**Due Date:** 30.12.2021, Until the lecture

**CE 498 – COASTAL AND HARBOR ENGINEERING**
**HOMEWORK #4**

***Policy on Homework:***

1. *It is your responsibility to follow assignments from ODTUCLASS.*
2. *You should do your homework on your own. Please ask your questions to your teaching assistant Y. Arda Cicek. Please make an appointment (by e-mail: ciceka@metu.edu.tr) before coming to see your teaching assistant.*
3. *You can ask your questions in the Forum to your friends and instructors. You can use these discussions in your work, and they will not be considered as `copy`. Make sure that you include the names of your friends that help with your homework (not copy or use their code directly) in your submission document.*
4. *You should submit your homework on time to the ODTUCLASS. <u>If you don't submit your homework until deadline, you will not be allowed to participate in class activity.</u>*
5. *There is no report, you only need to submit the code you have written to the system. You can use Excel, MATLAB, Python, etc.*

In this homework, it is requested to prepare a computational tool for rubble mound breakwater design. This computational tool might be an Excel sheet or a computer code (MATLAB, C, C++, Python, etc.). Your computational tool should perform the following calculations:

- Calculate armor stone weight
    - Using Hudson's method
        - Possible inputs: Deep water significant wave height ($H_{s0}$), significant wave period ($T_s$), unit weights of armor stone ( $\gamma_s$ ) and water ( $\gamma_w$ ), bottom slope (m), depth at the toe of the structure (h), structure face slope, stability coefficients ($K_D$)
        - Transform waves from deep water to the toe of the structure using the regular wave transformation approach.
        - Determine the design condition (Breaking or Non-Breaking).
        - Determine the design wave height and stability coefficient according to the design condition.
        - Calculate of armor stone weight using Hudson's equation.
    - Using Van der Meer's method

- Possible inputs (in addition to the Hudson's method): Damage level (S), notional permeability (P), storm duration
- Transform waves from deep water to the toe of the structure using energy decay charts.
- Calculate the surf similarity parameters to determine the type of breaking.
- Calculate the armor stone weight using the appropriate Van der Meer equation.

<u>Please include following formulas in your codes (you will learn them in the next lecture):</u>

- Calculate the weight of the filter and core units (anroşman = armour).

**Filter design**

$$\frac{D_{50(\text{anroşman})}}{D_{50(\text{filitre})}} \approx (2.2 - 2.5) \text{ veya } D_{15(\text{anroşman})} \leq 5 D_{85(\text{filitre})}$$

$$\frac{W_{50(\text{anroşman})}}{W_{50(\text{filtre})}} \left( \text{veya} \frac{M_{50(\text{anroşman})}}{M_{50(\text{filtre})}} \right) \approx (10-15)$$

$D_{50}$ : %50 elekten geçen taş çapı
$D_{85}$ : %85 elekten geçen taş çapı
$D_{15}$ : %15 elekten geçen taş çapı

**Core design**

$$\frac{D_{15(\text{filitre})}}{D_{85(\text{çekirdek})}} < (4 - 5)$$

$$\frac{W_{50(\text{filitre})}}{W_{50(\text{çekirdek})}} \left( \text{veya} \frac{M_{50(\text{filitre})}}{M_{50(\text{çekirdek})}} \right) \approx (10\text{-}25)$$

- Calculate the thicknesses of each layer (take $k_\Delta = 1$) (Eqn. 2.49).

Filter Thickness

$$t = n k_\Delta \left( \frac{W_{50}}{\gamma_r} \right)^{1/3} \qquad (2.49)$$

Filtre tabaka kalınlığı hesaplamalarında da Denklem (2.49) filtre tabakası taş ağırlığı ile kullanılır.

t : Ortalama tabaka kalınlığı
n : Taş ya da beton koruyucu tekil taş veya blok sayısı ( genellikle n=2)
$W_{50}$ : Koruyucu tekil taş veya blok birim ağırlığı
$\gamma_r$ : Koruyucu tekil taş veya blok birim özgül ağırlığı
$k_\Delta$ : Tabaka katsayısı

See next page.

- Calculate the minimum crest width for rock (irregular, n = 2 and random placement) (Eqn. 2.48).

$$B = nk_{\Delta}\left(\frac{W_{50}}{\gamma_r}\right)^{1/3} \qquad (2.48)$$

B : Kret genişliği
n : Taş sayısı (en az 3)
$k_{\Delta}$ : Tabaka katsayısı (Tablo 2.15)
$W_{50}$ : Koruyucu tekil taş ya da blok birim ağırlığı (ton)
$\gamma_r$ : Koruyucu tekil taş ya da blok birim malzemesinin özgül ağırlığı ($t/m^3$)

Dalga aşmasının olmadığı durumlarda, kret genişliği çok önemli değildir, fakat yapı üzerinde herhangi bir inşa ya da bakım yapılabilmesi için gerekli minimum genişlik sağlanmalıdır.

Tablo 2.15 Çeşitli koruyucu tabaka tekil taş ya da blok için tabaka katsayısı ve boşluk oranı (CERC, 2003)

| Koruyucu tabaka tekil taş yada blok | n | Yerleştirme | Tabaka Katsayısı ($k_{\Delta}$) | Boşluk Oranı(%) |
|---|---|---|---|---|
| Ocaktaşı ( düz) [1] | 2 | Rasgele | 1.02 | 38 |
| Ocaktaşı ( pürüzlü) [2] | 2 | Rasgele | 1.00 | 37 |
| Ocaktaşı ( pürüzlü) [2] | ≥ 3 | Rasgele | 1.00 | 40 |
| Ocaktaşı (paralel yüzlü) [3] | 2 | Özel | - | 27 |
| Ocaktaşı [4] | Sınıflandırılmış | Rasgele | - | 37 |
| Küp | 2 | Rasgele | 1.10 | 47 |
| Tetrapod [1] | 2 | Rasgele | 1.04 | 50 |

- Calculation of the total volume of the cross-section
    - Do not consider the layers. You will calculate the volume of the whole cross-section.
    - You will learn how to determine the free crest height in the next lecture. At this stage, assume that the free crest height is equal to the design wave height you use in Van der Meer's method.

In the abovementioned list of calculations, it is required to use some charts and tables such as energy decay charts and gravity wave table. You may read the values of the required parameters from the appropriate charts and tables. In other words, there is no need for automatic calculation of these parameters.