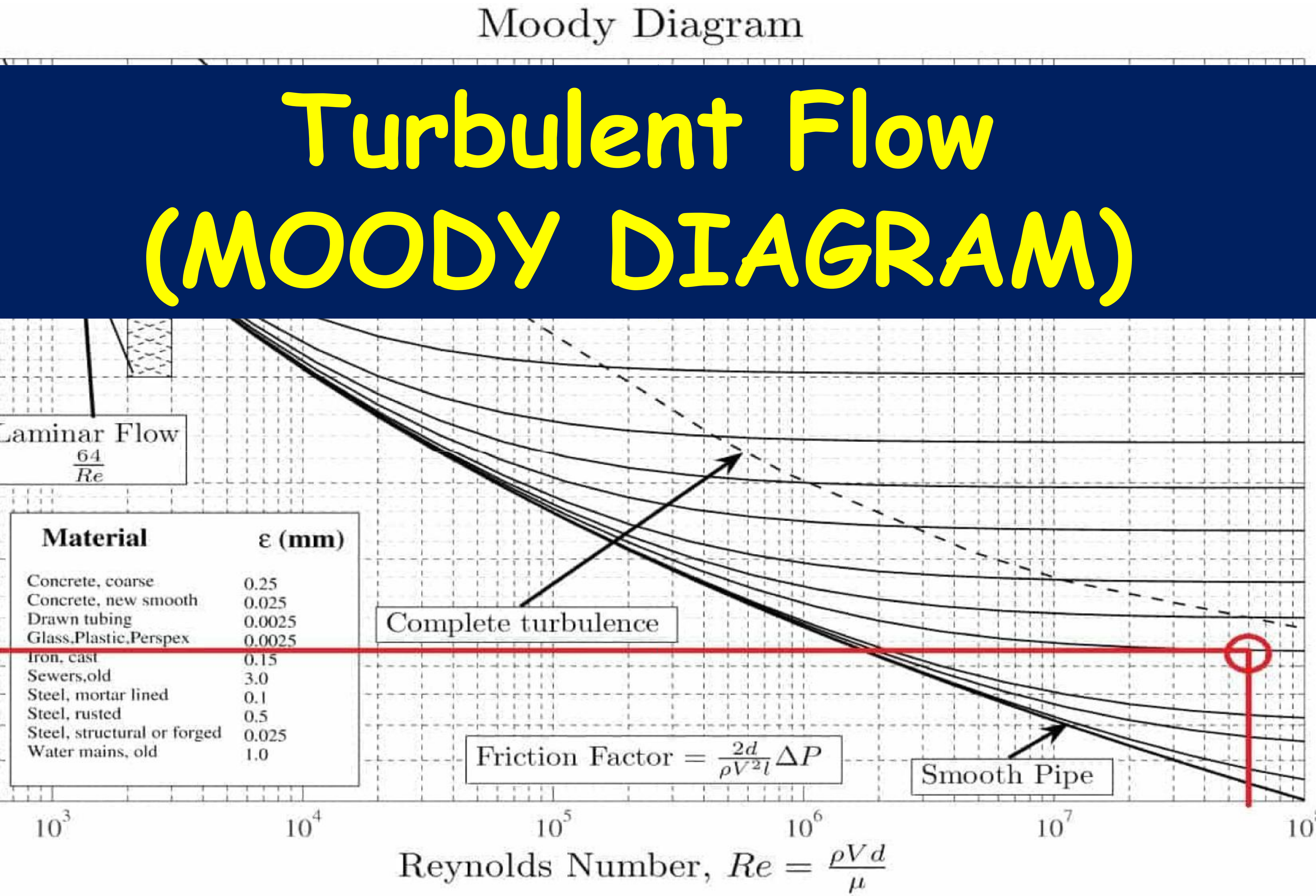
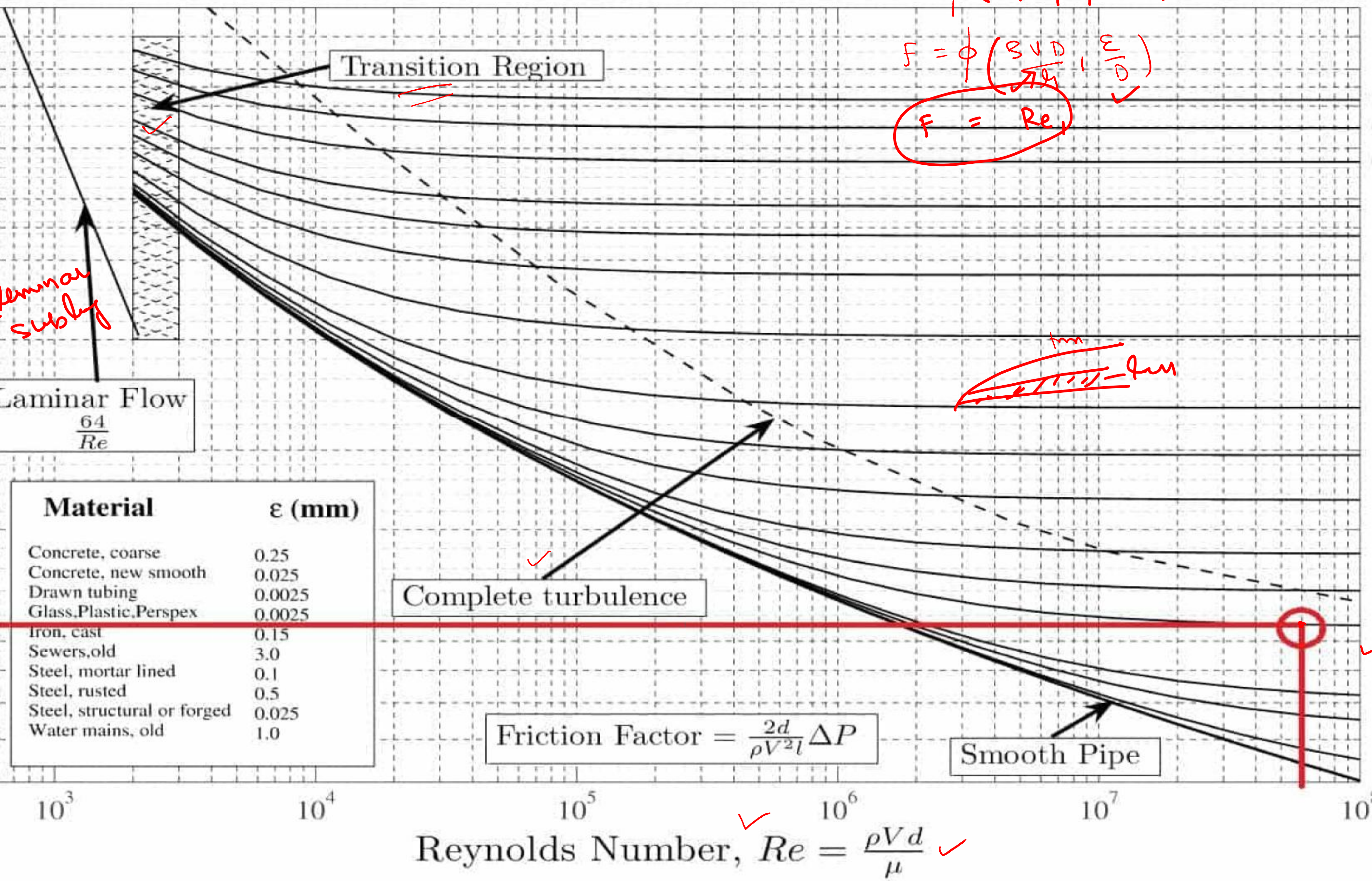
Turbulent Flow (MOODY DIAGRAM)



Moody Diagram



MOODY DIAGRAM

is Very useful in Practical World

$f \rightarrow \varepsilon/d, Re$

ecause we can find the value of Friction co-efficient for the given eynolds's Number and for the relative roughness of the smooth or rough pes

MOODY DIAGRAM

s made by Moody and Nikuradse

ney have performed lots of practical and then draw a graph for the three
lated criteria.

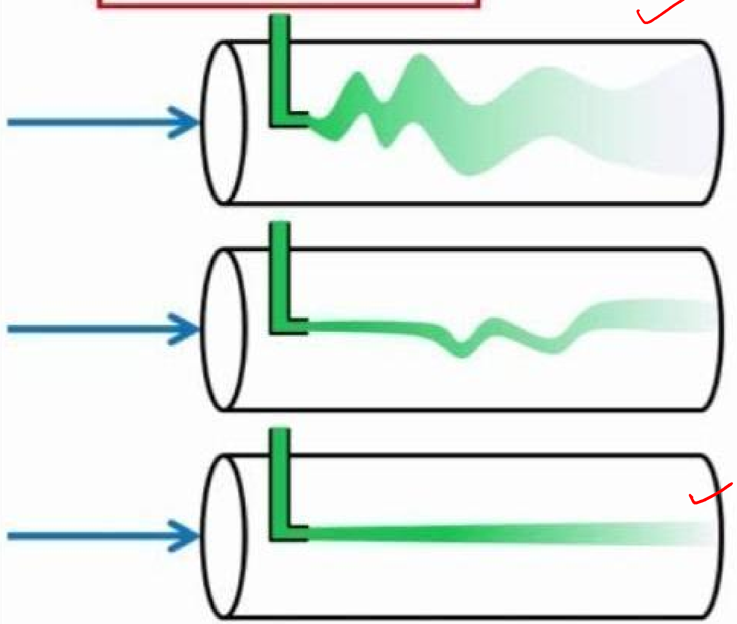
Ieans this is made by three axis.

eft Vertical axis represents friction coefficient (f)
Iorizontal axis represents Reynolds's Number (Re)
ight Vertical axis represents Relative roughness (ϵ/D)

Ieans It gives the value of f against the Re for the value of ϵ/D .

Turbulent Flow, Transition Flow & Laminar Flow

$$Re = \frac{\rho V_{avg} D}{\mu}$$



$Re > 4000$
turbulent (unpredictable, rapid mixing)

$2000 < Re < 4000$
transitional (turbulent outbursts)

$Re < 2000$
laminar (predictable, slow mixing)

om Darcy-Weisback Formula and for turbulent flow

$$h_f = \frac{C_f l V^2}{2gD}$$

$$h_f = \frac{4 f l v^2}{2gD}$$

Roughness of pipe = ϵ

Diameter of pipe = D

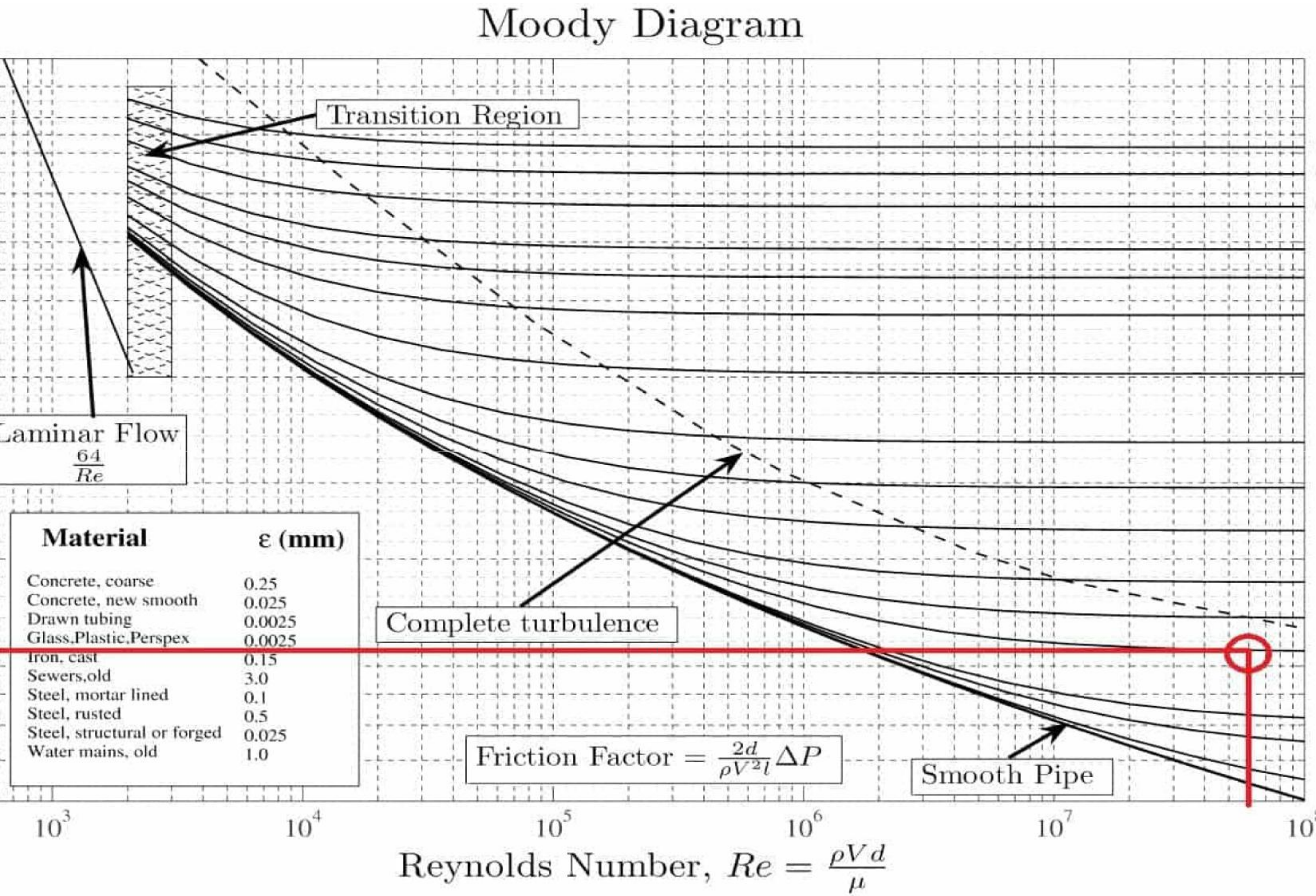
Relative Roughness of pipe = ϵ/D

Laminar Flow: $$f = \frac{64}{Re}$$

Smooth Pipe Turbulent Flow: $$f = \frac{0.316}{Re^{1/4}}$$

Completely Turbulent Flow: $$f = \left[1.14 + 2\log_{10}\left(\frac{D}{\varepsilon}\right)\right]^{-2}$$

Transition Region: $$f = \left\{-2\log_{10}\left[\frac{(\varepsilon/D)}{3.7} + \frac{2.51}{Re\,(f^{1/2})}\right]\right\}^{-2}$$



Moody Diagram
Transition Region
Laminar Flow
$\frac{64}{Re}$
Material
ε (mm)
Concrete, coarse 0.25
Concrete, new smooth 0.025
Drawn tubing 0.0025
Glass,Plastic,Perspex 0.0025
Iron, cast 0.15
Sewers,old 3.0
Steel, mortar lined 0.1
Steel, rusted 0.5
Steel, structural or forged 0.025
Water mains, old 1.0
Complete turbulence
Friction Factor = $\frac{2d}{\rho V^2 l}\Delta P$
Smooth Pipe
10^3
10^4
10^5
10^6
10^7
Reynolds Number, $Re = \frac{\rho V d}{\mu}$

Application of MOODY DIAGRAM

o find out value of Friction co-efficient – f

o find out the value of head loss h_f

o find out the value of Discharge – Q

o find out the diameter of pipe - D

pe of 30 cm in diameter and 500m long is carrying oil having sp. gravity
viscosity 0.08 poise. The oil flow rate is 120 litre per second. Calculate
n the pipe and power required to maintain the flow.
me f=0.079(Re)^1/4

$h_f = \frac{4flv^2}{2gD}$

ven Data

30×10^{-2} m

500 m

$= 0.9$

900 kg/m^3

$0.08 = 0.008$ N.s/m^2

120 lit/sec

120×10^{-3} m^3/sec

$.079(Re)^{1/4}$

$Q = AV$

$\text{Velocity of oil} = \frac{Q}{A} = \frac{120 \times 10^{-3}}{\pi/4 \times (30 \times 10^{-2})^2} = 1.6976 \text{ m/sec}$

$Re = \frac{\rho V D}{\mu} = \frac{900 \times 1.6976 \times 30 \times 10^{-2}}{0.008} = 57,295.78$

$f = 0.079 \times (Re)^{1/4} = 0.079 \times (57,295.78)^{1/4} = 0.005$

$h_f = \frac{4flv^2}{2gD} = \frac{4 \times 0.0051 \times 500 \times (1.69)^2}{2 \times 9.81 \times 30 \times 10^{-2}} = 5 \text{ m of oil}$

$P = \frac{\rho g h}{1000} \text{ kW} = \frac{900 \times 120 \times 10^{-3} \times 9.81 \times 5}{1000} = 5.2974 \text{ kW}$

ter Tank 4 km away from college hostel. Water supplies 150 litres per d
tudent. The strength of student in hostel is 1000. the total water required
ped into the tank in night time for 6 hours. Calculate the diameter of pip
head loss is limited to 25 m. Assume f=0.0018

Data

km $= 4 \times 10^{3}$ m

25 m

0.0018

student = 1000

= 150 lit/student

6 hr

$Q = 150$ lit/student

$= 150 \times 1000$ lit

$= \frac{150 \times 1000}{6}$ lit/hr

$= \frac{150 \times 10^{3} \times 10^{-3}}{6 \times 3600}$ m³/s

$Q = 0.006944$ m³/sec

$V = \frac{Q}{A} = \frac{0.006944}{\pi/4\, D^2} = \frac{0.008842}{D^2}$ m/sec

$h_f = 25$ m

$h_f = \frac{4 f l v^2}{2 g D}$

$25 = \frac{4 \times 0.0018 \times 4 \times 10^{3} \times (\ldots}{2 \times 9.81 \times D}$

$25 = 1.1476 \times 10^{-4} \times \frac{1}{D^5}$

$D^5 = 4.59 \times 10^{-6}$

$D = 0.085579$ m

D = 8.56 cm