**Trial Examination for Associate Professional Civil Engineers,
Qualification Examination for Professional Engineers, JSCE**

Answers and Explanations

Q1.

(1) ×

Concrete compressive strength increases as loading rate increases. The load will be static when the loading rate is normal, but if the loading rate is increased, the compressive strength will increase. This leads to a change in the fracture pattern of the specimen.

(2) ×

The cement paste becomes rough in structure with higher W/C ratio. On the other hand, when the W/C ratio is low, the structure becomes dense. This means that the W/C ratio of high strength concrete will have a low setting time.

(3) ○

The moisture content evaporates during the drying process, leading to shrinkage stress inside the concrete, which increases its compressive strength.

(4) ×

If the volume is increased while maintaining the diameter-height ratio constant, the probability of a weak point forming increases, causing the compressive strength to decrease. This is referred to as the “scale effect”.

It seems that unless the test conditions are kept constant as shown in (1) and (4), unable to measure the correct strength.

Q2.

When considering a beam subject to a triangular distributed load, the load is considered to be acting at the center of gravity of the triangle. Using the equilibrium equation to find the reaction force, we get

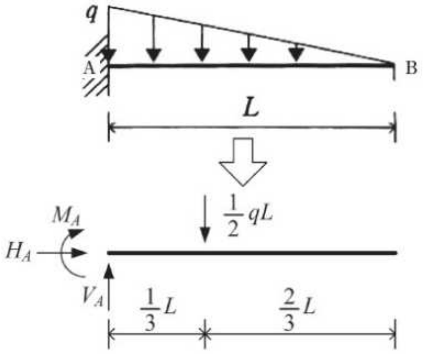
$\Sigma H = 0$ gives $H_A = 0$

$\Sigma V = 0$ gives $V_A = \frac{1}{2}qL$

$\Sigma M = 0$ gives $M_A + \frac{1}{2}qL \times \frac{1}{3}L = 0$

$\therefore M_A = -\frac{1}{6}qL^2$

Thus, the moment reaction at the support is $\frac{qL^2}{6}$



Q3.

The void ratio e, according to the definition, is $\mathbf{e} = \frac{V_v}{V_s}$.

We will introduce a useful way for considering the three-phase diagram of soil (see the figure below).

① Using the relationship of $\mathbf{e} = \frac{V_v}{V_s}$, the volume of voids can be derived as $V_v = eV_s$

② The mass of soil particles m_s can be derived by multiplying the volume of soil particles V_s by the density of soil particles ρ_s , and the relationship of the specific gravity of soil particles $G_s = \frac{\rho_s}{\rho_w}$ can be used to derive $m_s = V_s \times \rho_s = V_s \times G_s\rho_w$

③ The mass of water m_w can be expressed by multiplying the mass of soil particles m_s by the water content ratio w, therefore $m_w = m_s \times \frac{w}{100} = V_s G_s \rho_w \times \frac{w}{100}$.

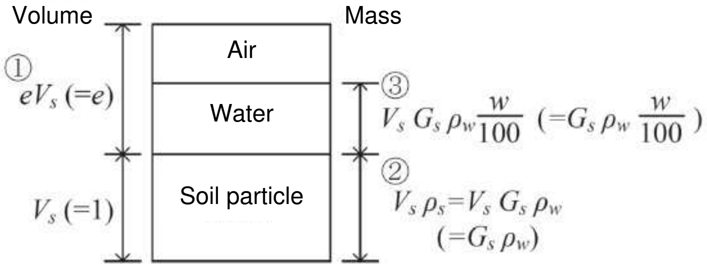
By using above we can derive

$$\text{Dry density } \rho_d = \frac{\text{Mass of soil particles}}{\text{Overall volume}} = \frac{m_s}{V} = \frac{V_s G_s \rho_w}{V_s + e V_s} = \frac{G_s \rho_w}{1+e}$$

$$\text{Wet density } \rho_t = \frac{\text{Overall mass}}{\text{Overall volume}} = \frac{m}{V} = \frac{V_s G_s \rho_w + V_s G_s \rho_w \times \frac{w}{100}}{V_s + e V_s} = \frac{G_s \rho_w \times (1 + \frac{w}{100})}{1+e}$$

$$= \rho_d \times (1 + \frac{w}{100})$$

This means that when calculating the density, the volume of soil particles V_s disappears due to reduction, so for convenience, the volume of soil particles can be considered as $V_s = 1$ for the quantity inside brackets in the figure!



Q4.

The hydrostatic pressure acting at the point with a vertical distance (depth) of z is
$p = \rho g z$. The total hydrostatic pressure acting on the surface is
$P = \rho g$ × (*depth from water surface to geometric center) × (total area)*.

In the question, the depth from the water surface to the geometric center of the plate is $\frac{H}{2}$, and the total area of the plate is HL, therefore the total hydrostatic pressure, assuming the plate is installed vertically, is

$$P_0 = \rho g \frac{H}{2} HL = \frac{\rho g H^2 L}{2}.$$

Therefore, the total hydrostatic pressure acting on the inclined plate is

$$P = \frac{P_0}{\sin\theta} = \frac{\rho g H^2 L}{2\sin\theta}$$

* In (2) and (3) , $\cos\vartheta$ is in the denominator, therefore when the board is installed vertically, $\vartheta = 90°$, the total hydrostatic pressure becomes infinite, which is inappropriate. For (1), when $\vartheta = 0$ and 180° , we get $\sin\vartheta = 0$ and the water pressure becomes 0 , which is inappropriate.

Q5.

Correct answer is (1)

* Key point!

"Reliability (probability that the route exists) = 1 - (probability that all routes fail)"

Consider the probability of not being able to go from A to B with regards to the current road network. Since the probability that any link can be followed is r, then the probability that the upper (or lower) route will fail is $1 - (r \times r) = 1 - r^2$.

The probability that all routes fail is

$(1 - r^2) \times (1 - r^2) = (1 - r^2)^2$.

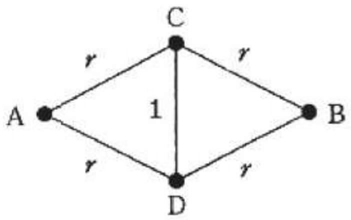
The probability that a route exists between AB is $1 - (1 - r^2)^2$.

Next, consider the probability of not being able to go from A to B once a bypass is created. The reliability of each network in Figure 2 is shown in the figure below. The probability of not being able to go from A to C & D arises when both links between AC and AD fail simultaneously, which is expressed as follows:

$(1 - r) \times (1 - r) = (1 - r)^2$

Similarly, the probability of not being able to go from C & D to B is $(1 - r)^2$. Thus, the probability of not being able to go from A to B is $(1 - r)^2 \times (1 - r)^2$. The probability of being able to go from A to B (therefore a route exists) is $\{1 - (1 - r)^2\}^2$. In order to obtain the increase in reliability, by subtracting the probability of being able to go from A to B when no bypass exists from the probability when a bypass exists, we get

$\{1 - (1 - r)^2\}^2 - \{1 - (1 - r^2)^2\} = \{4r^2 - 4r^3 + r^4\} - \{2r^2 - r^4\} = 2r^2 - 4r^3 + 2r^4 = 2r^2(1 - r)^2$.



Q6.

(1) ×

As installing a water storage facility always has some impact on the surrounding environment, the surrounding environment must be considered.

(2) ×

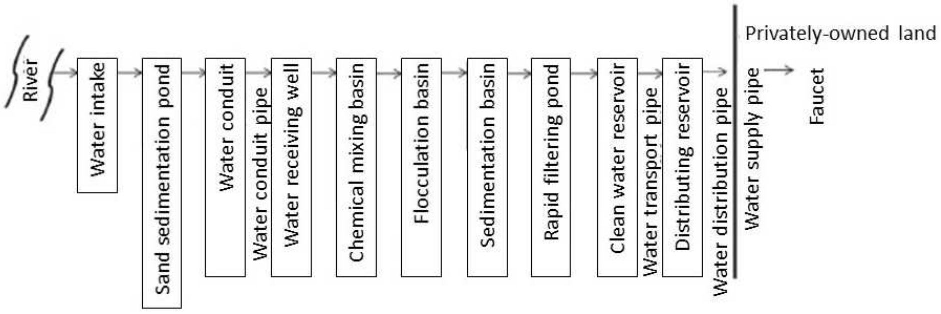
Since the water quality at the water source is related to the water purification costs, selection of purification methods as well as safety, water quality must also be considered. Selecting a water source with a water quality as good as possible is desirable, since that leads to more economical purification.

(3) ○

Since waterworks supply drinking water, the water supply is required to have a purification process that ensures the supplied water is epidemiologically safe (containing no pathogenic bacteria or harmful substances), has good physical properties (with respect to turbidity, color, taste, odor, etc.) and does not cause discomfort.

(4) ×

The flow of water supply is as shown in the figure. Water reaches the faucet in the sequence of collection → conveyance → purification → transfer → distribution. This sequence can be remembered based on the first letter of each stage.



Q7.

(1) ×

River gravel is named from where it is collected, not the rock it is made of. The rocks that are the source of river gravels may contain substances that cause an alkali-silica reaction.

(2) ○

The use of sea sand that has not been washed sufficiently with fresh water (salt removal) increases the possibility of corroding the reinforcing bars inside the concrete.

(3) ×

Using any aggregates with a large water absorption rate leads to an increase in water content, which increases the volumetric expansion associated with freezing of the water content, and potentially increases damage to the concrete.

(4) ×

The carbonation of concrete is a phenomenon associated with calcium hydroxide in concrete gradually turning into calcium carbonate due to the action of carbon dioxide in the atmosphere, which results in the decrease of alkalinity. Characteristics of concrete that have an impact on carbonation are the density of the pore structure and the amount of alkaline calcium hydroxide, which affect the ease with which carbon dioxide can penetrate; for practical purposes, the proportion of concrete is decided based on the water-cement ratio as an index. The maximum size of coarse aggregate does not change the water-cement ratio for the purpose of designing the concrete mixture proportion. Therefore, it can be safely said that there is no relationship between the maximum size of coarse aggregate and the promotion of carbonation.

Q8.

The explanations given here are intended to clarify the key points of the outline, rather than actually draw the diagram of shear force (Q) and bending moment (M). The bending moment at the hinge of point D is 0, i.e. (4) is eliminated.

The span from point E to point F is an overhanging beam and involves no reaction force at point F, so no shear force occurs in the cross-section, i.e. (2) is eliminated.

Furthermore, the sign of bending moment is as shown in the figure below. Therefore, the moment at point F is positive, i.e. (2) and (4) are eliminated.

Figure 1: Sign of bending moment

The roller support at point C and point E can rotate and move horizontally, but not vertically. We can therefore expect a negative moment to act at point C. Furthermore, the concentrated moment acts only at point F, but

the diagram of (3) is depicted with the moment jumping at point E and point F, therefore (3) can be eliminated.
For reasons described above (1) is the correct answer.
Getting the feel for the structure is the most important point!

Q9.

The effective stress σ' is defined as the value derived by subtracting the pore water pressure u from the total stress σ, which is expressed as $\sigma' = \sigma - u$. The total stress σ at point A is

σ = (Total stress from ground surface to groundwater level)
+ (Total stress from groundwater level to point A)
= (2.0 [m] × 15.0 [kN/m³]) + (4.0 [m] × 18.0 [kN/m³])
= 102.0 [kN/m²]

Furthermore, the pore water pressure u at point A is calculated by multiplying the depth of the groundwater level by the unit volume of water 9.8 [kN/m³], thus we derive

u = 4.0 [m] × 9.8 [kN/m³] =39.2 [kN/m²].

Thus the effective stress σ' at point A is

$\sigma' = \sigma - u$
= 102.0 [kN/m²] - 39.2 [kN/m²]
= 62.8 [kN/m²].

The correct answer, therefore, is (2).

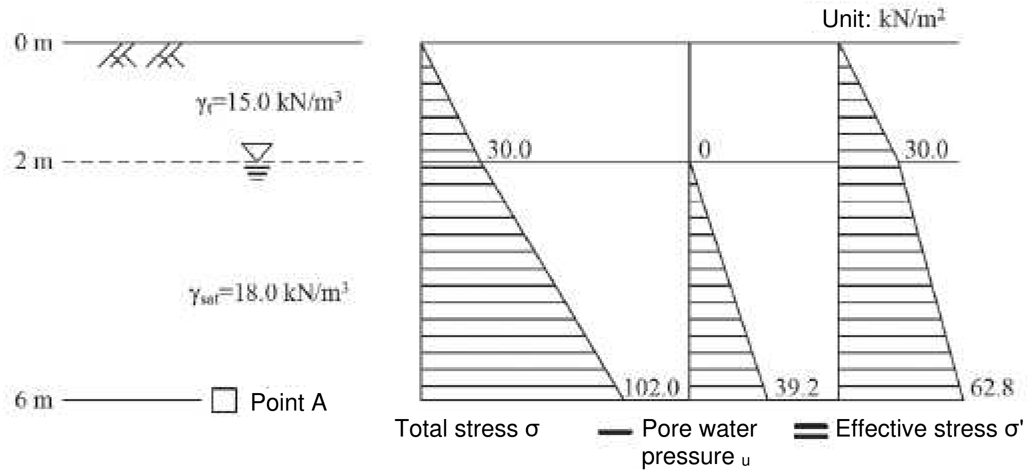


Figure 2: Vertical stress distribution in the direction of depth from the ground surface to point A

Q10.

Using Bernoulli's Theorem is the key point here!

$$\frac{v^2}{2g} + z + \frac{p}{\rho g} = const$$

The equation above is referred to as the formula for the law of energy conservation, and its terms from left to right are the velocity head, potential head, and pressure head, respectively. In order to satisfy this formula, the pressure decreases as the velocity of the fluid increases in case of constant elevation head. Applying Bernoulli's Law using the height of the pipe as a reference (z = 0), and assuming that the left side is the top of the tank and the right side is the end of the pipe, we derive

$H = \frac{v^2}{2g}\boldsymbol{A}$...①

At the top of the tank, the velocity v is 0. Since both pressures are atmospheric pressure, they are eliminated. As a result, the above equation ① remains. Now use of the equation of continuity is the key point!

$-\frac{dH}{dt} \cdot A = v \cdot aA$...②

where from equation ① we have

v = $\sqrt{2gH}$...③.

Therefore by substituting equation ③ into equation ② and rearranging, we derive

$$\frac{dH}{dt} = -\frac{a}{A}\sqrt{2gH}$$

for our calculation. The correct answer, therefore, is (3).

Q11.

If we let the benefit be B and the cost be C, then we derive

・ Cost-benefit ratio = *B/C*

・ Economic net present value = *B - C*

・ Economic internal rate of return: Social discount rate when the present values of benefits and costs are equal

* Benefits and costs are defined in each fiscal year, which are converted to present values and added up for the number of years.

The cost-benefit ratio, as the name suggests, is the cost of a project divided by the benefit. If this value is equal to 1 or more, the project is considered to have an effect that is worth the cost. In the case of this question, when the social discount rate is 4%, the benefit is 10 billion yen and the cost is 5 billion yen, therefore 10 billion ÷ 5 billion = 2.

The economic net present value determines the amount of benefits by subtracting costs from benefits. In the case of this question, 10 billion yen - 5 billion yen = 5 billion yen.

The economic internal rate of return is the discount rate with which the present values of benefits and costs become equal, and indicates the discount rate up to which the benefits are greater. Based on the statement of the question, we know that the benefits and costs are equal when the social discount rate is 12%, therefore the economic internal rate of return for this project is 12% . The correct answer, therefore, is (3).

Q12.

The BOD-SS load, as implied by the unit, represents the quantity of the daily BOD with respect to 1 kg of the MLSS (mixed liquor suspended solid). In other words, it is the amount of organic matter flowing in daily per unit amount of microorganisms. If the load is too large, the removal will not be complete and the quality of the treated water will deteriorate. If the load is too small, then there will be excessive aeration (too much air being fed in) and there is a risk of the sludge breaking up. The BOD-SS load of the standard activated sludge method is generally controlled to 0.2 to 0.4 kg-BOD/kg-SS/day.

Since mg/ℓ is same as g/m^3, the daily inflow of organic matter is 140 g/m^3 × 6,000 m^3/day, and the amount of microorganism is 1,500 g/m^3 × 2,800 m^3. The BOD-SS load is the daily amount of organic matter ÷ amount of microorganisms, which can be calculated as 0.2 kg-BOD/kg-SS/day. The correct answer, therefore, is (3).

Q13.

(1) ×

Drying shrinkage cracks are cracks that occur when moisture evaporates from the surface of concrete after hardening, causing the concrete to shrink, while a restraint is imposed by the inside or outside of the members that do not dry. The higher unit water content, the greater amount of evaporated moisture and the larger the amount of drying shrinkage, making it easier for cracks to occur.

(2) ×
Thermal cracks refer to cracks that occur when the temperature of concrete rises due to the heat of hydration of cement, causing the member to expand, and when the temperature drops later on and contraction occurs, which results in a restraint imposed by the inside or outside of the members. The smaller the unit cement content, the smaller the temperature rise due to heat generated by hydration and the subsequent temperature drop, making it difficult for thermal cracks to occur.

(3) ○
The concrete sinks due to bleeding immediately after the concrete is poured. The settling of concrete, however, is locally restrained by fixed horizontal reinforcing bars, causing settlement cracks to occur along the horizontal reinforcing bars on the concrete surface. Settlement cracks are more likely to occur in concrete with high unit water content and, therefore, a large bleeding volume.

(4) ×
Plastic shrinkage cracks are septarian-shaped cracks that occur on the concrete surface immediately after pouring. This is caused by the rapid drying shrinkage of the concrete surface due to rapid evaporation of moisture from the fresh concrete.

Q14.
From the force equilibrium condition, we derive

$$\Sigma V = 0 : R_A + R_B - P = 0$$
$$\Sigma_A M = 0 : -R_B \times \ell_1 + P \times (\ell_1 + \ell_2) = 0$$

Solving this, we get

$$R_B = \frac{\ell_1 + \ell_2}{\ell_1} \times P$$

$$R_A = P - \frac{\ell_1 + \ell_2}{\ell_1} \times P = -\frac{\ell_2}{\ell_1} \times P$$

The correct answer, therefore, is (1).

Q15.
Using both Bernoulli's Theorem and the Continuity Equation is the key point here!

Bernoulli's Theorem: $\frac{v^2}{2g} + z + \frac{p}{\rho g} = const \cdots ①$

Continuity Equation: $Q = AV \cdots ②$

Let us look at the assumptions first!
The values for each cross-section are expressed with subscripts 1 and 2.
The area of each cross-section, therefore, becomes A_1, A_2,

and based on the statement of the question, we get $A_2 = \frac{1}{2} A_1$.

Furthermore, we get $z_1 = z_2$ by fixing the height at the center of the pipe.
Furthermore, the pressure becomes p_1, p_2, and based on the statement of the question we derive $p_1 - p_2 = \rho gh$.
Now that we are ready, let us solve the question!
Using ① and ②, we get

$$\frac{v_1^2}{2g} + z_1 + \frac{p_1}{\rho g} = \frac{v_2^2}{2g} + z_2 + \frac{p_2}{\rho g} \cdots ③$$

$$Q = A_1 v_1 = A_2 v_2 \cdots ④$$

and by rearranging ④ with respect to *v* and substituting it into ③, we get

$$\frac{Q^2}{2g}\left(\frac{A_1^2 - A_2^2}{A_1^2 A_2^2}\right) = \frac{p_1 - p_2}{\rho g} \cdots ⑤$$

We then substitute the assumptions for the cross-sectional area and the pressure head difference into ⑤, to solve for *Q*. We then derive

$$Q = \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}}\sqrt{2gh} = \frac{\frac{1}{2}A_1^2}{\sqrt{\frac{3}{4}A_1^2}}\sqrt{2gh} = A\sqrt{\frac{2gh}{3}}.$$

The correct answer, as described above, is (1)!

Q16.
The correct answer is (2).
Make sure you understand this, since this is a basic graph related to consolidation!

A simple example is provided here for those who have difficulty remembering the terms “normally consolidated ground” and “over-consolidated ground”.
For example, let us assume that we conduct a consolidation test by sampling the ground at a depth where the effective pressure (effective stress in the vertical direction) is 100 kN/m^2 and draw a curve for *e*-log *p*. If the *e*-log *p* curve is bent at the position where the top load *p* (load applied in the consolidation test) is 100 kN/m^2, then the ground is “normally consolidated ground”. On the other hand, if the *e*-log *p* curve bends at the top load that is larger than 100 kN/m^2 (120 kN/m^2 or 150 kN/ m^2), then the ground is “over-consolidated ground”. In other words, normally consolidated ground is ground where the consolidation yield stress is equal to the current effective pressure, whereas over-consolidated ground is ground where the consolidation yield stress is greater than the current effective pressure.

As is evident from the graph in Figure 1, the void ratio changes little with respect to the load in over-consolidated areas, but changes significantly in normally consolidated areas, thereby causing ground subsidence and requiring special attention.

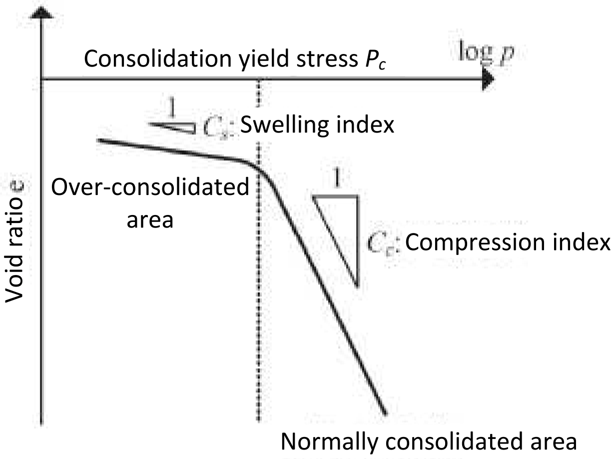


Figure 1: e-log p curve

Q17.
The correct answer is (4).
The Neighborhood Unit Theory is one of the classic urban planning theories that aims to create communities in suburban residential areas of the United States, involving a scientific examination by linking it to the physical planning of neighborhoods (Fig. 2).

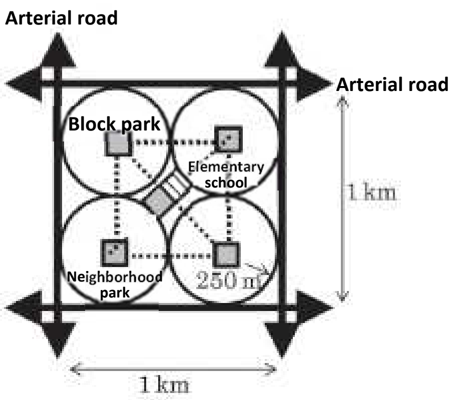


Figure2: Conceptual diagram of Neighborhood Unit Theory

(1) ×
The size of the residential area will be based on the **elementary school**, and will fit within a radius of about 400 meters from the elementary school.

(2) ×
The boundary of the residential area is bordered by **arterial roads**. This eliminates passing traffic.

(3) ×
Open spaces (such as parks) are spread out at approximately 250 m intervals**, so that children can visit to play**.

(4) ○
The generation of passing traffic and speed of vehicles are inhibited by intentionally making streets wind through residential areas or by reducing visibility.

Q18.

(1) ×

Fine aggregates refer to aggregates that pass all the way through a 10 mm sieve and at least 85% of which by weight pass through a 5 mm sieve.

(2) ×

The content of fine particles is considered to comprise 1% or less with gravel and 3% or less with sand. Aggregates with a diameter of 75 µm or less are called fine particles.

(3) ○

Fineness modulus refers to the nominal size of 80 mm, 40 mm, 20 mm, 10 mm, 5 mm, 2.5 mm, 1.2 mm, 0.6 mm, 0.3 mm and 0.15 mm, for which the sum of the mass percentages of those that remain on sieves is divided by 100. If there are many large aggregate particles, then the value for the fineness modulus will also be large.

(4) ×

Solid content in aggregate refers to the percentage of the absolute volume of aggregate filled in a container with respect to the container volume. If the solid content in aggregate is small, the particle size is often poor and fluidity is poor.

The correct answer, therefore, is (3).

Q19.

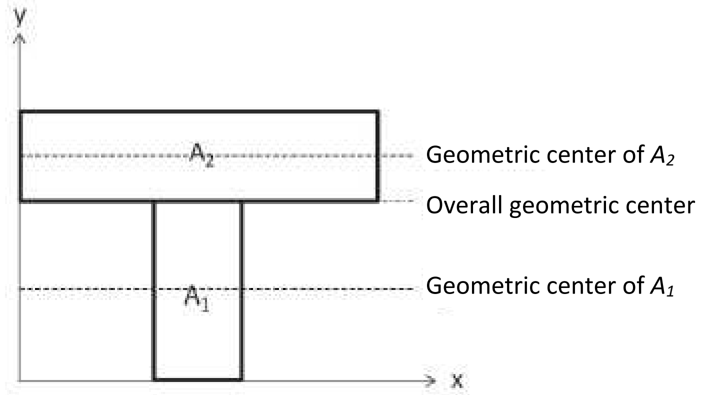


Figure 1: Division of T-type cross-section

The cross-sectional quadratic moment is a quantity that expresses the rigidity of an object in response to a bending moment.

Divide the T-shaped cross-section into two rectangles, to derive A_1 and A_2, as shown in the figure.

First, we need to find the overall geometric center position.

$$y_g = \frac{A_1 \cdot \text{(Distance from x-axis to geometric center of } A_1) + A_2 \cdot \text{(Distance from x-axis to geometric center of } A_2)}{A_1 + A_2}$$

$$= \frac{b \cdot 2h \cdot h + 4b \cdot h \cdot (2h + \frac{1}{2}h)}{b \cdot 2h + 4b \cdot h} = 2h$$

Next, we need to derive the overall cross-sectional quadratic moment .

Since the cross-sectional quadratic moment of a rectangle is $\frac{bh^3}{12}$, we get

$$I_x = \frac{b\cdot(2h)^3}{12} + \text{Area of } A_1 \cdot (\text{Overall geometric center - geometric center of } A_1)^2$$
$$+ \frac{4b\cdot(h)^3}{12} + A_2 \cdot (\text{Overall geometric center - geometric center of } A_2)^2$$
$$= 4bh^3$$

This means that the required cross-sectional quadratic moment is $4bh^3$.

Q20.

Establishing a momentum conservation equation in directions to the left and right of the cross-sections 1 and 2 is the key point of this question! The law of momentum conservation states that the "momentum flux moving in and out between cross-sections" = "sum of forces acting between cross-sections", and the momentum flux is expressed as (=ρQV). Furthermore, the pressure at each cross-section is assumed to be P_1, P_2, respectively. Therefore, if we ignore the force acting on the wall and apply the law of momentum conservation, we get the following.

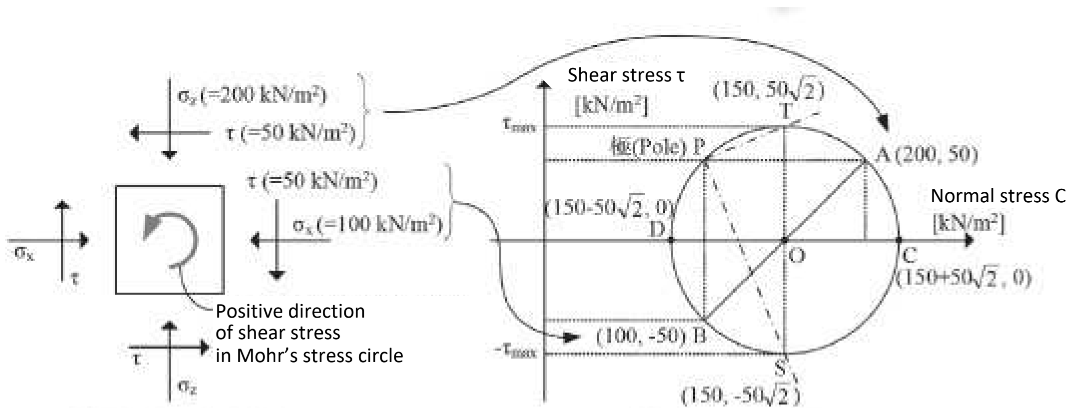
$$\rho g A \cdot \frac{P_1 - P_2}{\rho g} = \rho(Q_0+Q)\cdot\frac{(Q_0+Q)}{A} - \rho Q\cdot\frac{Q}{A}$$

Dividing both sides of this equation by ρgA and rearranging with respect to Q, we derive the following.

$$\frac{P_1 - P_2}{\rho g} = \frac{(Q_0+Q)^2 - Q_0^2}{gA^2} = \frac{Q\times(2Q_0+Q)}{gA^2}$$

The correct answer, therefore, is (2)

Q21.



(a) Stress state of soil element (b) Mohr's dynamic circle

Figure 2: Mohr's stress circle

Based on the given conditions, the stress state of the soil element becomes as shown in Figure 2(a). Here, in soil mechanics, the coordinate system is determined in such a way that the direction of the vertical stress is positive in compression, and the direction of the shear stress is "matched to the sign of the normal stress". In other

words, if the vertical stress is in the negative direction of the x axis, the shear stress acting on that surface will also be in the negative direction of the y axis. Let us draw this stress state with Mohr's stress circle.
When using Mohr's stress circle, it is important to pay attention to the direction of stress. In relation to the vertical stress, compression is considered positive in the same way the positive and negative directions are determined in the coordinate system and thus there are not many mistakes, but in relation to the shear stress, a set of shear stresses that cause a "counterclockwise" moment is considered positive (Figure 2(a)) . This is a rule established to match the direction of rotation between the actual working surface and Mohr's stress circle. This means that it is necessary to pay attention to the signs of shear stresses, since they do not necessarily match with the coordinate system of the soil element with regards to positive and negative directions. The "Polarity method", which is often used to draw Mohr's stress circle, is used to explain the method for solving the question by using Mohr's stress circle below.

① Coordinates for points A and B are determined based on the stress state on the horizontal plane (the plane on which σ_z acts) and the vertical plane (the plane on which σ_x acts).

② Draw a circle with diameter AB. The radius of the circle (in this instance 50√2) is derived in this way and the coordinates of respective points on the circle are derived.
Point C (D): Stress on the maximum (minimum) principal plane of stress.
Point T (S): Stress on the surface where the shear stress is maximum (minimum)

③ [This is where the polar method begins] Since point A represents the stress state on the horizontal plane, we draw a line horizontally from point A. Similarly, since point B represents the stress state in the vertical plane, we draw a line vertically from point B. These intersect at a single point (point P) on Mohr's stress circle. This point P is referred to as the pole. (When seeking the pole, it can be found from either point A or B.)

④ By using poles it is possible to determine the direction of the surface at any stress point. For example, the line drawn from point P to point T represents the direction of the plane where the maximum shear stress acts, where the angle between this plane and the horizontal plane is ∠TPA = 22.5°.

The correct answer, therefore, is (1).

Q22.
(1) ×
The reinforcement ratio is the value obtained by dividing the cross-sectional area of the main tensile bar by the effective cross-sectional area of concrete. The reason for using the effective cross-section is because the tensile stress of the concrete in the cover area is ignored.

(2) ×
The effective height is the distance from the compression edge of the member section to the center of the cross-section of the main tensile bar or main compression bar.

(3) ×
The cover depth is the shortest distance between the concrete surface and the reinforcing bar surface.

(4) ○

The correct answer, therefore, is (4).

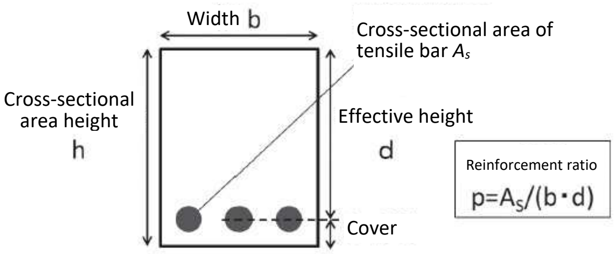


Figure 1: Tensile

Q23.

The most important point is to consider the deformation when the parts indicated by thick lines are removed. Other than (3), the nodes at both ends of the thick-lined members are separated due to the load. In other words, tensile force acts on these members. On the other hand, the nodes at both ends do not move in (3) .

The correct answer, therefore, is (3).

Q24.

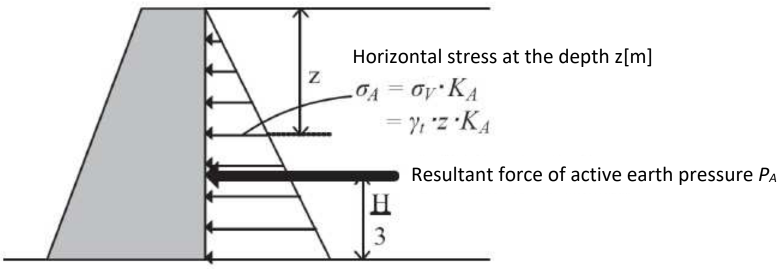


Figure 2: Horizontal stress acting on retaining wall and its resultant force

In the active earth pressure state, the horizontal stress σ_A at the depth z[m] is equal to the value derived by multiplying the vertical stress σ_V at depth z[m] by the active earth pressure coefficient K_A, and is expressed as

$$\sigma_A = \sigma_V \cdot K_A = \gamma_t \cdot z \cdot K_A$$

.

Since the horizontal stress σ_A increases in proportion to depth, the distribution of the horizontal stress σ_A acting on a retaining wall with height H[m] becomes a triangular shape, as shown in the figure. Since the active earth pressure P_A is the resultant force of the horizontal stress σ_A, it can be calculated by integrating the horizontal stress σ_A from the depth of 0 to H.

$$P_A = \int_0^H \sigma_A \, d_Z = \int_0^H \gamma_t z K_A \, d_Z = \frac{1}{2} \gamma_t H^2 K_A$$

$$= \frac{1}{2} \cdot 17.6 \cdot 5^2 \cdot 0.27 = 59.4\text{kN/m}$$

The correct answer, therefore, is (1).

Q25.

(A) ○

The discharge of a river can be measured more stably and accurately by measuring in a “straight section” that is not affected by river meandering!

(B) ×

The purpose of gauging stations is to measure changes in discharge. Therefore, accurate measurements will no longer be possible when any scouring or sand bar formation occur!

(C) ○

The river discharge data is derived by using the observed value of water level as input and using the relationship curve between the water level and discharge!

(D) ×

While there are many methods for measuring discharge during floods, the method using floats is used even today!

The correct answer, therefore, is (1).

Q26.

[Key point]

Understanding what exactly you are estimating, not merely memorizing names and sequences, will make it easier to imagine.

[Explanation]

With the four-stage estimation method, trips are estimated by dividing them into four stages in the order of “generated/concentrated traffic volume”, “distributed traffic volume”, “modal split traffic volume” and “route assigned traffic volume”.

Generated/concentrated traffic volume:

The traffic volume generated in each zone of the target area and the traffic volume concentrated in each zone of the target area.

Example: Estimation of the amount of people departing from Tokyo and Kanagawa Prefecture, and how many people are coming to Tokyo and Kanagawa Prefecture.

Distributed traffic volume:

The moving traffic volume that is derived by linking the generated zone and the concentrated zone with regards to the generation and concentration of traffic volume in each zone.

Example: Estimation of how many people travel between Tokyo and Kanagawa Prefecture.

Modal split traffic volume:

Traffic volume allocated to transportation modes (train, bus, private car, etc.).

Example: Estimation of how many people travel between Tokyo and Kanagawa Prefecture, sorted according to **respective transportation modes.**

Route assigned traffic volume:

The traffic volume derived by finding the modal split traffic volume for each link on the network.

Example: Estimation of how many people are traveling between Tokyo and Kanagawa prefectures for users of specific transportation modes, and by **which routes**.

The correct answer, therefore, is (1).

Q27.

(1) ×

Carbon dioxide and methane are greenhouse gases (also including dinitrogen monoxide, HFCs, PFCs, and SF6s). Ozone-depleting substances include specific fluorocarbons (freons 11, 12, 113, 114 and 115) as well as other organic chlorine compounds such as CFCs (freon 13, etc.), trichloroethane and carbon tetrachloride, or organic bromine compounds such as specific halons (halon 1211, 1301 and 2402).

(2) ×

See (1).

(3) ○

(4) ×

The ozone layer is destroyed and the amount of harmful ultraviolet radiation from the sun increases.

The correct answer, therefore, is (3).

Q28.

(1) ×

When the mass of an admixture to cement is 1 to 3%, the admixture is referred to as a “chemical admixture”. When the amount exceeds 3%, it is considered a “mineral admixture” and the amount of admixture used must be taken into account in the mixture calculation.

(2) ×

In general, the mineral admixtures are pozzolan, ground granulated blast furnace slag, silica fume, and expansion agents, while the chemical admixtures include AE agents, water reducing agents, hardening accelerators, setting retarders, and high performance AE water reducing agent, etc.

(3) ×

Entrained air is introduced by AE agents. Water reducers improve the dispersibility of cement, so they are used to reduce the amount of water required to produce concrete with the required slump.

(4) ○

The correct answer, therefore, is (4).

Q29.

The conditions assumed when calculating the bending capacity of reinforced concrete beams are as described below.

i) The plane section remains plane.

ii) Reinforcements and concrete are perfectly bonded.

iii) Reinforcements are perfectly elastic and have already yielded.

iv) The compressive stress of concrete has a nonlinear distribution, and the tensile resistance of concrete is ignored.

v) Failure is defined as the moment when the strain of concrete at the compression edge reaches 0.0035.

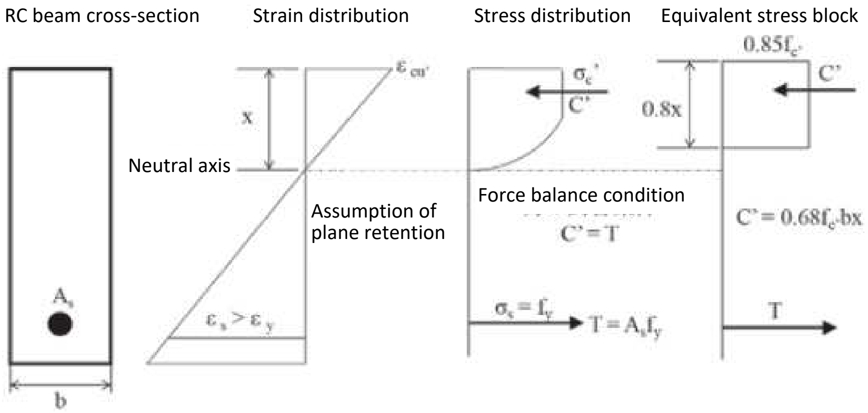


Figure 1: Conditions assumed when calculating the bending capacity of reinforced concrete beams

(1) Although the strain of concrete is proportional to the distance from the neutral axis, the compressive stress relationship of concrete is nonlinear.
(3) Since both strains are assumed to be proportional to the distance from the neutral axis, they are equal.
(4) The restraining effect of stirrups (shear reinforcing bars) may affect the peak strength and ultimate strain of concrete, but does not contribute to the strength of tensile bars.

The correct answer, therefore, is (2).

Q30.
(A) ○
The rate of slip stability F_s on a slope is defined as follows.

$$F_s = \frac{\textit{Force (or moment) that resists slipping}}{\textit{Force (or moment) that causes slipping}}$$

This indicates that the degree of stability increases with greater safety factor. The standard stability for slopes, incidentally, is as shown in Table 1.

(B) ×
Since the degree of stability is determined by considering only the balance of forces in stability analysis, it is not possible to determine the amount of displacement associated with slip failure.

(C) ×
The safety factor is set smaller than in normal times for earthquakes.

(D) ×
In general, the shear resistance force in the ground below the groundwater level decreases due to the decrease in effective stress as the groundwater level rises, which in turn reduces the safety factor.
The correct answer, therefore, is (3).

Table 1: Slope stability safety factor

$F_s < 1.0$	Instability
F_s =1.0 to 1.2	Stable but somewhat unstable
F_s =1.3 to 1.4	Stable for excavation and embankment work, but unstable for earth dams
$F_s > 1.5$	Stable even for earth dams

Q31.

(A) ×

When a tsunami propagates from offshore to the coast and is influenced by the bottom, it undergoes deformation (refraction, reflection, diffraction, scattering, etc.).

(B) ×

Relying solely on hardware measures such as structures as protection against tsunamis is insufficient; it is important to also develop soft measures such as evacuation procedures!

(C) ○

The wave speed of the long wave by which the tsunami travels can be calculated with $v = \sqrt{gh}$.

$v = \sqrt{9.8 \cdot 250}$ = 49.5 (m/s)

The unit of the question in this instance is km/h, therefore by converting the unit we obtain
49.5 (m/s) = $49.5 \times 10^{-3} \times 60 \times 60$ = 178.1 (km/h)

(D) ×

Tsunamis often begin with what is called a run-up wave.

The correct answer, therefore, is (4).