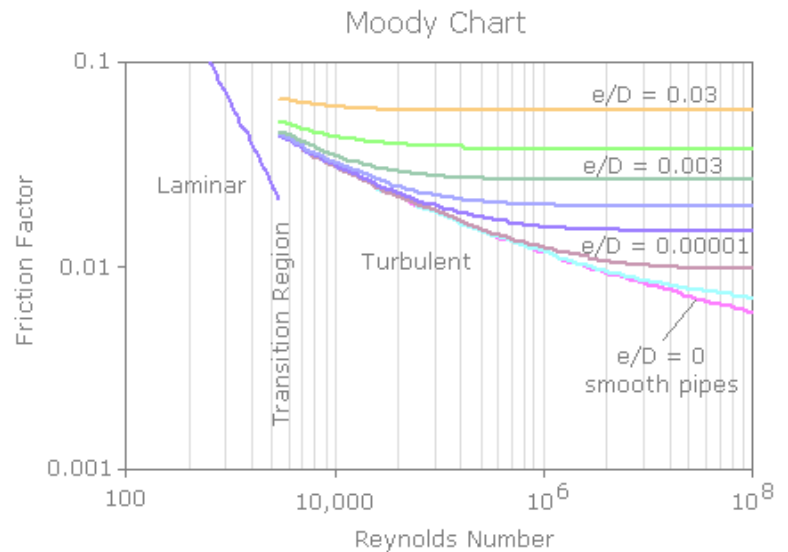


FTC-010

# Test Report

**Influence of the Tyfo® Fibrwrap® System on the Water Flow in a Retrofitted Concrete Pipe**

Report prepared by FTC  
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## Influence of the Tyfo® Fibrwrap® System on the Water Flow in a Retrofitted Concrete Pipe

Pipe wall friction will lead to a pressure drop in the pipe fluid flow, and adversely affect the flow rate ( $v$ ) / flow capacity. When water flows from point A to B in a relative straight pipe (no sharp bends) with a uniform diameter ( $D$ ), the pressure drop ( $P_B - P_A$ ), indicating the flow resistance, can be calculated with the following equation:

$$P_B - P_A = -\rho g \left( \Delta z + f \frac{L}{D} \frac{v^2}{2g} \right) \quad 1$$

where,  $\rho$  is water density (constant),  $g$  is the gravity acceleration constant,  $\Delta z$  is the change in pipe elevation,  $f$  is the pipe friction factor, and  $L$  is the length of the pipe. According to the above equation, for a determined pipe with fixed  $L$ ,  $D$  and  $\Delta z$ , the pressure drop is mainly dependent on the pipe friction factor,  $f$ .

Generally, the friction factor  $f$ , is dependent on the Reynolds Number ( $R = v \times D / \textit{kinematic Viscosity}$ ) of the pipe flow and the relative roughness  $e/D$  of the pipe wall, where  $e$  is the average size of the bump on the pipe wall. Table 1 presents the internal roughness of common pipe materials. As for a pipe rehabilitated with the Tyfo® Fibrwrap® System, the finished internal pipe surface with Tyfo® PWC is expected to have a roughness closed to PVC pipe,  $\sim 0.005$  mm (0.000197”).

Table 1: Internal roughness ( $e$ ) of common pipe materials.

Materials	$e$ (mm)	$e$ (inch)
Cast iron (Asphalt dipped)	0.1220 mm	0.004800”
Cast iron	0.4000 mm	0.001575”
<b>Concrete</b>	<b>0.3000 mm</b>	<b>0.011811”</b>
Copper	0.0015 mm	0.000059”
<b>PVC</b>	<b>0.0050 mm</b>	<b>0.000197”</b>
Steel	0.0450 mm	0.001811”
Steel (Galvanised)	0.1500 mm	0.005906”

See in: <http://knol.google.com/k/d-gardiner/how-to-calculate-pressure-drop-and/35e6sqhxsbdsg/2#>

It is worth noting that for the pipes used for water transportation with a relatively high diameter, the Reynolds Number is readily higher than 3000, indicating turbulent flow.

For laminar flow ( $R < 2000$  in pipes),  $f$  is independent of the friction factor:

$$f = \frac{64}{R} \quad 2$$

For turbulent flow ( $R > 3000$  in pipes),  $f$  can be determined from experimental curve fits with the following equation:

$$\frac{1}{\sqrt{f}} = -2 \log \left( \frac{\epsilon}{3.7D} + \frac{2.51}{R\sqrt{f}} \right) \quad 3$$

The solution of this equation plotted versus  $R$  make up the well-known Moody Chart for pipe flow (Figure 1).

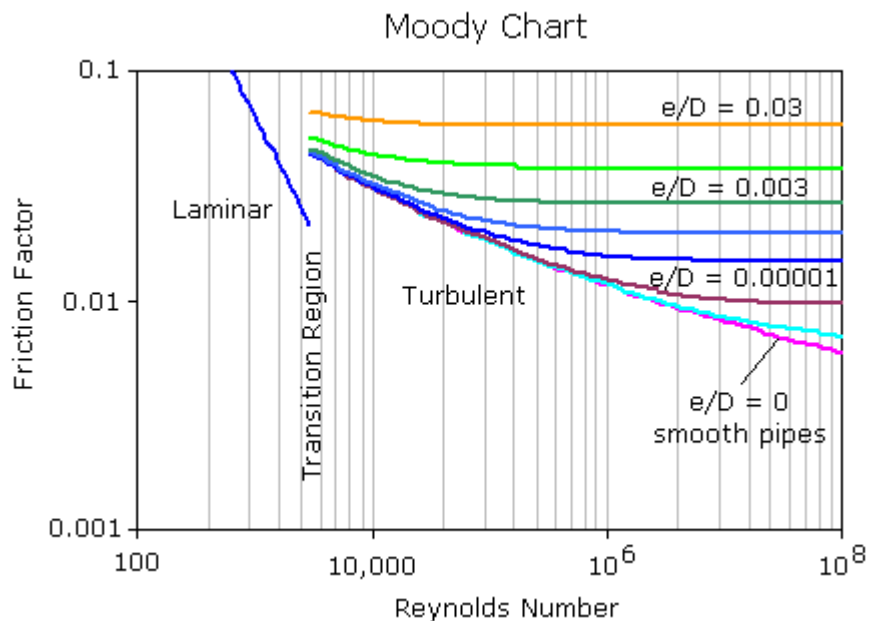


Figure 1: Moody Chart indicating the friction factor as a function of Reynolds Number. See in:

[http://www.efunda.com/formulae/fluids/calc\\_pipe\\_friction.cfm#friction](http://www.efunda.com/formulae/fluids/calc_pipe_friction.cfm#friction)

As shown in Figure 1, under a fixed Reynolds Number for turbulent flow, the friction factor increases with the roughness remarkably.

Compared to the concrete pipe, the surface of the Tyfo<sup>®</sup> Fibrwrap<sup>®</sup> System will have a much lower roughness (i.e., much smoother). Under the same flow conditions (i.e., the same Reynolds Number) in a pipe, the friction factor of the Tyfo<sup>®</sup> Fibrwrap<sup>®</sup> System repaired surface will be much lower than the original concrete surfaces. That is, the water flow in the retrofitted pipe with the Tyfo<sup>®</sup> Fibrwrap<sup>®</sup> System will have a lower resistance.

### **Remarks**

The typical thickness of the Tyfo<sup>®</sup> Fibrwrap<sup>®</sup> System applied to retrofit an existing concrete pipe is less than 0.25 inch. Due to the smoother internal surface (lower roughness) of the pipe retrofitted with the Tyfo<sup>®</sup> Fibrwrap<sup>®</sup> System, the flow friction will be reduced remarkably. Consequently, the flow capacity of the retrofitted pipe will be enhanced rather than reduced compared to the original concrete pipe.