

# CHAPTER III

Civil Engineering, Hydraulic Engineering, and Public Works

# Civil Engineering



# Definition of Civil Engineering

- ❖ Civil engineering is a branch of engineering concerned with the planning, design, construction, and management of structures and infrastructure that support modern society. This includes a broad spectrum of projects ranging from transportation systems like roads, bridges, and railways, to water-related infrastructure such as canals, dams, and sewage systems .[1]
- ❖ Civil engineers also contribute to the creation and maintenance of airports, pipelines, and the structural elements of buildings. Essentially, civil engineering is pivotal in ensuring the functionality, safety, and sustainability of the physical environment in which we live and work.[2]



Tennessee Valley Authority civil engineers monitoring hydraulics of a Tellico Dam scale model.

# Civil engineering profession

## History of structural engineering:

- In 1818, Louis Vicat developed the theory of hydraulicity, which specifies the proportions of the various components necessary for the formation of artificial cement during the firing process.[3]
- In 1824, the Scotsman Joseph Aspdin patented Portland Cement.
- In France, a graduate of the École Polytechnique, Pavin de Lafarge, installed lime kilns in Teil (France) in 1833, and the first cement plant was created by Dupont and Demarle in Boulogne-sur-Mer (France) in 1848.
- Thus, in the mid-19th century, the material conditions were met for the invention of concrete and then reinforced concrete.[4]



A Roman aqueduct [built C. 19 BC], Pont du Gard, France



Chichen Itza was a large pre-Columbian city in Mexico built by the Maya people of the Post Classic

# Sub-disciplines التخصصات الفرعية

Civil engineering is divided into:

- 1. Construction Engineering:** Specializes in designing and constructing metal, concrete, and wooden structures, both residential and industrial.
- 2. Transportation Engineering:** Specializes in designing and constructing roads, transportation systems, and traffic engineering.
- 3. Surveying and Geomatics Engineering:** Focuses on studying spatial dimensions and engineering geographic locations.
- 4. Fluid Mechanics Engineering:** Studies the properties of fluids and their impact on structures, such as wind effects on buildings or water pressure on dams, among others.
- 5. Sanitary Engineering:** Designs and operates sewage systems and water treatment plants.
- 6. Irrigation Engineering:** Studies methods of controlling various irrigation types and agricultural water structures.

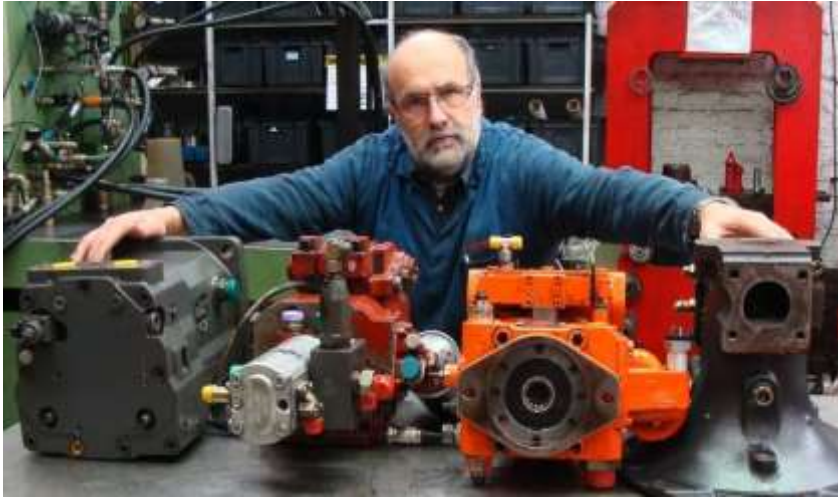
- 7. Geotechnical Engineering:** Studies the chemical, physical, and mechanical properties of soil and rocks, as well as their techniques. Also involves designing foundations, tunnels, and underground structures, known as "soil mechanics" or "geotechnics."
- 8. Construction Management Engineering:** Focuses on quantity surveying, executing structures with minimal cost and time, and managing construction sites.
- 9. Dams and Water Resources Engineering:** Specializes in designing water structures, infrastructure, foundations, and hydraulic designs.
- 10. Coastal and Marine Engineering:** Focuses on designing and constructing ports, marine structures such as piers and breakwaters, and shoreline protection measures.

# Professions of Civil Engineer

A civil engineer is responsible for developing structural designs for architectural plans that adhere to international standards applicable in that country and overseeing their on-site implementation. They work as:

- Structural Design Engineer. مهندس تصاميم إنشائية
- Performing cost estimation and calculations. القيام بالحسابات التقديرية والتكلفة
- Site Engineer. مهندس تنفيذ
- Construction Site Manager. مدير موقع بناء
- Water Engineer. مهندس مياه
- Roads and Bridges Engineer. مهندس طرق وجسور
- Infrastructure Engineer. مهندس البنية التحتية
- Project Management. إدارة المشاريع
- Calculating loads on buildings and bridges. حسابات الحمولات على الأبنية والجسور
- Quality Control Engineer. مهندس ضبط الجودة
- Safety Engineer at construction sites. مهندس ضبط السلامة في مواقع الإنشاء
- Blast Engineer. مهندس تفجير

# Hydraulic Engineering





# Definition of Hydraulic Engineering

- ❖ Hydraulic engineering is a sub-discipline of civil engineering that deals with the flow and transport of fluids, particularly water and sewage. Gravity is widely utilized in this field as the driving force for fluid movement. This discipline is closely associated with the design of bridges, dams, and channels, as well as with sanitary and environmental engineering.
- ❖ Hydraulic engineering involves applying principles of fluid mechanics to issues related to the collection, storage, transportation, regulation, measurement, and utilization of water.[5]

## History

Hydraulics is one of the oldest activities of human civilization.

- Sanitation canals in the Nile Valley, 4,000 years before the Christian era.
- Wooden water wheel, Hama in Syria.
- Pascal (1623-1662): Theory of Hydrostatics
- Daniel Bernoulli (1700-1782): Bernoulli's theorem
- Some of the key founders of modern hydraulics: Leonhard Euler (1707-1783), Louis de Lagrange (1736-1813), Jean-Louis Marie Poiseuille (1799-1869), Adhémar Barré de Saint-Venant (1797-1886), William Froude (1818-1879), Henri Navier (1785-1836), Joseph Boussinesq (1842-1929), Osborne Reynolds (1842-1912).

# Definitions and Quantities: Pressure and Flow

**Hydrostatics** is defined as the branch of hydraulics that studies the properties of **fluids at rest**.

➤ Its field of application relates to the transmission of pressures according to Pascal's principle.

➤ **Hydrodynamics** is defined as the branch of hydraulics that studies the properties of **fluids in motion**. Its field of application relates to flow and pressure.

*In a hydraulic transmission:*

- Pressure exists in a circuit only if there is resistance to the flow of oil.
- Pressure is the mechanical equivalent of force.
- Flow rate is the equivalent of velocity.

# Darcy's Law

Incompressible fluid flowing in steady-state through a porous medium of cross-sectional area  $A$  and length  $L$  under the effect of a head difference  $\Delta H$ .

□ Formulated by Henry Darcy in 1856, it is expressed as:

$$Q = KA \frac{\Delta H}{L}$$

avec :

- $Q$  : le débit volumique ( $\text{m}^3/\text{s}$ ) filtrant.
- $K$  : la **conductivité hydraulique** ou « coefficient de perméabilité » du milieu poreux ( $\text{m/s}$ ), qui dépend à la fois des propriétés du milieu poreux et de la **viscosité** du fluide.
- $A$  : la surface de la section étudiée ( $\text{m}^2$ )
- $\frac{\Delta H}{L}$  : Le gradient hydraulique ( $i = \Delta H/L$ ), où  $\Delta H$  est la différence des hauteurs **piézométriques** en amont et en aval de l'échantillon,  $L$  est la longueur de l'échantillon.

# Hydraulic conductivity or permeability coefficient

Hydraulic conductivity ( $K$ ) is a measure that expresses the ability of a porous medium to allow fluid to pass under the influence of a pressure gradient.

$$K = \frac{k \cdot \rho \cdot g}{\mu}$$

avec :

- $k$  : la **perméabilité intrinsèque** du milieu poreux ( $\text{m}^2$ ),
- $\rho$  : la **masse volumique** du fluide ( $\text{kg}/\text{m}^3$ ),
- $g$  : l'**accélération de la pesanteur** ( $\text{m}/\text{s}^2$ ),
- $\mu$  : la **viscosité dynamique** du fluide.

# Role of the Hydraulic Engineer دور المهندس الهيدروليكي

- Ensures the operation and maintenance of hydraulic installations يكفل تشغيل وصيانة المنشآت الهيدروليكية
- Conducts control visits on equipment القيام بزيارات مراقبة للمعدات
- Monitors civil engineering works يرصد أعمال الهندسة المدنية
- Prepares and carries out all operational maneuvers and optimizes the availability of installations إعداد وتنفيذ جميع المناورات التشغيلية وتحقيق التوافر الأمثل للمنشآت
- Ensures the safety of people and property, taking into account environmental constraints. يضمن سلامة الناس والممتلكات، مع مراعاة القيود البيئية
- Is responsible for quality and safety in his field of activity. مسؤول عن الجودة والسلامة في مجال نشاطه.
- Has technical and financial responsibility for the operations he undertakes. مسؤول تقنيا وماليا عن العمليات التي يقوم بها

# Advantages of hydraulic systems

Hydraulic systems offer numerous advantages and notably allow for:

- Transmission of high forces and torques; نقل القوى العالية وعزم الدوران ؛
- Great flexibility of use across various domains; مرونة كبيرة في الاستخدام في مختلف المجالات
- Excellent speed control of actuators due to the incompressibility of the fluid; التحكم الممتاز في سرعة المشغلات بسبب عدم قابلية السائل للضغط
- Precise control of speeds and developed forces; التحكم الدقيق في السرعات والقوات المتطورة
- Ability to start installations under load; القدرة على بدء التركيبات تحت التحميل
- Long lifespan of components due to the presence of oil. طول عمر المكونات بسبب وجود النفط.

# Disadvantages of hydraulic systems

Hydraulic systems also have disadvantages:

- More complex installation compared to pneumatic systems; تركيب أكثر تعقيدا مقارنة بالأنظمة الهوائية
- Need to return fluid to the reservoir; الحاجة إلى إعادة السوائل إلى الخزان
- Risks of accidents due to high pressures (50 to 700 bars); مخاطر الحوادث الناجمة عن الضغوط العالية (50 إلى 700 بار)
- Leaks leading to decreased efficiency; التسريبات التي تؤدي إلى انخفاض الكفاءة
- Pressure losses due to fluid circulation in pipelines; خسائر الضغط الناجمة عن تداول السوائل في خطوط الأنابيب
- Fire hazards: hydraulic oil is particularly flammable; مخاطر الحريق: الزيت الهيدروليكي قابل للاشتعال بشكل خاص
- Expensive technology (costly components, regular preventive maintenance). الثمن (مكونات مكلفة، صيانة وقائية منتظمة)

# Public Works & Development

The Public Works & Development sector encompasses all companies that construct and maintain public infrastructure and collective facilities:

- Roads and various networks (water supply, sanitation, and other pipelines), الطرق والشبكات المختلفة (إمدادات المياه والصرف الصحي وغيرها من الأنابيب)
- Water storage structures, مرافق تخزين المياه
- Earthworks, surveys, and drilling, أعمال الأرض، الآبار
- Construction of roads and sports surfaces, civil engineering structures, and underground works, إنشاء الطرق والأرضيات الرياضية والأعمال الهندسية والأعمال تحت الأرض
- Railways, waterways, airports, port infrastructure, السكك الحديدية والمجاري المائية والمطارات والبنية التحتية للموانئ
- Works in maritime or river sites, العمل في موقع بحري أو نهري
- Agricultural engineering works, أعمال الهندسة الزراعية،
- Bridges, الجسور
- Etc...

# Bibliography

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