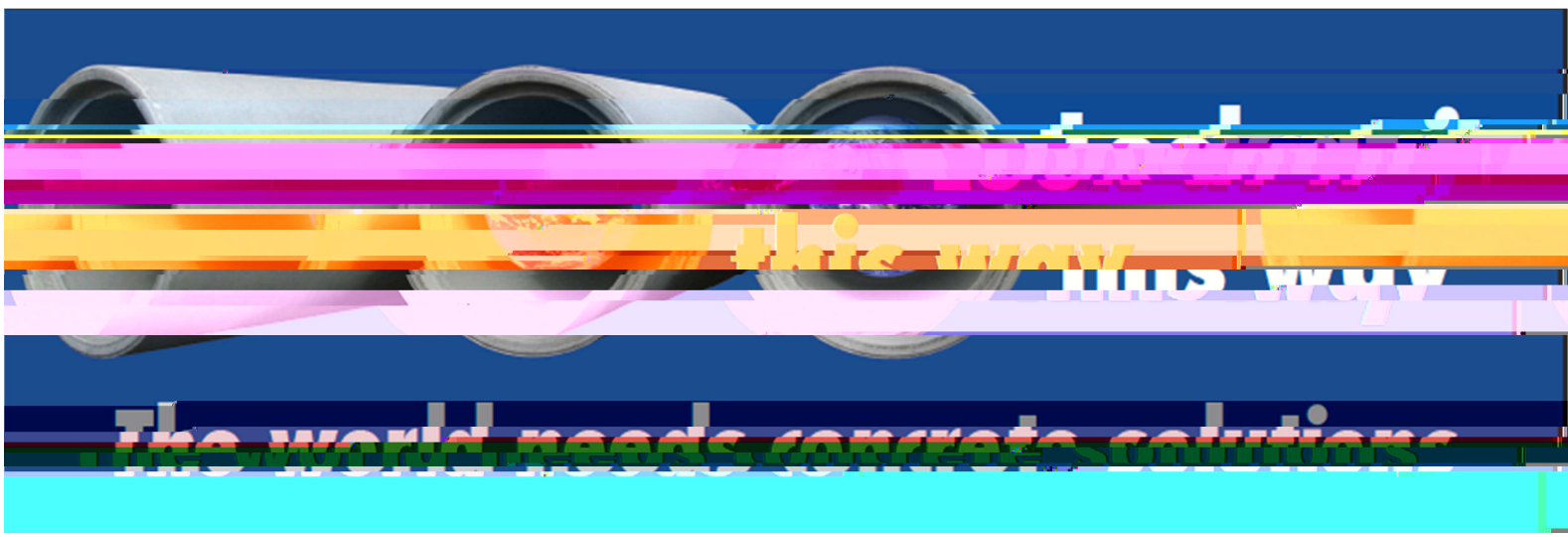




Indirect vs. Direct Design

When do Designers Need to Think Beyond Classed Pipe?

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Designers can opt between two design methods for Reinforced Concrete Pipe (RCP):

- Indirect Design
- Direct Design

This bulletin will discuss the appropriate applications for each of these methods to be used effectively. The most commonly used method is indirect design, in which the designer's goal is to determine the class of concrete pipe for the project. Each class represents a different load capacity with Class 1 being the lowest and Class 5 being the highest. The proof of design for indirect design is confirmed through three-edge bearing testing, which tests the pipe for strength. A service load (D-Load) is applied to the pipe, based on the dimensions and material properties of pipe manufactured according to ASTM C76. The pipe has passed the three edge bearing test when the D-Load value is reached and all visible cracks are smaller than 0.01 inches.

PipePac is a free software tool available online for indirect design of RCP. It allows designers to control inputs such as:

- Pipe Size
- Wall Thickness
- Soil Conditions
- Design/Manufacturing Standards
- Loading Conditions
- Depth of Cover
- Desired Installation Methods

The software outputs the required pipe class based on these parameters and is a great alternative to fill height tables. Use caution with fill height tables as they are designed to a

The indirect design method is the most commonly used design method for standard burial depths, but it only accounts for one mode of failure (flexure). What about shear and radial tension failures?

Direct design should be considered when the soil cover is so small that live loads are more significant or in deep burial applications. It is important to check other governing modes of failure for RCP with the following parameters:

- 1050mm diameter or larger
- Indirect design results of Class 4 or 5

Heavy vertical loads on large diameter pipe can cause the pipe to fail in diagonal or radial tension before it fails in flexure. Direct design uses Limit States Design to ensure the required steel area is appropriate to resist all other possible failure modes. The proof of design is not achieved through product testing but through the calculations of the factored loads in the design. PipeCar is the software of choice for direct design as it accounts for shear, radial tension, and flexural failures.

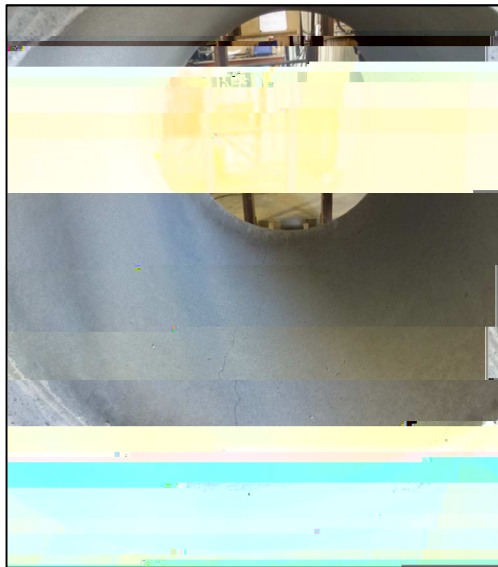


Figure 3 (left): Flexural Failure in Three-Edge Bearing Machine Test

Figure 4 (above): RCP Displaying Shear Failure

Below is a table summarizing the differences between the two design methods:

	ASTM C76	ASTM C1417
	ACPA Design Data 9	ASCE 15-98 or CHBDC
	Empirical	Limit States
	Pipe Class (1-5)	Design per Application
	Pipepac	Pipecar
	Three-Edge Bearing Test	In Design
	Flexure	Flexure, Diagonal Tension, Radial Tension

It is important to note that direct design can be more conservative in small diameter applications (pipe with an inner diameter less than 1050mm). Therefore, it is important to use indirect design to avoid additional expenses when classing small diameter pipe.

In closing, here are the steps to follow when determining which design method to use:

- 900mm diameter and smaller – Use indirect design
 - o Utilize PipePac software for design
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REFERENCES

1. ACPA,