CALCULATIONS 1

Bulk density, hydrostatical balance

P1.1 In the volumetric cylinder is given 1000 cm^3 of water. 500 g of the lightweight absorptive aggregate was added to the water and the aluminum weight with the mass of 216 g was put down on the aggregate. The water increased to the level 1760 cm^3. Than the aggregate was taken out from water, dried on the surface and its mass was 545 g. What is the bulk density of the aggregate?

690 $kg.m^{-3}$

P1.2 Dry lightweight aggregate with the mass 1.5 kg was submerged under water and the metal plate was put down on it. Next day the aggregate was taken out from the water, dried on the surface and weighed. The mass of the aggregate was 1820 g. Immediately the aggregate was weighed under water by the hydrostatic balance and its mass under water was 120 g. What is the bulk density of the aggregate?

882,4 $kg.m^{-3}$

P1.3 The bulk density of the cement mortar was measured by the hydrostatic balance. Sample of dry mortar with the mass 1,2 kg was attached to the wire from the stainless steel and with the wire was submerged under water. The mass of the sample with the wire under water was 650 g. After that only the wire was submerged and its mass was 70 g. What is the bulk density of the mortar?

1935 $kg.m^{-3}$

Sorptivity and moisture

P1.4 Determine the gravimetric and volumetric sorptivity of the aggregate from the P 1.2

w_m = 21,3 % , w_V = 18,8 %

Porosity, loose bulk density

P1.5 The mass of the block from lightweight concrete with the dimensions 600 x 600 x 300 mm is 52 kg. Fully soaked concrete has mass 91 kg. The density of the concrete is 2400 kg/m3. Determine the gravimetric sorptivity and closed porosity of the concrete.

w_m = 75 %, p_{closed} = 43,9%

P1.6 Board from the expanded polystyrene has size 1000 x 500 x 40 mm, bulk density 20 kg/m^3, density 1050 kg/m^3. Fully saturated board weights 1,2 kg. Determine the gravimetric and volumetric sorptivity of the board and its total, closed and open porosity.

w_m = 200 %, w_V = 75 %, p_{total} = 98%, p_{open} = 4%, p_{closed} = 94%

P1.7 The mass of 1 m^3 of stone was 2960 kg. The stone was grinded into the aggregate with the size 4/8 and the aggregate with the size 16/32. Both aggregates were loosely poured into the calibrated 5l vessel. The vessel with the aggregate 4/8 had mass 8,96 kg and the vessel with the aggregate 16/32 had mass 8,66 kg. After that the both aggregates were compacted to the maximum. The vessel with the consolidated aggregate 4/8 than weighed 10,085 kg and with the 16/32 aggregate weighed 9,32 kg. Mass of empty vessel was 2,3 kg.
Determine the loose bulk density of both aggregates
a) in loose (uncompacted) state
b) in consolidated state

Aggregate 4/8: a) ρ_l= 55%, b) ρ_l = 47,4%

Aggregate 16/32: a) ρ_l = 57%, b) ρ_l = 52,6%

Aggregate gradation – particle size curve

P1.8
We have aggregate with the size 0,5/4. Total mass of the aggregate was 1 kg. After sieve analysis these retained were obtained:

Sieve	Individual retained [g]
8	50
4	100
2	250
1	400
0,5	100
0,25	50
0,125	0
< 0,125 (pan)	50
Total	1000

Make the particle size distribution curve of the aggregate.
What is oversize und undersize of this aggregate?

Cumulative passings:

sieve 8 = 95%, sieve 4 = 85%, sieve 2 = 60%, sieve 1 = 20%, sieve 0,5 = 10%, sieve 0,25 = 5%, sieve 0,125 = 5%, pan = 0%

FM = 4,15, oversize = 15 %, undersize = 10 %

P 1.9 Aggregates C, M, and F are given.

Aggregate C 8/32 :

passing on sieve 63	100%,
passing on sieve 32	70%,
passing on sieve 16	50%,
undersize	5 %.

Aggregate M 2/16:

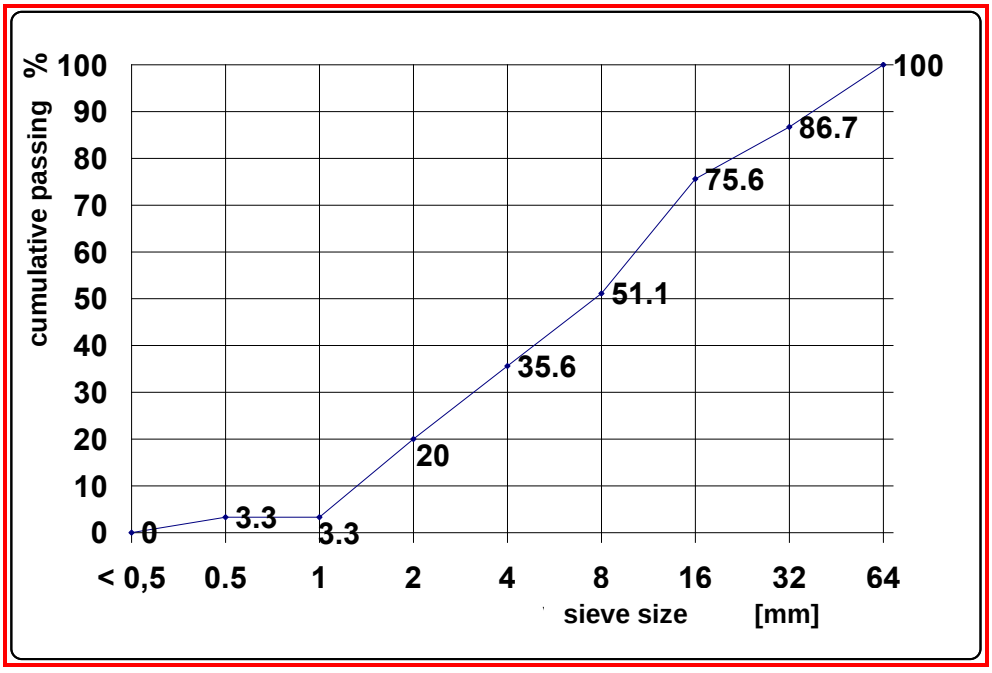
oversize	10%,
passing on sieve 8	70%,
passing on sieve 4	40 %,
passing on sieve 2	0 %,

Fine aggregate F:

passing on sieve 8	100%,
passing on sieve 4	80%,
passing on sieve 2	60%,
passing on sieve 1	10 %,
passing on sieve 0.5	10 %.

Calculate the total percentage passing for the mixture **C : M : F =** 4 : 2 : 3 and draw the particle size distribution curve.

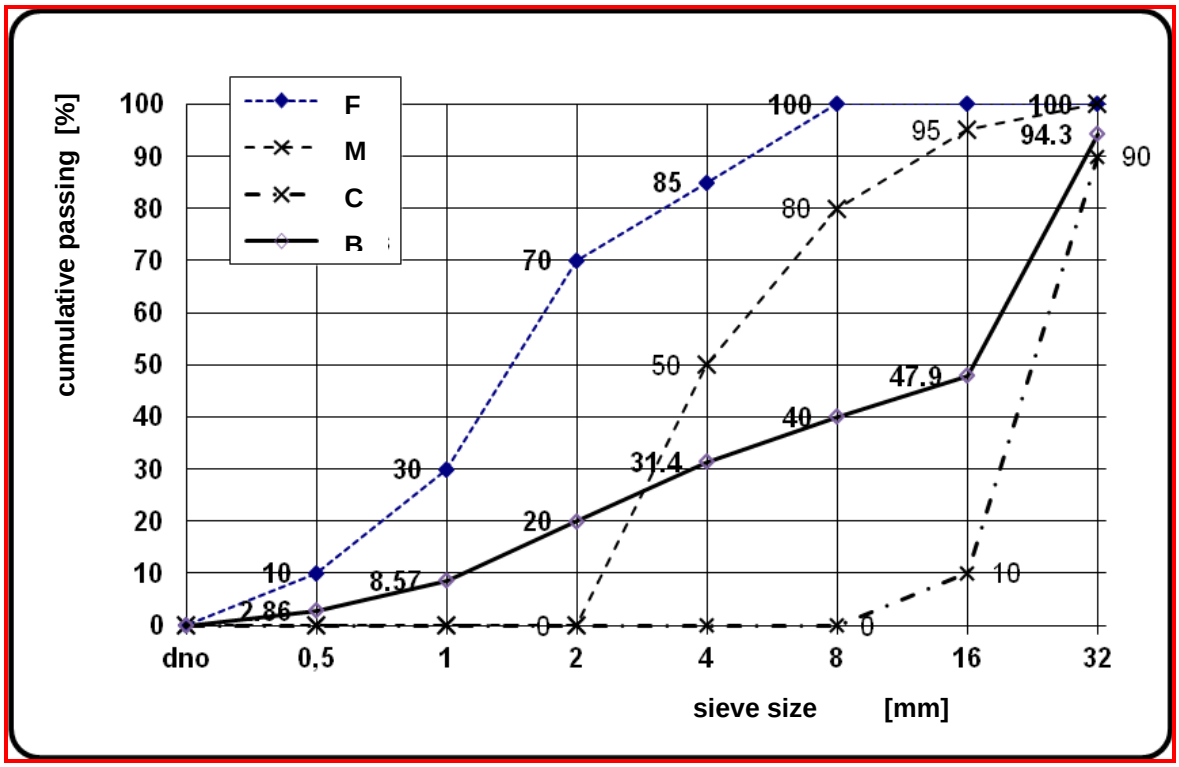
Particle size distribution curve:



P1.10 We have these aggregates:

F fraction 0,5/4		**M** fraction 2/16		**C** fraction 16/32	
oversize	15%	oversize	5%	oversize	10%
sieve 2 passing	70%	sieve 8 passing	80%	undersize	10%
sieve1 passing	30%	sieve 4 passing	50%		
undersize	10%	undersize	0%		

Make the particle size distribution curves of all the aggregates and the curve of the mixture B = F : M : C = 2 : 1 : 4.



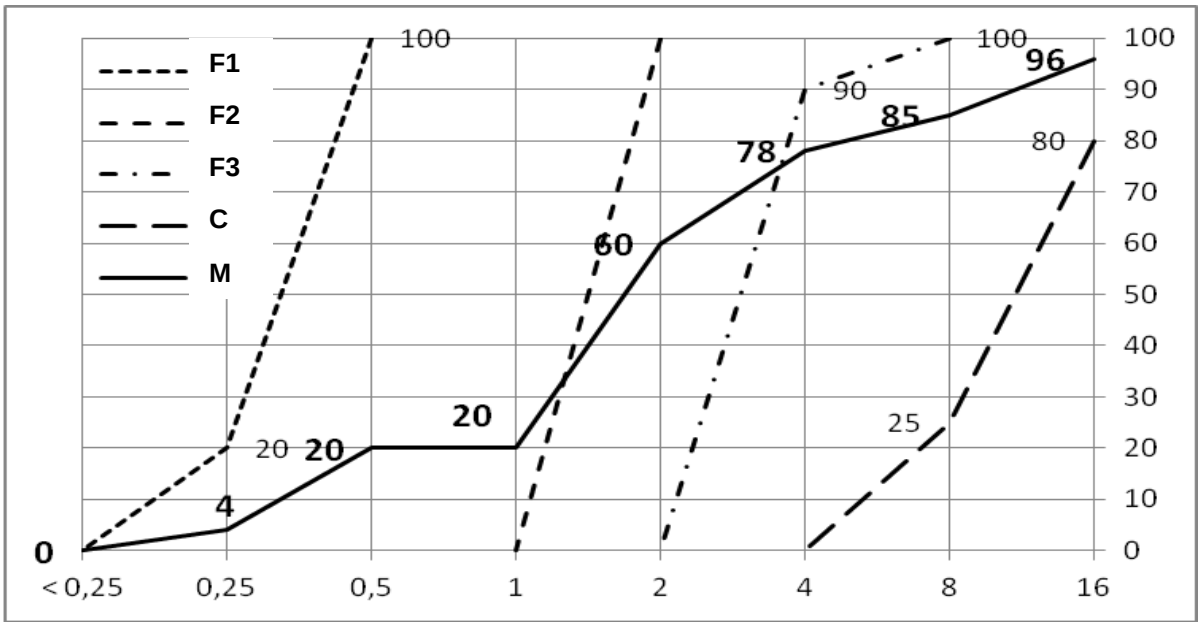
P1.11 a) Draw the particle size distribution curve of these aggregates:

aggregate F1, fraction 0,25/0,5	20 % undersize, 0 % oversize
aggregate F2, fraction 1/2	0 % undersize, 0 % oversize
aggregate F3, fraction 2/4	0 % undersize, 10 % oversize
aggregate C, fraction 4/16	0 % undersize, 20 % oversize and ¼ of particles is smaller than 8

b) Calculate the total percentage passing of the mixture M = **F1 : F2 : F3 : C =** 1:2:1.1 and draw its particle size distribution curve.

c) Determine the value of oversize of mixture M, declared as fraction 0/16.

a) + b)



c) M oversize: 4 %

CALCULATIONS 2

Strength

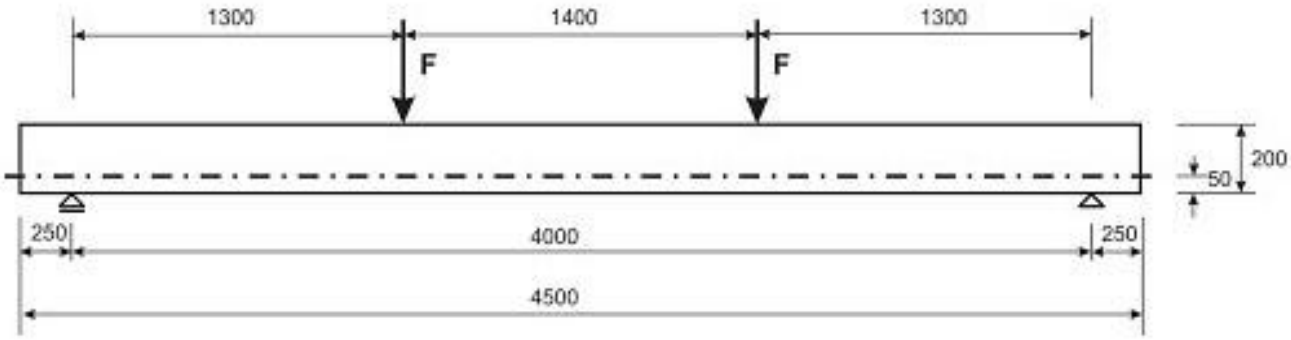
P2.1 Dural rod with regular octagon cross section with side length 5 mm has 60 cm in length and weight 195.6g. During the flexural strength test the rod was broken with the force 58.7 kN. Determine tensile strength of the tested material.

R_t = 486,3 MPa

P2.2 We want to do splitting tensile strength test of granite. We use cylindrical testing specimen with diameter 40 mm and height 30mm. The expected strength of granite is cca 10 MPa.
We use testing machine with adjustable force range 10 kN, 30kN and 50kN. Which force range we should set in order that the force would not exceed 75% of the range?

range 30 kN

P2.3 Determine maximal forces applied on concrete beam with flexural strength 5.62 MPa. Beam sizes: length 4.5 m, width 0.6 m, height 0.2 m. Beam was loaded with symmetrical four-point-load shown below.



F* = 17,3 *kN

P2.4 How long must be vertically hanged steel cable with tensile strength 1800 MPa that it breaks by its own weight?

L = 22,9 km

P2.5 Determine minimal diameter of a lift steel cable, which is placed in the world highest building (Burj Chalifa – 828 m). The lift cabin bearing capacity is 300 kg and weight 500 kg. Use the length of the cable as 800 m and involve the weight of the cable. Tensile strength of the cable is 2000 MPa.

d = 2,29 mm

Modulus of elasticity

P2.6 Bar from unknown metal with length 45 cm and diameter 10 mm elongated by loading force 20 kN to the length 47.41 cm and after unloading shortened to 47.25 cm. Determine the modulus of elasticity and try to find out which kind of metal is it.

E= 70 736 MPa, aluminum or its alloy

P2.7 HDPE sample (= high density polyethylene) with cross section 5 mm x 20mm and length 80 cm was tested in tension. Tensile strength of the material is 23 MPa and modulus of elasticity is 1.35 GPa.

a) Determine the elastic deformation of the strap at the moment of break.
b) Determine the total elongation of the strap at the moment of break, if the ductility of the material is 120%

a) ΔL_{elast} = 13,6 mm, b) ΔL_{total} = 973,6 mm

P2.8 Steel bar with length 60 cm and diameter 12 mm was tested in tension. Bar broke at loading 66 kN. Measuring machine scale shown maximal elongation at the moment of break 68.6 cm. Determine the ductility of the steel.

if elastic deformation is not substracted (is neglected) δ = 14,3 %
if elastic deformation is substracted δ = 14 %

P2.9 The 50 m long steel rope has diameter 6 mm, tensile strength 1620 MPa, yield limit 1285 MPa and elasticity limit 1190 MPa. Determine maximal tensile force, such that after loading the rope returns to its original length and determine the length of the rope at that loading.

F = 33,6 kN, ΔL_{el} = 283,3 mm, total length at the loading 50283.3 mm