Entrance Examination for the 2015,

Department of Civil Engineering,

Graduate School of Engineering, the University of Tokyo

Problems of "Civil engineering"

August 25th 2014 (Monday) 13:00 - 16:00 (180 minutes)

(Fields 1, 3 and 4 are not provided in English.)

Please write your answer to problems in two fields which you have selected on questionnaire sheet. If you answer problems in different fields, your answer shall not be marked.

Please use different answer sheets for different problems. For each of answer sheet you have, please fill your examinee's number, field number, and problem number (e.g. Field 1, Problem 1).
You can use the reverse side of answer sheets. When you require additional answer sheets for fields 1 to 6, please raise your hands. If you use multiple answer sheets for one problem, please put sheet number. You can ask additional answer sheets for calculation.
You have to submit problems, questionnaire sheet, and all answer sheets (including blank sheets or ones for calculation) after the examination.
For Field 7 (Mathematics), please select two problems out of six problems. Please note that special answer sheets are provided for field 7 and that you cannot use additional answer sheets for field 7.

Field 2 (Concrete Engineering and Geotechnical Engineering)

Problem 1

(1) Answer the following questions. If you judge that some characteristic values of materials are not provided for solution, you may solve the problems by defining them by yourself.

a) Calculate the ultimate flexural capacity "Mu" of the cross-section (see Fig. 1) when the axial force is zero.

b) The ultimate flexural capacity varies according to the axial force, which is first applied to the cross-section as shown in Fig. 1 prior to flexure. Compute the axial force which leads to the maximum ultimate flexural capacity.

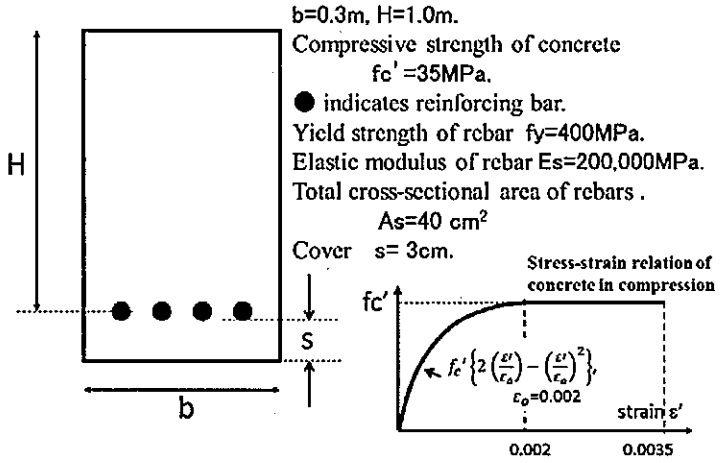


Fig. 1 Reinforced concrete section and characteristic values of materials

(2) Answer the following questions.

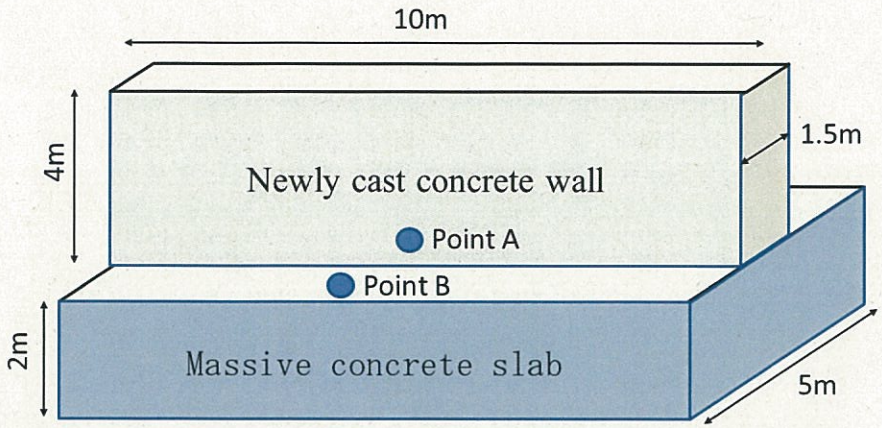
a) Explain within 5 lines how the slump value of fresh concrete just after mixing, drying shrinkage of the hardened concrete and the compressive strength of concrete at 28 days vary when cement content is increased under the fixed unit water content and sand/aggregates volume ratio (s/a) as shown in Table 1.

Table 1 Mix proportion of concrete

Max. size of coarse aggregate (mm)	Slump (cm)	Water to cement ratio (%)	Air content (%)	Fine aggregate ratio: s/a (%)	Unit content (kg/m³)				
					water W	cement C	sand S	gravel G	admixture
20	8	55	2	44	187	340	800	1050	0

note) normal Portland cement used

b) Figure 2 shows a wall which is newly constructed above the massive concrete slab whose strength has been sufficiently developed. Illustrate how the principal stress and the tensile strength at Point A and Point B vary according to time after casting concrete of the wall.



Joint between the massive slab and the wall was properly processed and constructed according to codes for practice.
Age of slab concrete exceeds 100 days
The structure is exposed to 100% relative humidity.
Point A and Point B are located on the surface of concrete body.

Fig. 2 Concrete wall constructed above the massive slab.

c) Figure 3 shows a simply supported reinforced concrete beam subjected to repeatedly travelling traffic loads on the beam through a deck slab. Explain with about 8 lines which one of the following cross sections A and B (See Fig.3) may bring about longer service life. The concrete used for construction is shown in Table 1. Concrete placing and curing are well done according to standard specifications and codes for practice.

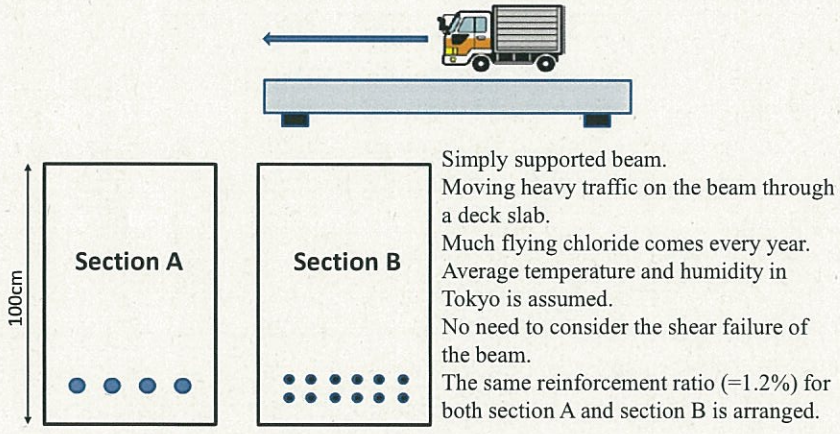


Fig. 3 Reinforced concrete beam subjected to moving traffic loads

Problem 2

(1) Answer the following questions.

a) Explain the reason why rapid construction of high embankment using soils with low permeability and high water content causes higher risk of failure of embankment, within 6 lines.

b) Explain the reason why the time required for consolidation is proportional to square of the thickness of the consolidating soil layer, within 6 lines. Conditions other than the thickness of the consolidating soil layer are supposed to be the same.

(2) Limit equilibrium method uses Coulomb's earth pressure theory to calculate the total earth pressure on a retaining wall for every 1 m of width, as well as the angle of slip surface. In Fig. 4, the wall tilts to the active direction with a hinge at its bottom. Show the process of this calculation following the questions below. The backfill soil is a dry sand with cohesion $c = 0$ (kN/m^2), friction angle $\phi > 0$, and unit weight γ_d (kN/m^3). The height of wall is H (m), and the friction between the wall and the backfill soil is ignored.

a) Suppose that the angle of the slip surface is α. The forces applied on the triangle block between the slip surface and the wall consist of gravity force W (kN), total earth pressure P (kN) on the wall, friction force S (kN) on the slip surface, and normal force F (kN) on the slip surface. Show the equations of equilibrium of these forces in the vertical and horizontal directions.

b) Solve the equations of a), and show the formula to calculate the total earth pressure P from the friction force S and normal force F.

c) Based on the Mohr-Coulomb failure criteria, calculate the maximum friction force S_{max} (kN) which can be expected on the slip surface when a normal force F is applied.

d) Calculate the safety factor $SF = S_{max} / S$ for the slip failure along the slip surface using α and P.

e) The total earth pressure P reduces while the wall tilts to the active direction, and the backfill soil fails along a slip surface for which the safety factor SF becomes 1. Calculate the total earth pressure P and corresponding angle of slip surface α when active failure takes place.

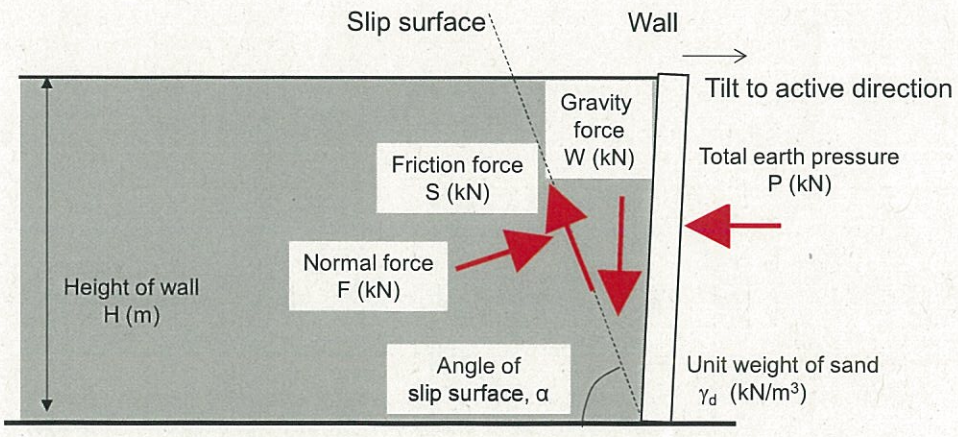


Fig. 4. Wall tilting to active direction and corresponding slip surface.

Field 5 (Land, Urban, Transportation and Landscape Planning)

Problem 1

Considering the recovery of railways in the face of disaster reconstruction in a region, answer the following questions.

(1) Railway operators (A) are considering a recovery. In this case, the users (B) and the railway operators (A) are assumed to gain benefits based on the combination of strategy alternatives as shown in Table 1. Explain the desired combination of strategy alternatives with reasons, and explain policies to realize the combination of strategy alternatives in details.

Table 1 A pay-off matrix of each player's strategy alternatives in the situation of railway recovery

Railway operators (A)

Users (B)		**Restore the railways**	**Withdrawal from the railway business**
	Use the railways	**(1, 1)**	**(-1, 2)**
	Use the cars	**(2, -1)**	**(0, 0)**

* If users (B) are trying to use the railway and railway operators (A) decide to withdraw from the railway business, (B) gain -1 and (A) gain 2 temporarily.

(2) Explain two survey analysis methods to evaluate the feasibility of railway restoration projects in disaster reconstruction process in about five lines each.

(3) Explain three measures for public transportation recovery in a disaster affected region, other than restoring the railways to the original state, including their advantages and disadvantages, in about four lines each.

Problem 2

Answer the following questions on the revitalization of central urban areas.

(1) In recent years local shopping districts consist of personally owned stores have been declining in many cities. Give two factors for this declining and explain each in three lines.

(2) Compact city is one of the ideas to realize sustainable city by revitalizing central urban areas. Explain in about five lines, the concept of compact city by using all the words given bellow.

hollowing out of central urban areas, public transport, pedestrians,
concentration of urban functions, local communities

(3) Figure 1 shows a basic policy concerning the townscape formation in a commercial area presented in the landscape plan of a city. It is intended to realize an attractive street space for pedestrians by forming low-rise buildings into a townscape on a human scale.

a) Both total coordination and diversity of building designs are necessary to create fascinating street spaces for pedestrians. From this aspect, explain the design ideas shown in Fig.1 in about five lines.

b) Impressions of street space depend on the proportion of the width of streets D to the height of buildings H. Give an example of D/H appropriate for the townscape shown in Fig.1, and explain the reason referring to your design image of the street space, in about seven lines.

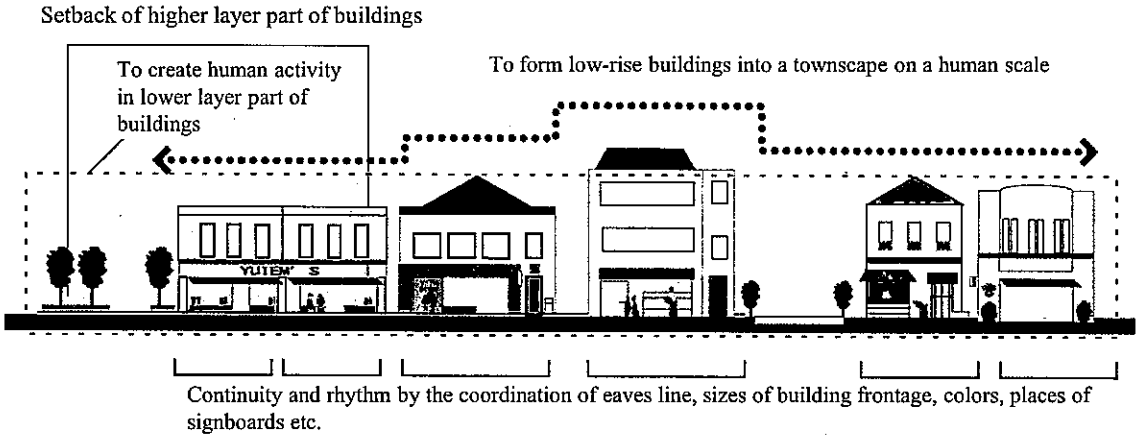


Figure 1 An example of basic policies of the townscape formation in a commercial area

(Source : Landscape Plan, Kamakura city, 2007.1, partially modified)

Field 6 (International Project and Management)

Problem 1

Read the following sentences on the management of infrastructure development projects and answer the questions related with the underlined parts.

A local public body was selected to hold a world sport event and had planned to develop infrastructure facilities for that purpose. First, the project manager of infrastructure development organized the team for promoting projects with outside professionals$_1$ to make up for a deficiency of in-house engineers. Budget, time for completion, and features of infrastructure facilities$_2$ are needed to be considered in the design stage of individual infrastructure facility. The project manager selected a construction company$_3$ to obtain information on methods and price for construction in the stage of detailed design to meet the targeted budget and time for completion. Furthermore, the project manager determined the design details based on the information, negotiated the price of construction$_4$ with the construction company, and made a contract agreement for work with it. The construction was smoothly executed with less numbers of design changes$_5$, compared with the traditional project delivery method, and was completed on time and within the budget.

(1) Regarding the underlined part 1, select an appropriate form of contract with outside professionals and explain its reason in approximately four lines.
(2) Regarding the underlined part 2, there are generally trade-off relationships among cost, time and quality, in project management. Describe the trade-off relationships concretely among cost, time and quality, considering a case of construction project for infrastructure facility in approximately eight lines.
(3) Regarding the underlined part 3, explain an appropriate method of selection for a construction company and its reason in approximately six lines.
(4) Regarding the underlined part 4, take an important issue to be considered in the negotiation with the construction company and explain its reason in approximately six lines.
(5) Regarding the underlined part 5, explain reasons in approximately six lines for less numbers of design changes in this project delivery method described in the above sentences.

Problem 2

Answer the following questions regarding the recent infrastructure-system exporting policy promoted by the Japanese Government:

(1) Raise two expected benefits for Japan that could stem from the promotion of infrastructure-system export and explain them in approximately four lines for each.

(2) Recently, a series of changes in institutional system of the Official Development Assistance (ODA) have been made in Japan for promoting the infrastructure-system export. One of them is the reform of the ODA Loans in 2013, where the concessionality level (*) has been raised in important sectors and the Special Terms for Economic Partnership has been revised. Explain a reason that the above reform would lead to the promotion of infrastructure-system export in approximately four lines.

(3) One of the methods to promote the participation of Japanese private businesses in the infrastructure projects of developing countries is the vertical separation approach incorporating the ODA. Explain the reason that this could promote the participation of the Japanese private businesses in approximately four lines.

(4) It is often pointed out that the infrastructure-system export has not been successfully implemented in spite of the Japanese Government's efforts. Raise three major reasons for it and explain them in approximately three lines for each.

* Concessionality level is a measure of the "softness" of a credit, reflecting the benefit to the borrower compared to a loan at market rate. It is equal to 100 percent when it is a grant, while it is equal to 0 percent when it is a loan at market rate.