 2, is directly related to the change in the strength of the ground bearing capacity. The stronger the ground the less area is required, the softer the ground the more area is required.

Chart 1 illustrates the varying results between the rules of thumb indicated above compared to the equalization results when two different soil bearing capacities are used, as applied to five different cranes.

Using the equalization method

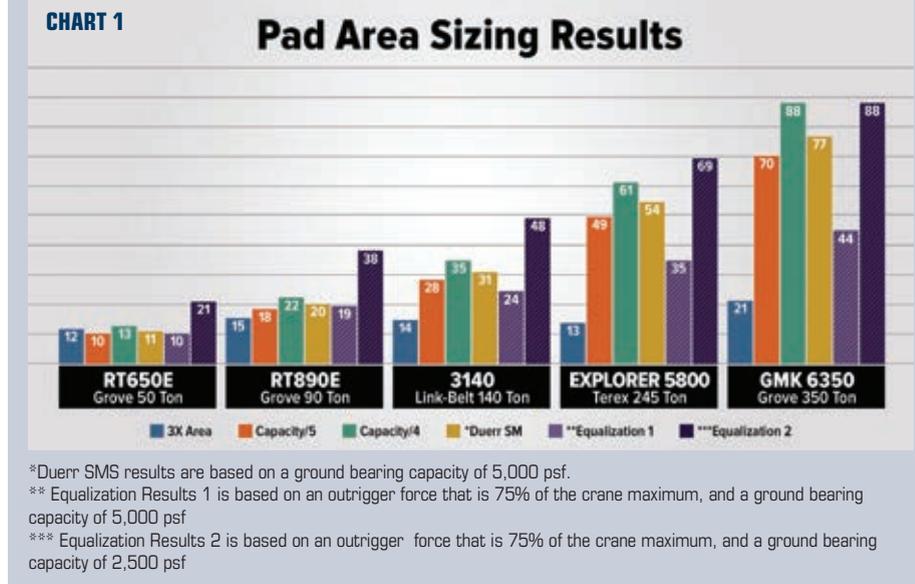
Identifying the outrigger pad size that is suitable for each job is more of a slide rule calculation than a simple rule of thumb. The outrigger pad size you need for a specific lift is a function of the force being >20

exerted through the outriggers divided by the ground bearing capacity. This simple calculation indicates if you have the right size pad/mat for that lift. However, *as the outrigger force increases* your need for more pad area also increases, assuming the ground bearing capacity doesn't change. If the *ground bearing capacity decreases* (is softer) your need for pad area increases, assuming that the outrigger force is unchanged. Let's break this idea down.

Chart 2 shows the outrigger pad size (area) needed based on the relationship between the outrigger force and the ground bearing capacity. The X axis represents the force applied through the outrigger. The three colored lines represent different soil bearing capacities. The Y axis represents the pad/mat area required to equalize the outrigger force to the ground bearing capacity.

An outrigger force of 140,000 lbs. will need a 56ft² outrigger pad on a ground bearing capacity of 2,500 psf. However if the ground is stronger, 5,000 psf, the pad area required to equalize the outrigger force to the ground bearing capacity is reduced to 28ft².

There is a direct relationship between the outrigger force and the ground bearing capacity when it comes to selecting outrigger pad size. It's critical to understand and plan for ground bearing capacity when sizing outrigger pads, and why rules of thumb that don't take the ground into account should be avoided.



Everyday applications

Below is a simple suggestion for sizing the outrigger pads you use for routine, every-day lifts. Consider the typical outrigger loads you generate and the typical ground conditions found in your region. Then select outrigger pads with adequate area for most of your lifts. This approach provides an everyday solution that is lighter to handle and less expensive to purchase. The key is knowing when additional pads or matting are needed based on outrigger forces generated for specific lifts and actual ground conditions or ground bearing capacities at the jobsite.

Refer to Part 1 of this series (Feb. 2016,

page 25) to review the steps for setting up for success.

- 1 Specify the outrigger force to be fit for.
- 2 Specify a ground bearing capacity to be fit for.
- 3 Apply the Equalization Method after you have identified the outrigger force to be fit for and have specified a soil bearing capacity.

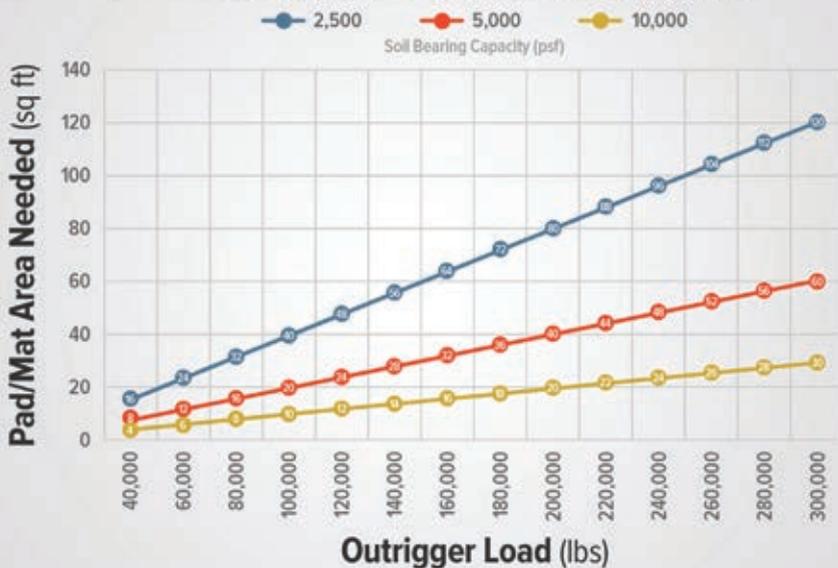
Use Chart 2 to identify the pad area you need. Simply identify the outrigger force you want to size your pad for and select the ground bearing capacity you wish to use. The intersection of these lines tells you the pad/mat area that you need.

If you apply these principals you will know your numbers and where they came from so you can clearly communicate to your operators the parameters for using the outrigger pads you are supplying. Always continually monitor your surroundings. If your outrigger pad is being driven into the ground, the area of the pad is not large enough. If your pad and ground under the pad is bending, or deflecting then the pad you are using is not rigid enough. In both cases you need to stop the lift and address the need.

The final piece in selecting outrigger pads/mats is to ensure they have adequate strength for their intended use, and adequate rigidity to keep the equipment level and distribute the load over the intended area. Ignoring either of these properties could leave you in an unstable situation. Consult with your outrigger pad manufacturer or an engineer to ensure these needs are met. For more detailed information on this topic refer to David Duerr's new book *Mobile Crane Support Handbook*.

CHART 2

Outrigger Pad/Mat Sizing Graph



Pad area needed to equalize the outrigger load to the soil bearing capacity. Consult with your outrigger pad/mat manufacturer to determine the correct material, thickness and construction to adequately spread and support the load.

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