

Learning outcomes

At the end of this chapter and exercise, the students should be able to:

- a. classify and know the main types and elements of hydraulic waterways
- b. differentiate between free-surface and pressurized waterways
- c. identify its main elements
- d. recognize where surge control measures need to be applied
- e. assess water losses
- f. recognize where tunnel lining is required and design it
- g. recognize where tunnel lining needs to be watertight and design it
- h. know, understand, and apply the basic equations behind the design of pervious and impervious tunnel linings
- i. define and identify critical situations in pressurized waterways
- j. propose and design countermeasures

Contents

1. Pressurized waterways – impervious linings

- a. Design of near-impervious concrete linings
 - i. Modèle de dimensionnement « à 2 couches » d'un revêtement en béton admis étanche
 - ii. Modèle de dimensionnement « à 3 couches » d'un revêtement en béton admis étanche, avec zone injecté. Purpose of grouting the disturbed rock zone
- b. Design of impervious linings (steel or membrane)
 - i. Modèle de dimensionnement « à 4 couches » d'un revêtement étanche (blindage ou membrane), avec deux couches fissurées et semi-perméables
 - ii. Joint behaviour of thin steel lining and concrete backfilling – notion of initial void
 - iii. Limits of stress and deformation in the steel lining
 - iv. Load sharing with surrounding rock
 - v. Design of thin-wall cylinder under internal and external water pressure
 - vi. Graphical solution provided by Seeber diagram.
 - vii. Resistance against buckling under external overpressure
 1. Amstutz method
 2. Morel method
 - viii. Measures to prevent buckling
 - ix. Design example of the pressure shaft of Collierville (USA)
- c. Accident sur le puits blindé de Cleuson-Dixence (2000, CH)
 - i. Caractéristiques de la solution de base. Complexité du chantier.
 - ii. Solutions techniques de réhabilitation. Avantages / Inconvénients
 1. Chemisage du puits sur l'ensemble du lineaire.
 2. By-pass du tronçon accidenté.

2. Exercise 3

- Pressurized waterways