A-Jacks® Packing and Stacking Technical Note

Summary

Standard river A-Jacks with a 24 inch length should be placed with a separation of 12 inches both along a row and across rows. Two rows are recommended over single row placement because two rows are much more stable. Small river A-Jacks may be stacked to a maximum height of three layers. There is little interlock between layers to provide lateral strength and stacked A-Jacks should not be used as a retaining structure. A 2-1 stack may be used if the back side is supported, typically by the bank or fill. If the stack is free standing, then the minimum width cross-section is a 4-2 stack.

Coverage

The placement density or coverage coefficient for A-Jacks relates the length of the unit to the area covered,

$$A = K_p L^2$$

in which A is the area covered by one A-Jack in the nested configuration, L is the A-Jacks length, and K_p is the coverage coefficient. For standard river A-Jacks[1] units in uniform placement is K_p = 0.25.

For 24 inch units, this means that the distance between A-Jacks in a row should be 12 inches and the distance between adjacent rows should be 12 inches. It is physically possible to place units more densely, especially if just one or two rows of units are placed. This note addresses 'over packing' during placement.

Single Row of A-Jacks

It is very easy to place a single row of A-Jacks at a higher density than one unit per 12 inches. Figures 1a and 1b show a single row of A-Jacks in the maximum achievable density and the recommended standard uniform density. In the figures Δx is the distance between units along the

[1] Standard river A-Jacks have a waist ratio of 1/6.5 and the most common length is 24 inches. The comments in this note are based on this size/type of A-Jacks unit.

row. The maximum density corresponds to 7.2 inches of separation. At this density, 67% more units are installed in the row than at standard density. For a separation of 9.0 inches, 33% more units are installed.

This dense, single row placement has been used on some A-Jacks projects. For a single row, the higher placement density has a somewhat higher stability. But this type of placement is generally not recommended because a double row has a much higher stability. This is discussed in the tech note, Lateral Load Capacity of Rows of A-Jacks. The relevant result is that two rows of A-Jacks are 4 to 8 times more stable against lateral loads than a single row. For this reason, two rows are recommended. This will result in an increase in the number of A-Jacks. To provide 100 feet of toe protection would require 167 units in single row, maximum density and 200 units in double row, standard density.

Multiple Rows of A-Jacks

It is more difficult to place a multiple rows of A-Jacks too densely because inserting the second row requires a separation in the first row. Figures 2a and 2b show the maximum achievable and the recommended placement densities for multiple rows. In the figures Δy is the distance between rows. The maximum placement density uses approximately 55% more units to cover and area than standard density.

The more dense placement is more stable. For two rows of A-Jacks that are hand placed, it is possible to obtain higher than standard densities in the field. But in applications with three or more rows, placing units in dense placement may be very difficult to obtain in the field. Stability studies have been based on standard placement density. Therefore, the standard placement is recommended.

Stacking

The percent of structural capacity consumed by self weight increases as the size of the unit increases. As a result, small river A-Jacks may be stacked, but large coastal units should not be stacked.

Adjacent layers of A-Jacks have less interlock in the vertical direction than they do in the horizontal plane. Stacked A-Jacks have a low lateral load capacity and should not be used as retaining walls. Stacked A-Jacks may be used to provide a greater vertical range of erosion control, particularly for toe stabilization projects. The stack height should not exceed three layers. If a higher structure is required, then larger units or an A-Jacks revetment-type design should be considered.

A 2-1 stack (2 rows on the bottom and 1 row on top) stack has been widely used (*ie.* Field Manual of Urban Stream Restoration). A 2-1 stack is shown in Figures 3a and 3b. The front view shows that the two visible lower legs on the top row are supported by the bottom layer. But the back view shows that the third leg is not fully supported. The 2-1 stack should only be used if the back side is supported. This support is typically provided by the bank or a fill. Willow posting the stack or using other woody plants can significantly increase stability.

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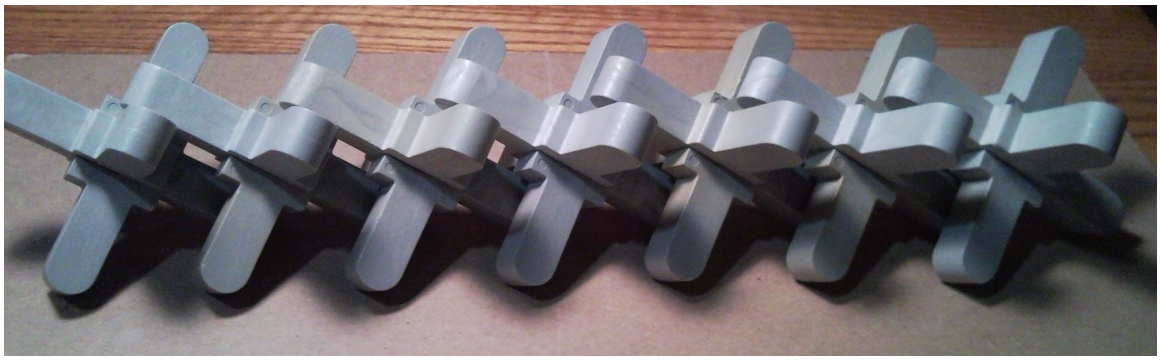
A 3-1 stack (3 rows on the bottom and 1 row on top) provides full vertical support for the top layer and some lateral support. Figure 4a shows a 3-1 stack. The placement and packing density of the top row just follow the bottom layer. However, as stated above, a double row is much more stable than a single row of A-Jacks. Therefore, a free standing 3-1 stack is not recommended. Figure 4b shows a 4-2 stack. This is the minimum tree standing cross-section for open channel applications. In the case of waves, the top layer must have a minimum width of three A-Jacks.

Max 1-dimensional packing
Δx/L = 0.3



Standard 1-dimensional packing
Δx/L = 0.5

Figures 1a and 1b Single row of A-Jacks in maximum and standard placement density.

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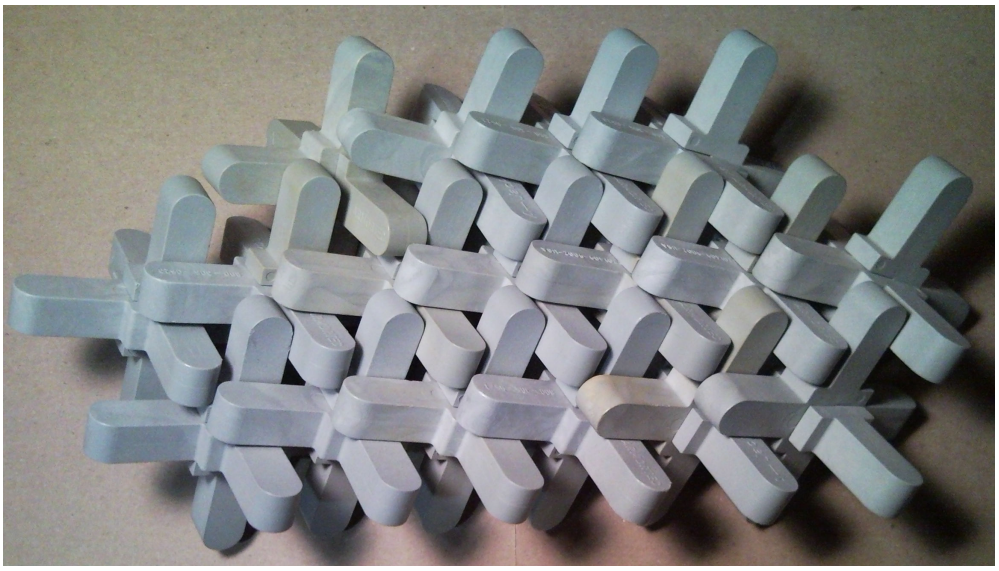
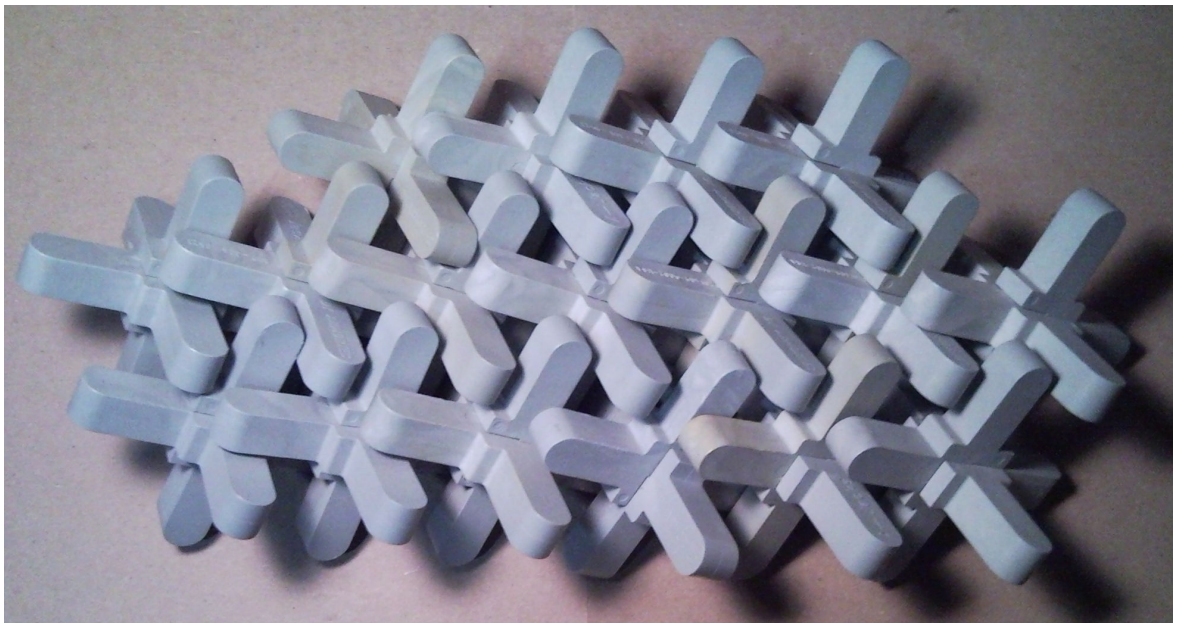


Max 2-dimensional packing
Δx/L = 0.4
Δy/L = 0.4



Standard 2-dimensional packing
Δx/L = 0.5
Δy/L = 0.5

Figures 2a and 2b Multiple rows of A-Jacks in maximum and standard placement density.

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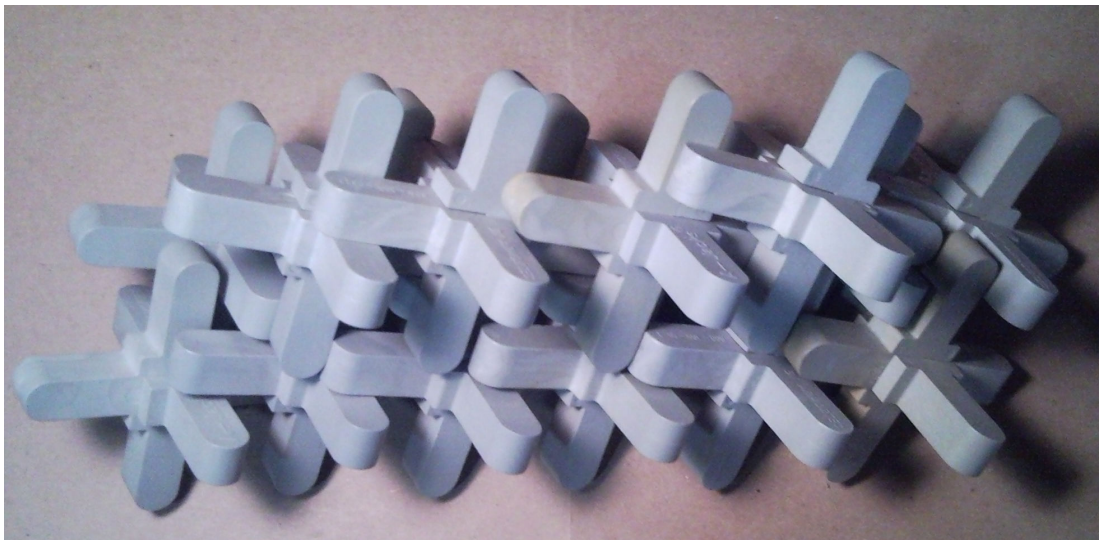
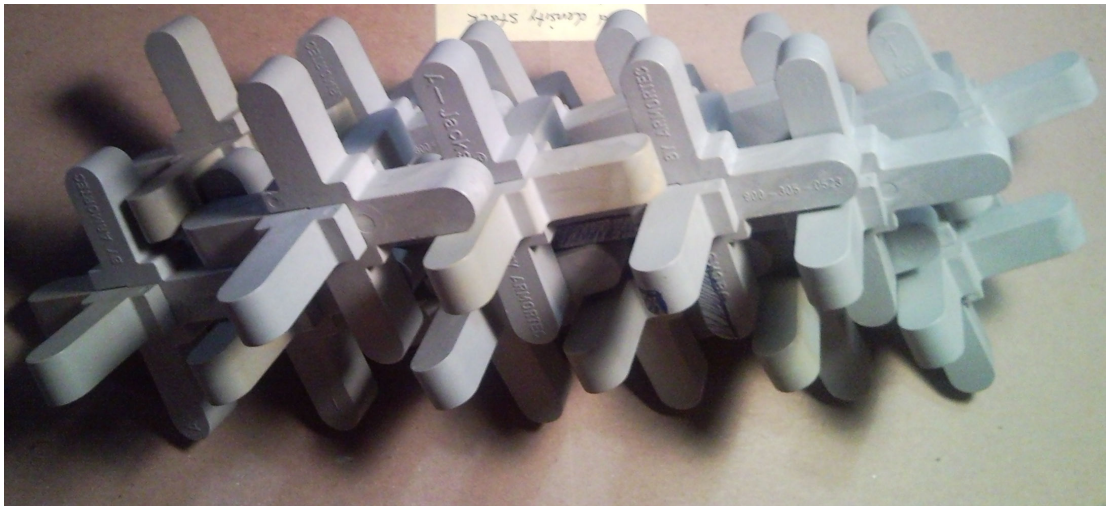


Standard density stack
2 base row



Figures 3a and 3b 2-1 stack front and back view.

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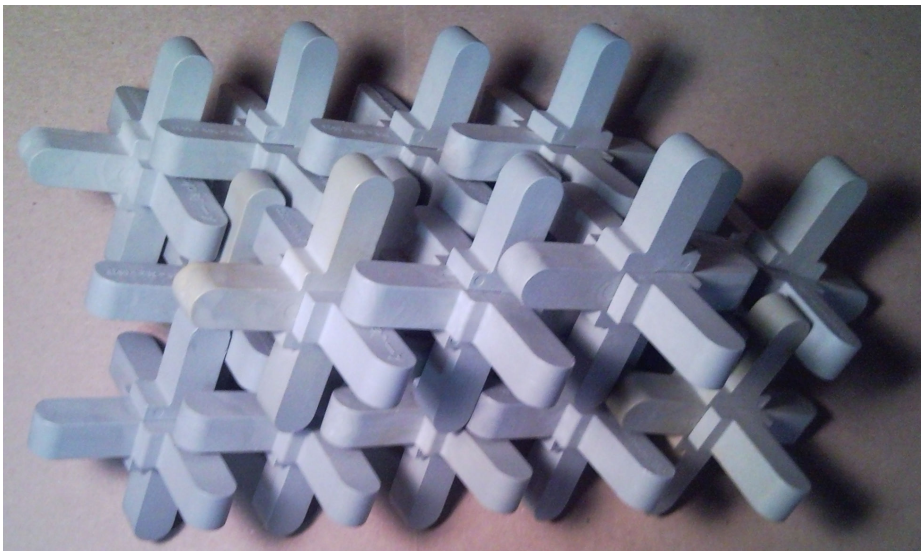
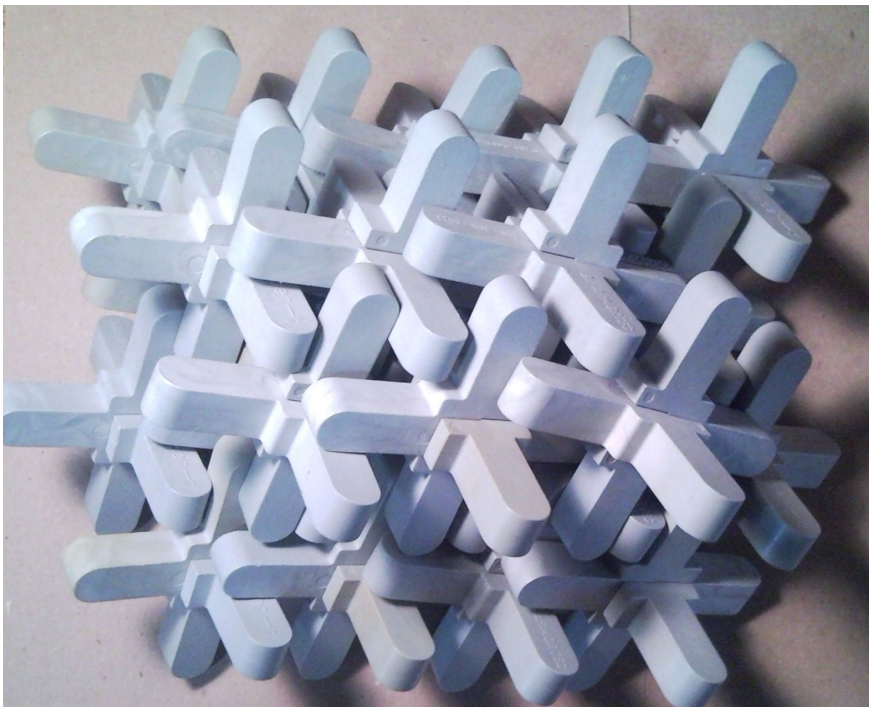


Standard density stack



4-2 standard density stack

Figures 4a and 4b 3-1 stack and 4-2 stack.