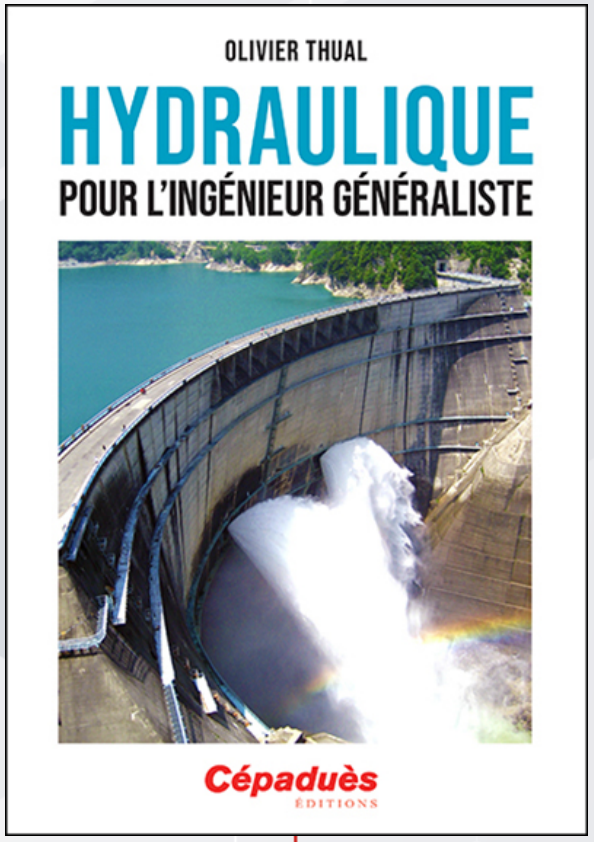
Dans le cadre de la
Formation « Hydraulique Fondamentale »
Unité de Formation pour la Performance Industrielle

EDF

en collaboration avec l'INP-ENSEEIHT



Olivier THUAL
Toulouse INP
ENSEEIHT

INP TOULOUSE ENSEEIHT

Chapitre 3
Pertes de charge

Contrainte pariétale

$$\frac{dH}{ds} = -S_f = -\frac{\Phi_f}{\rho\, g}$$

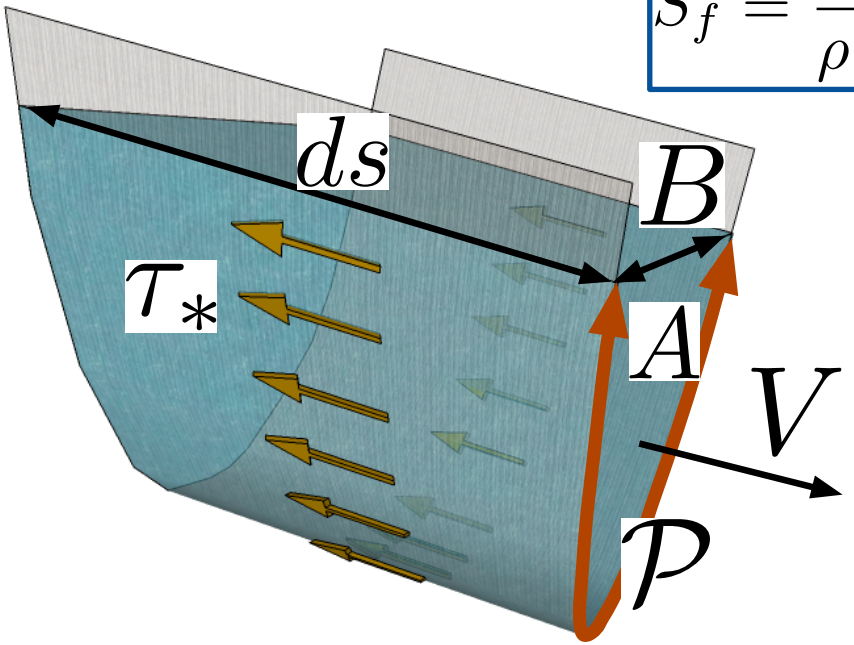
$$\tau_* \,\mathcal{P}\, ds = \Phi_f \, A \, ds \iff \tau_* = \Phi_f \, R_H$$

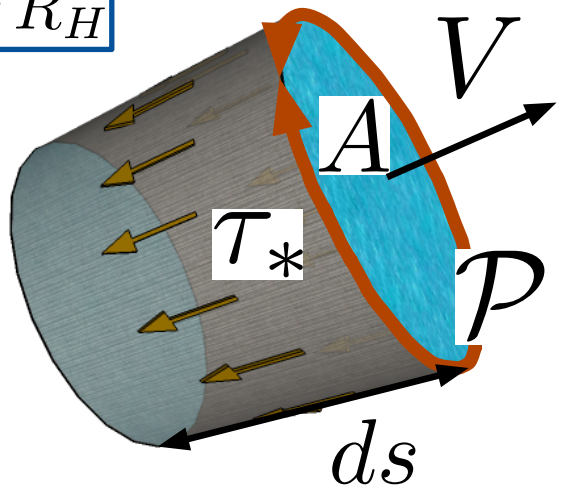
$$\tau_* = \rho\, g \, R_H \, S_f$$

$$S_f = \frac{\tau_*}{\rho\, g \, R_H}$$

Rayon hydraulique :

$$R_H = \frac{A}{\mathcal{P}}$$

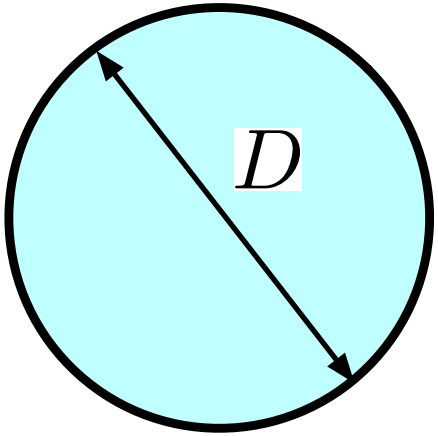


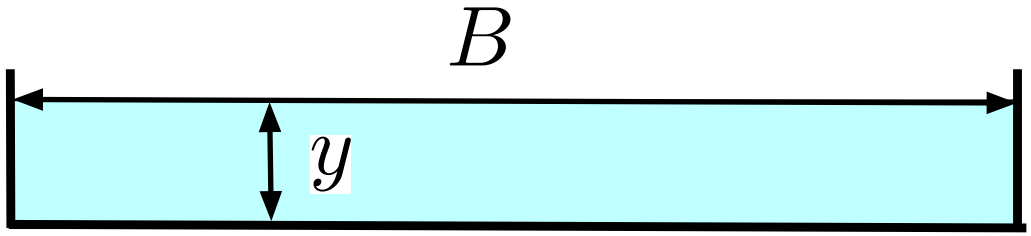


Rayon et diamètre hydrauliques

$$R_H = \frac{A}{\mathcal{P}}$$

$$D_H = 4\,R_H$$

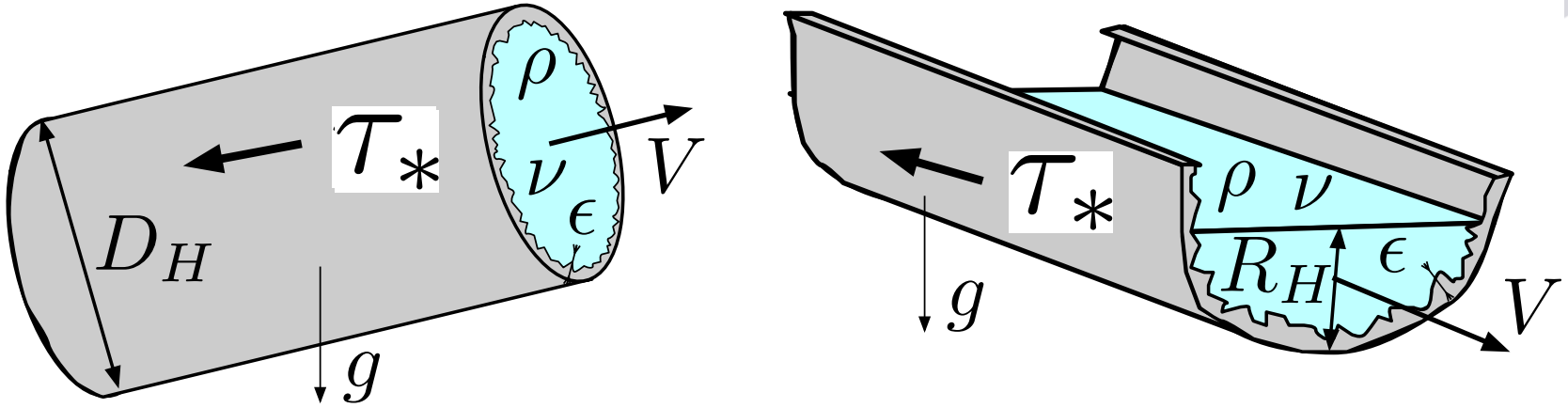




$$D_H = D$$

$$R_H = y \quad \text{si} \quad y \ll B$$

Coefficient de frottement



Cinq paramètres : $(\epsilon,\ D_H,\ V,\ \nu,\ g)$

Deux unités : $(\mathrm{m},\ \mathrm{s})$

Rugosité relative — Nombre de Reynolds — Nombre de Froude

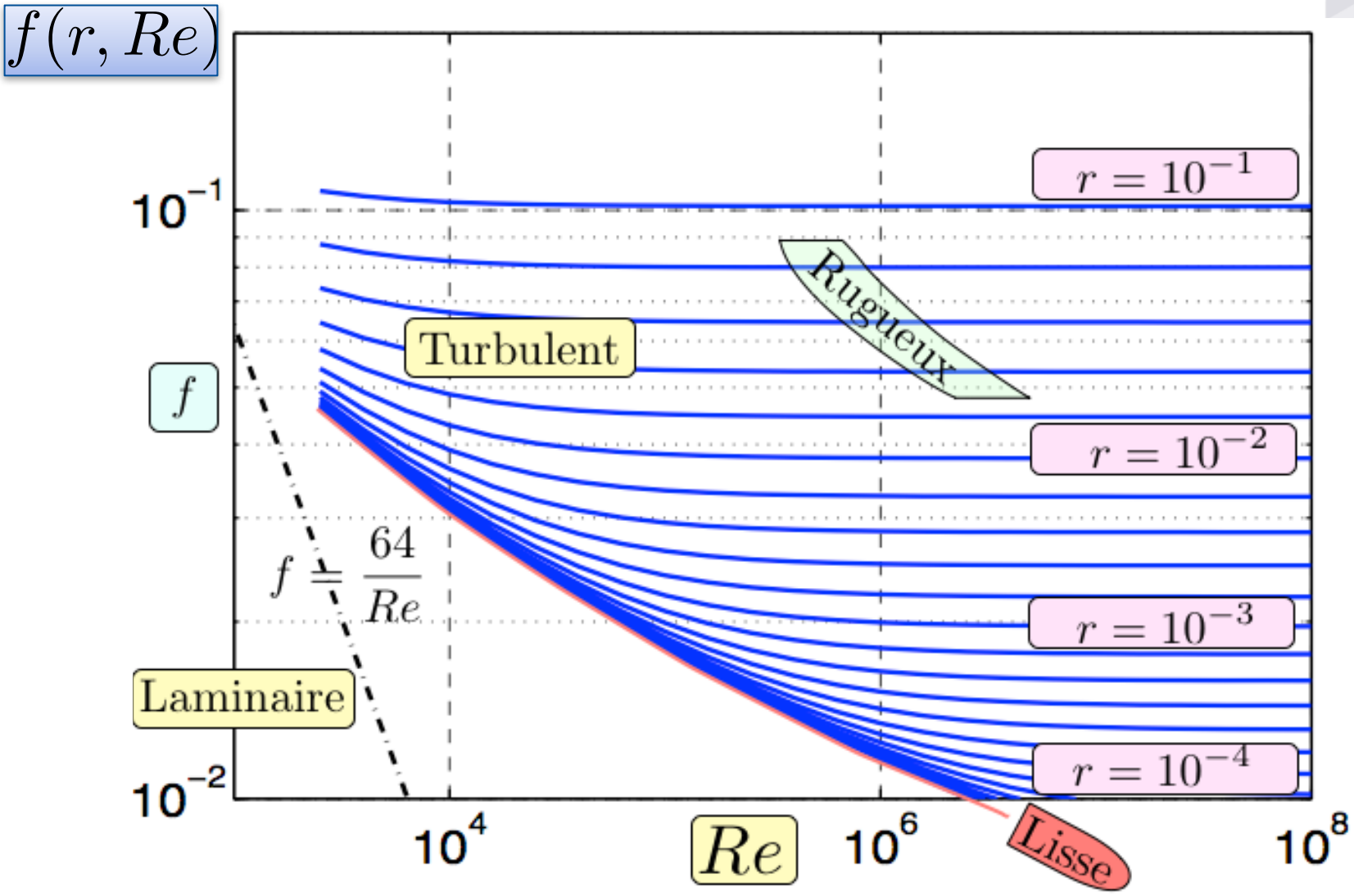
Trois nombres sans dimension :

$$\left(r = \frac{\epsilon}{D_H},\quad Re = \frac{V\,D_H}{\nu},\quad Fr = \frac{2\,V}{\sqrt{g\,D_H}} \right)$$

La contrainte pariétale ne dépend pas de la gravité :

$$\tau_* = \frac{1}{8}\, f(r, Re)\, \rho\, V^2$$

Diagramme de Moody

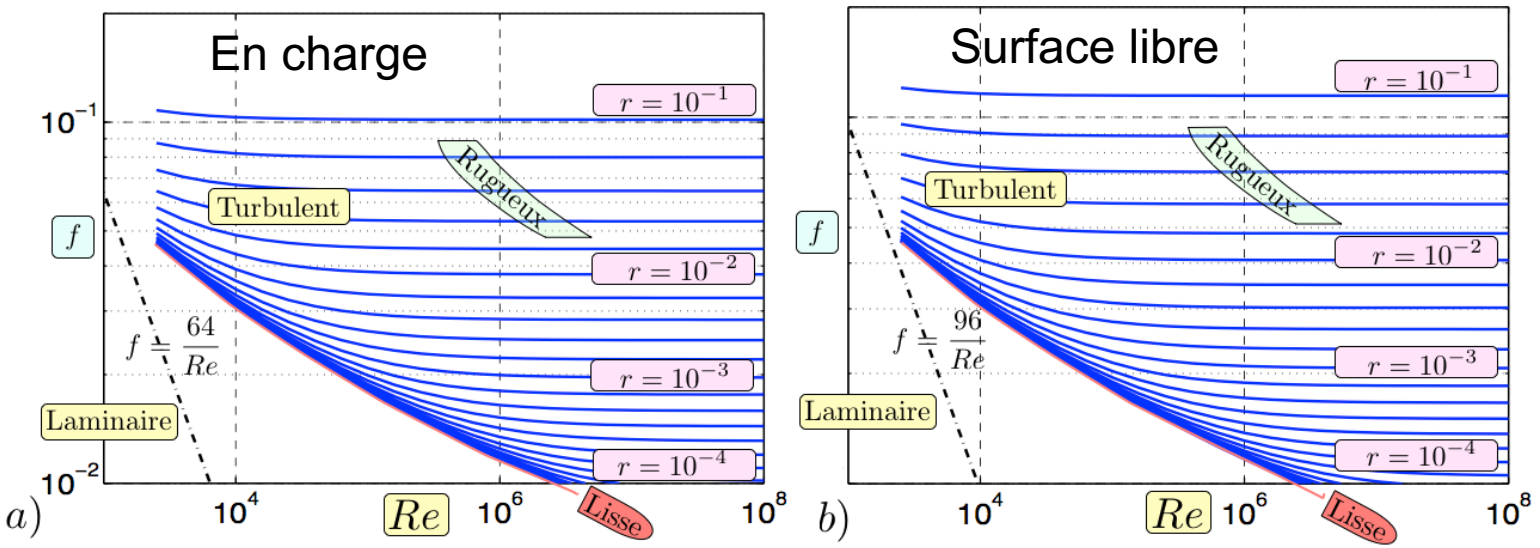


Relation de Darcy-Weisbach

$$\frac{dH}{ds} = -S_f \;,\quad S_f = \frac{\tau_*}{\rho\, g\, R_H} \;,\quad D_H = 4\, R_H \quad \text{et} \quad \tau_* = \frac{1}{8}\, f(r, Re)\, \rho\, V^2$$

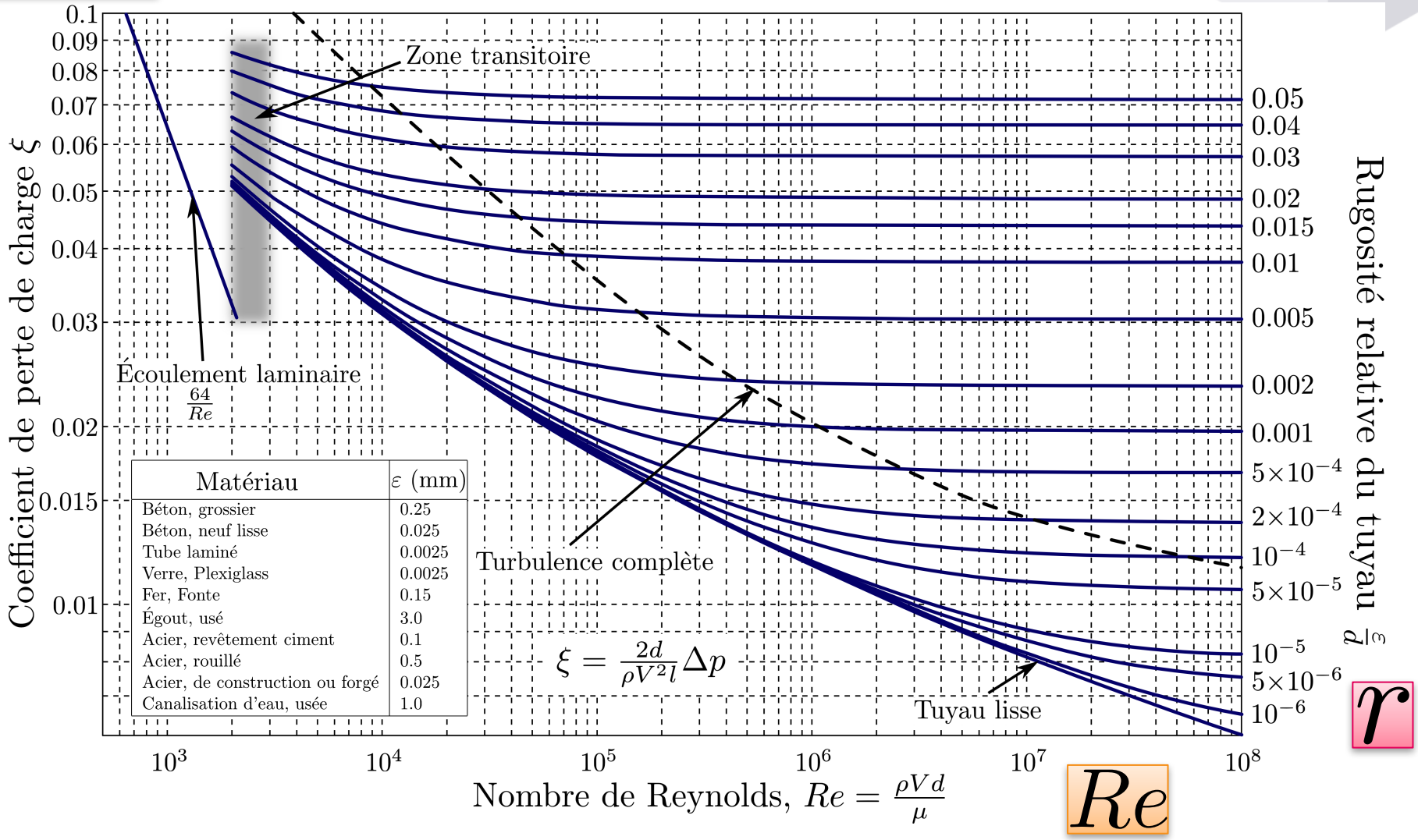
$$\Downarrow$$

$$-\frac{dH}{ds} = S_f = f(r, Re)\, \frac{V^2}{2\, g\, D_H} \quad \text{avec} \quad r = \frac{\epsilon}{D_H} \quad \text{et} \quad Re = \frac{V\, D_H}{\nu}$$



Conduites circulaires

$f(r, Re)$

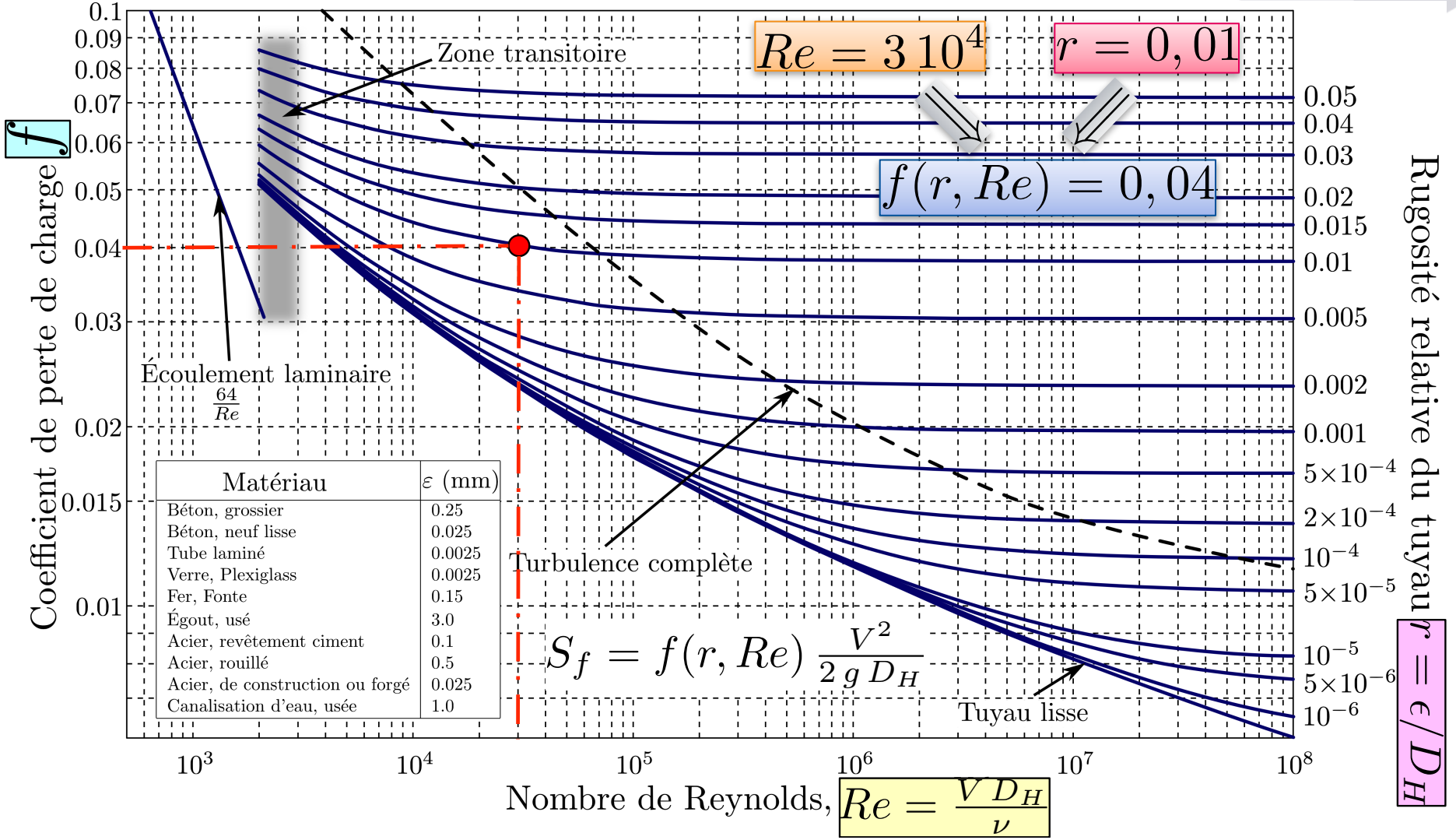


Matériau	ε (mm)
Béton, grossier	0.25
Béton, neuf lisse	0.025
Tube laminé	0.0025
Verre, Plexiglass	0.0025
Fer, Fonte	0.15
Égout, usé	3.0
Acier, revêtement ciment	0.1
Acier, rouillé	0.5
Acier, de construction ou forgé	0.025
Canalisation d'eau, usée	1.0

r

Re

Lecture du diagramme



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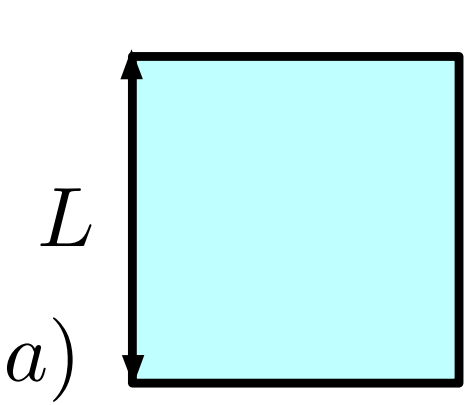
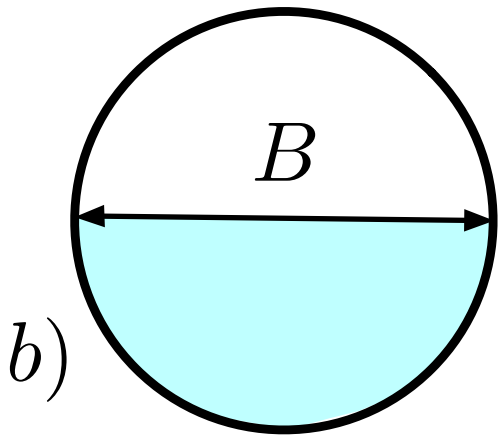
Rayon et diamètre hydrauliques

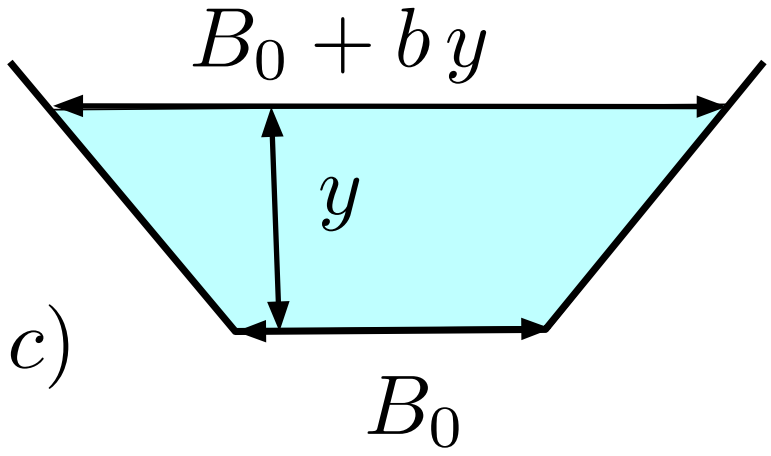
$$R_H = \frac{A}{\mathcal{P}} \qquad D_H = 4\,R_H$$



$$D_H = L \qquad R_H = L/4$$



$$D_H = B \qquad R_H = B/4$$



$$R_H = y\,\frac{1 + b\,\frac{\xi}{2}}{1 + 2\,\xi\sqrt{1 + \frac{b^2}{4}}}$$

avec $\xi = \dfrac{y}{B_0}$