

HYDRAULIC CAPACITY OF PRECAST CONCRETE BOXES

The hydraulic capacity of precast concrete box culverts is a key factor in determining the best application for this product. The hydraulic characteristics of boxes are similar to those for circular, arch and elliptical pipe. The Manning Formula is the most widely accepted method for evaluating the hydraulic capacity of non-pressure conduits.

MANNING FORMULA

$$Q = (1.486/n) * A * R^{2/3} * S^{1/2}$$

Q = Discharge, cfs

n = Manning's Roughness Coefficient

A = Cross-Sectional Area of Flow, sf

R = Hydraulic Radius, ft (equals the area of the flow divided by the wetted perimeter)

S = Slope of Conduit, ft/ft

It should be noted that in storm sewer design, for two conduits of similar materials but different shapes to be equal hydraulically, it is necessary for the factor $A * R^{2/3}$ to be equal for both shapes. A hydraulic comparison cannot be made based solely on cross sectional area of the conduit. The hydraulic capacity of the conduit is determined by multiplying this factor by $(1.486/n) * S^{1/2}$ which accounts for the surface roughness and slope. Commonly used n value for precast concrete products is 0.012. When determining the various values used in the Manning Formula, the Engineer must account for the effect of the corner haunches on the cross-sectional area and wetted perimeter.

The American Concrete Pipe Association (ACPA) has a number of Design Data's that cover in detail the hydraulic capacity of precast concrete boxes. These Design Data's cover full flow conditions, partial flow conditions and inlet and outlet control issues.

The attached chart is for various size boxes, assuming 12" haunches, listing the full flow and partial flow (0.7Ht) capacity for a slope of 0.005 Ft/Ft with a Manning's n of 0.012.

BOX HYDRAULIC FLOW

Box (Span x Rise)	Slope (Ft/Ft)	Area (Ft²)	Full flow (CFS)	0.7Ht Flow (CFS)
8'x4'	0.005	30	327.32	265.99
8'x6'	0.005	46	596.11	467.00
8'x8'	0.005	62	890.16	681.16
10'x4'	0.005	38	433.53	355.48
10'x6'	0.005	58	796.50	631.62
10'x8'	0.005	78	1199.57	930.02
12'x4'	0.005	46	541.21	447.03
12'x6'	0.005	70	1001.58	802.21
12'x8'	0.005	94	1519.09	1190.76
14'x4'	0.005	54	649.84	539.94
14'x6'	0.005	82	1209.78	977.01
14'x8'	0.005	110	1845.61	1460.19
16'x4'	0.005	62	759.09	633.82
16'x6'	0.005	94	1420.17	1154.89
16'x8'	0.005	126	2177.20	1736.19
18'x4'	0.005	70	868.79	729.39
18'x6'	0.005	106	1632.17	1335.08
18'x8'	0.005	142	2512.57	2017.28
20'x4'	0.005	78	978.82	823.48
20'x6'	0.005	118	1845.36	1517.06
20'x8'	0.005	158	2850.85	2302.40