UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester 7 Examination in Engineering: June 2014

Module Number: CE7324 **Module Name: Geotechnical Engineering Design**

[Two Hours]

[Answer **all questions**, each question carries 10 marks]

Q1. It was decided to construct a multi storey shopping complex in a Colombo city center. Due to the limitations of suitable land in Colombo city area, which is undergoing rapid development, it was decided to construct an underground car park with 2 floors within the shopping complex.

Construction process is to be started with casting 10.0 m high concrete diaphragm wall along the perimeter of the proposed excavation. A lateral support will be provided at a depth of 1.0 m from ground surface at 3.0 m apart to enhance the stability. The proposed floor level of the basement 2 of the car park is at a depth of 6.0 m from the existing ground level.

Based on site investigations, it was found that the soil profile consists of 16.0 m thick silty sand layer followed by the bed rock. The saturated unit weight of silty sand is 18.0 kN/m^3. The drained shear strength parameters of soft clay are c' = 5 kPa, φ'= 30°. The water table was found to be at the existing ground level. The unit weight of water is 9.81 kN/m^3.

a) Briefly describe the construction sequence of a diaphragm wall with suitable sketches.

[2.0 Marks]

b) Sometimes after the construction is completed, a steady state flow condition with the given water levels will be established. Evaluate the stability of the proposed wall according to BS 8002 using Free Earth Support method.
Figure Q1.1 and Figure Q1.2 may be useful in the calculations.

[6.0 Marks]

c) What would be the expected compressive force on the lateral support?

[1.0 Marks]

d) As a junior geotechnical engineer in this project, do you agree with the proposed design? If you do not agree with the proposed design, suggest suitable methods to stabilize the diaphragm wall.

[1.0 Marks]

Q2. There was a collapse of retaining wall at Labuduwa, Karapitiya during December 2012, which caused heavy damaged to the properties. Cross section of the site is shown in Figure Q2.1. Soon after the construction of 6.0 m high retaining wall, back filling was started with the intention of further increasing the area of back yard by the defendant (person who is on the retained side). Few hours after the backfilling, retaining wall was completely failed destroying the properties of the plaintiff (person who is in front of the retaining wall). Later, it was realized that retaining wall was constructed without consulting a qualified engineer and failure was occurred basically due to the poor design.

Later, a geotechnical engineer has designed a random rubble masonry retaining wall

up to a height of 4.2 m and top 1.8 m was suggested to turfed with grass after making a slope of 1:1 as shown in Figure Q2.2.

The bulk unit weight of backfill material is 16 kN/m^3. Backfill material has effective shear strength parameters, with usual notations, of $c' = 20$ kN/m^2 and $\varphi' = 30°$. The unit weight of random rubble masonry material can be taken as 22 kN/m^3. It was realized that water table is well below the ground surface. The dead and live load of the building on the retained side can be taken as 30 kN/m^2.

a) Determine the design shear strength parameters for the long term stability of the retaining wall according to BS8002.

[1.0 Marks]

b) Evaluate the long term stability of the retaining wall against sliding according to BS8002 neglecting the passive resistance. Assume that the building on the retained side is within the active failure zone.
Figure Q2.3 and Figure Q2.4 may be useful in the calculations.

[6.0 Marks]

c) Evaluate the long term stability of the retaining wall against overturning according to BS8002.

[1.5 Marks]

d) If the allowable bearing capacity of the founding soil is 250 kN/m^2, evaluate the stability of the retaining wall against bearing failure according to BS8002.

[1.0 Marks]

e) As a junior geotechnical engineer in this project, do you agree with the proposed design? If you do not agree with the proposed design, suggest suitable methods to stabilize the slope.

[0.5 Marks]

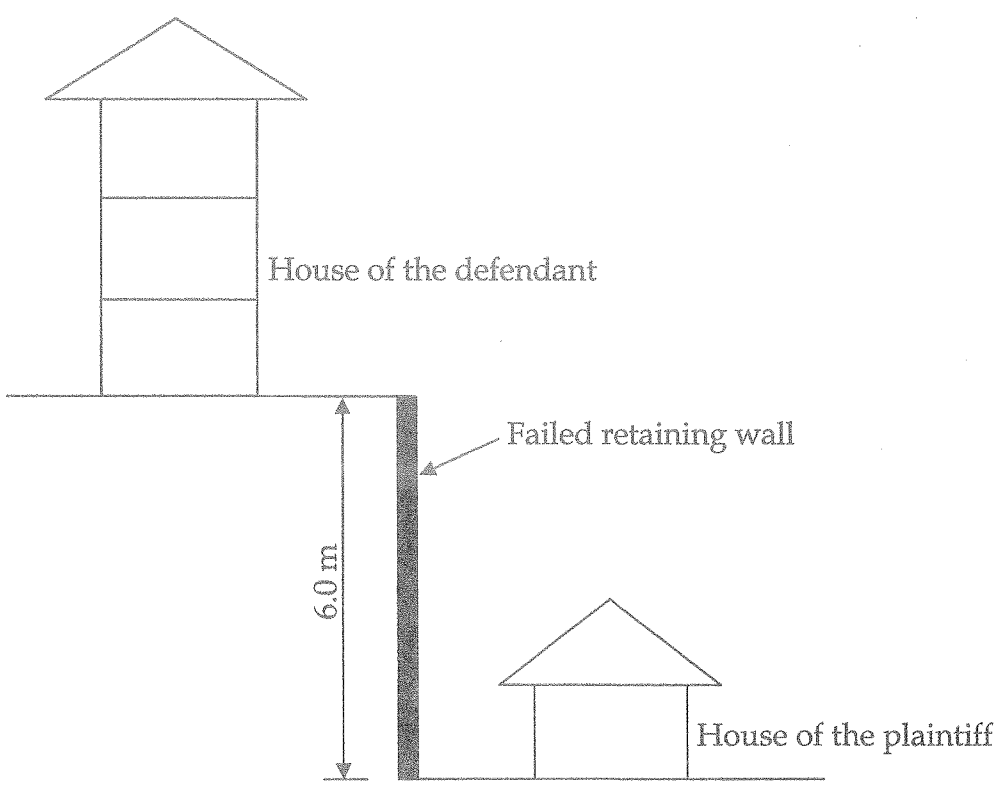

Figure Q2.1 – Cross section of the site

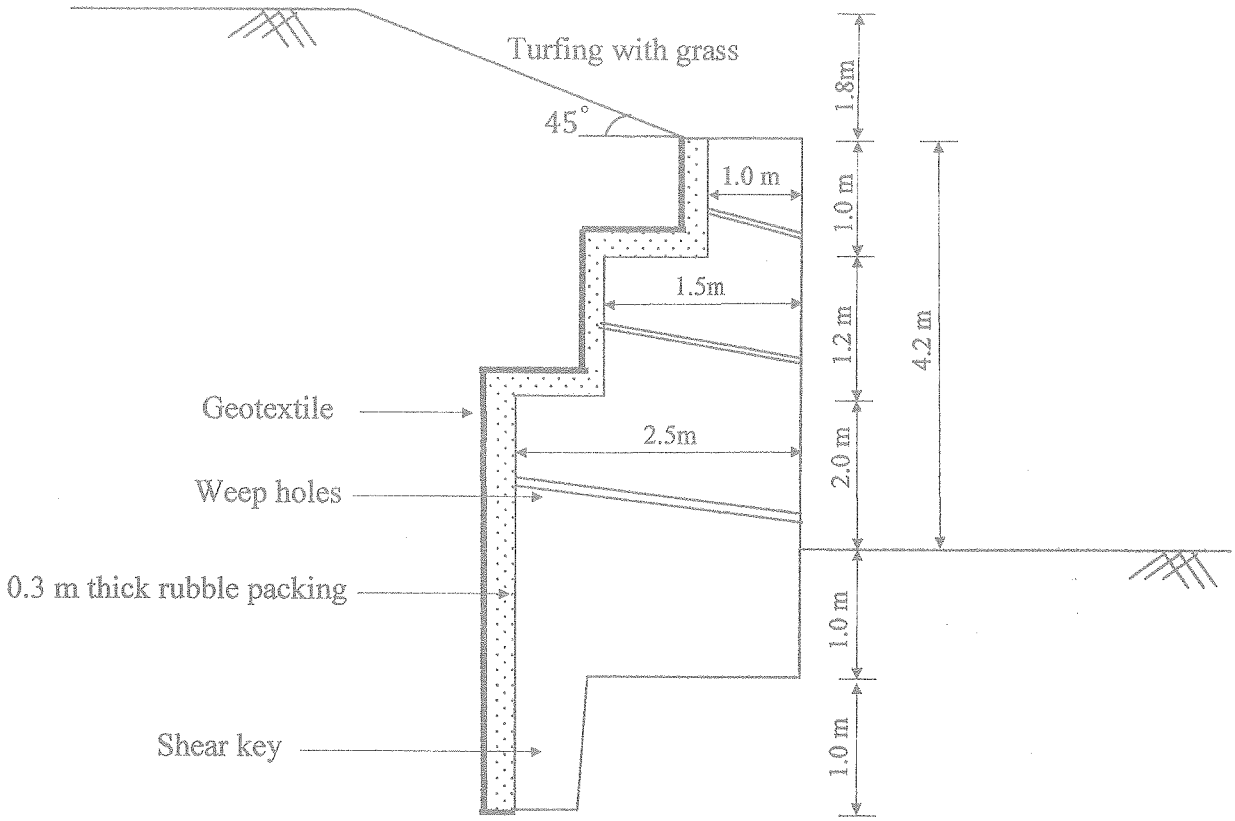

Figure Q2.2 – Cross section of proposed retaining wall

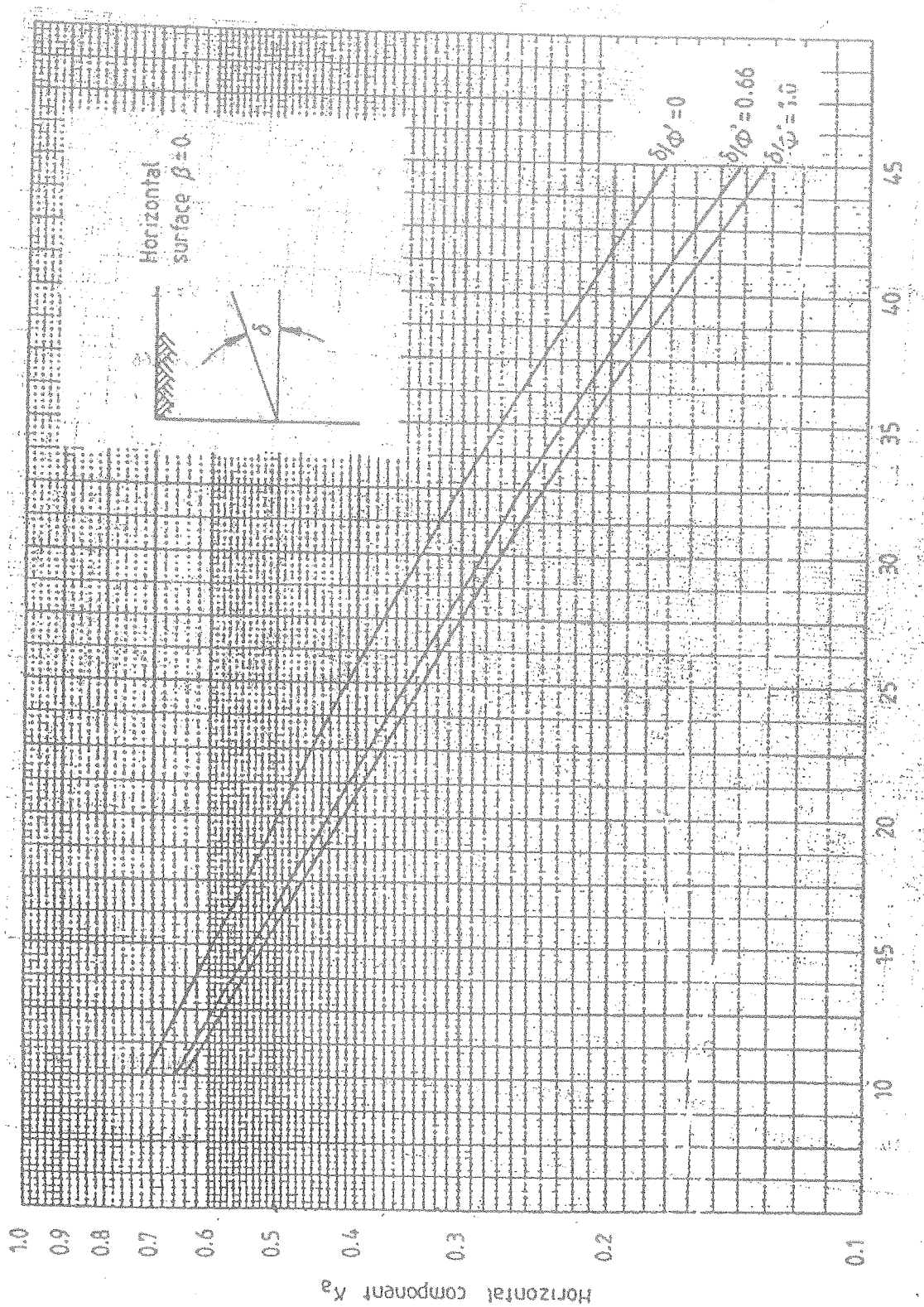

Figure Q1.1 Variation of K_A with ϕ'_{design}

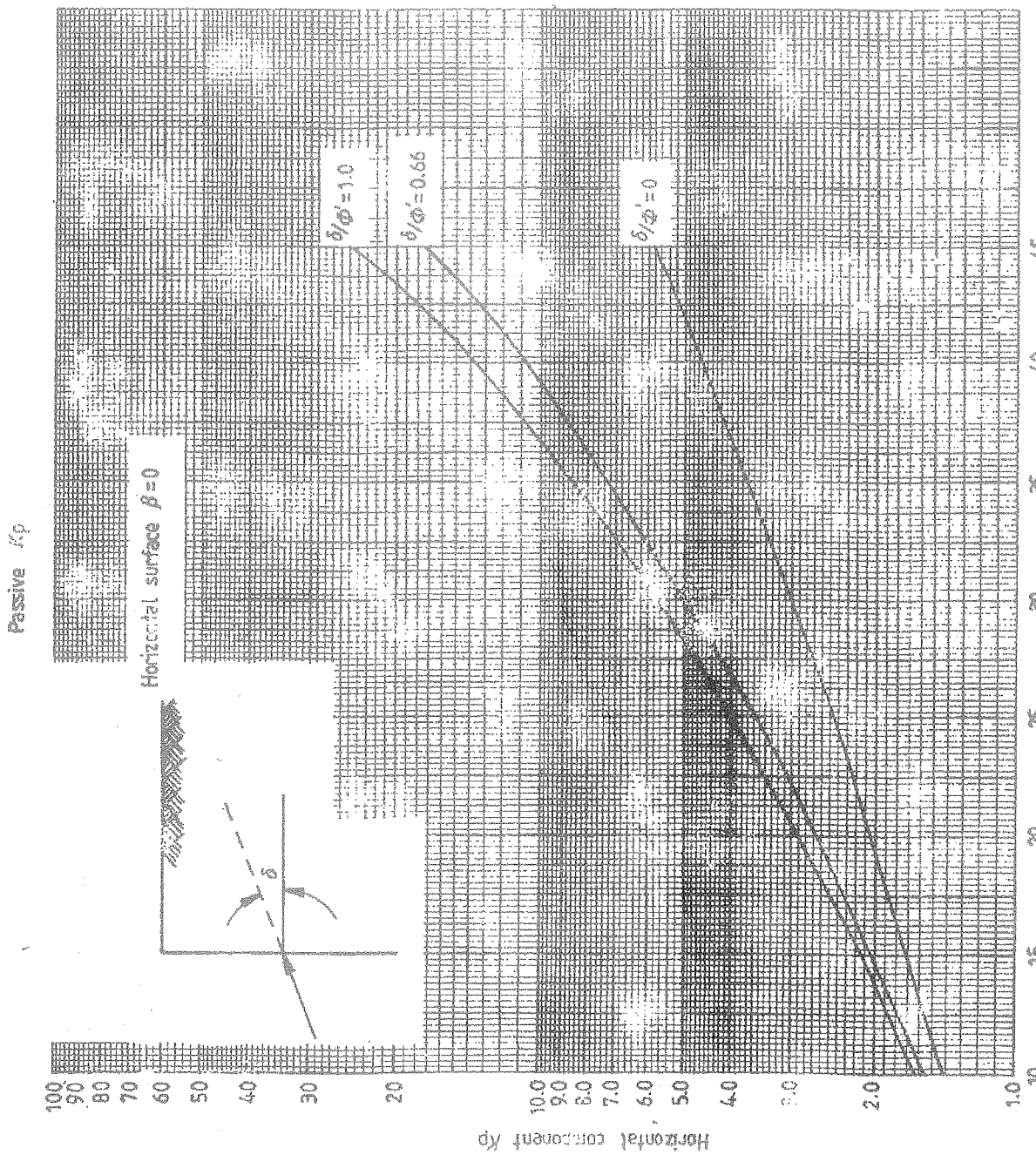

Figure Q1.2 Variation of K_P with φ'_{design}

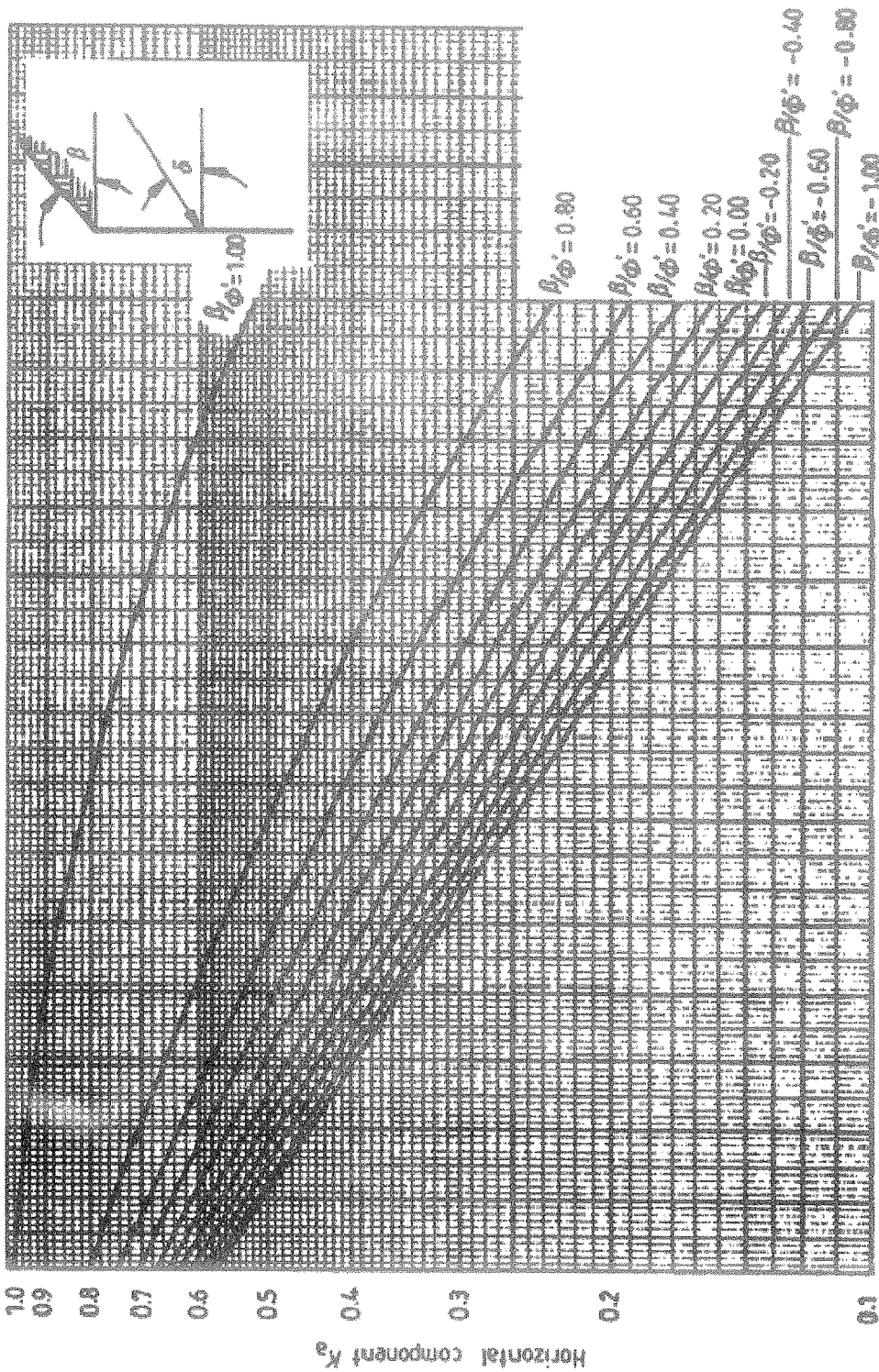

Figure Q2.3 Variation of K_A with φ'_{design} and β ($\delta/\varphi=0.66$)

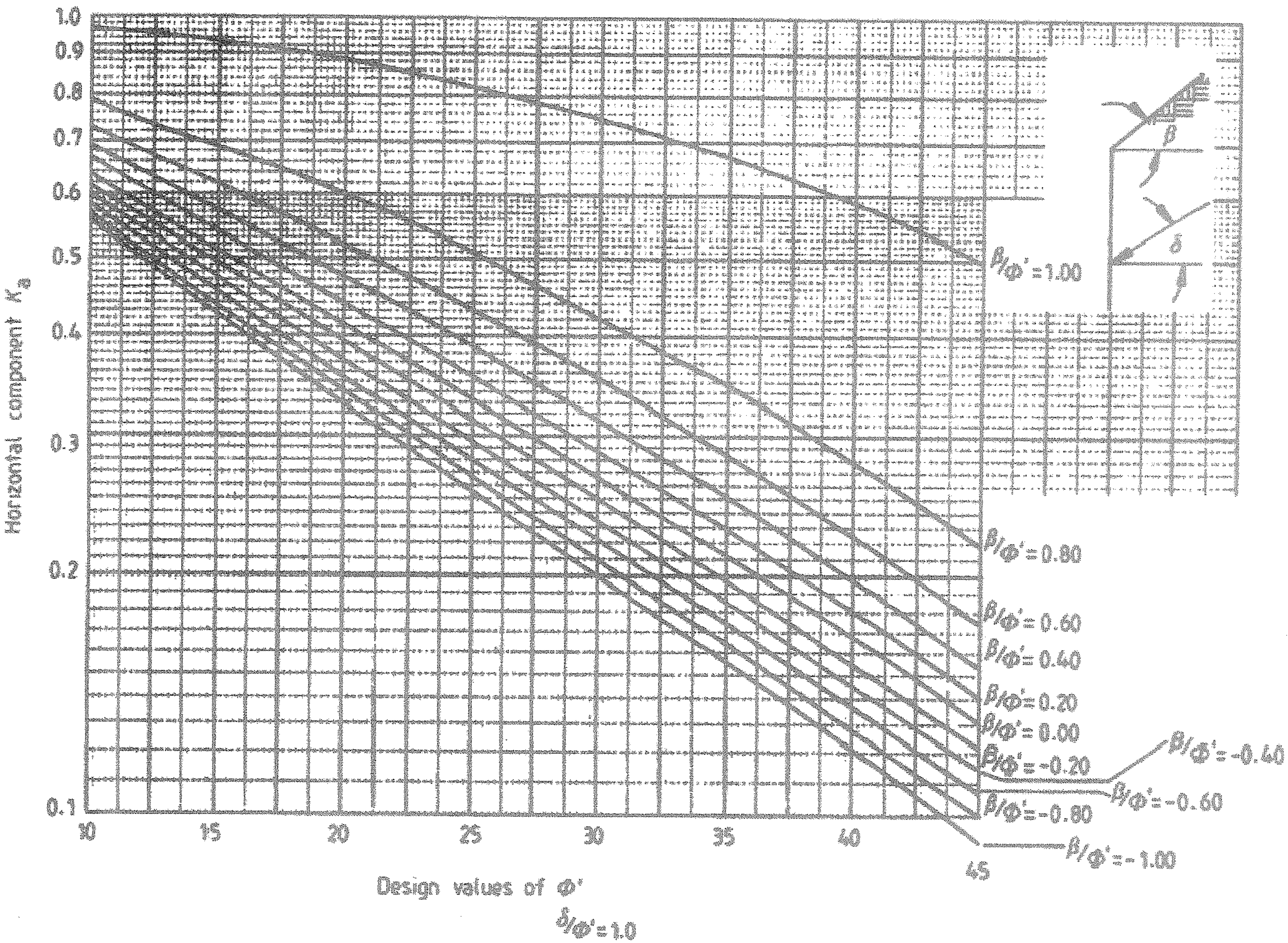

Figure Q2.4 Variation of K_A with φ'_{design} and β $(\delta/\varphi=1.0)$