

**The University of Melbourne
Semester 1 Assessment 2005**

Faculty of Architecture, Building and Planning

Subject Number: 702-308 & 702-889
Subject Title: Structures and Construction 3A

Exam Duration: Three hours
Reading Time: 15 minutes
This paper has 5 pages

Authorised materials:

The following items are authorized:
Electronic calculators and drawing instruments

Instructions to Invigilators:

Students require 3 script books. (1 x 7 page and 2 x 14 page)
This exam paper may be removed from the examination room at the completion of the exam.

Instructions to students:

The student is to write their student number in each examination booklet.
Write on the front cover of each booklet, the questions number/s answered in that booklet.

Candidates should attempt All FIVE (5) questions. You will require at least 3 booklets.

Questions 1 and 2 must be answered in ONE 14 page booklet.

Questions 3 and 4 must be answered in a SEPARATE 7 page booklet.

Question 5 must be answered in a SEPARATE 14 page booklet.

Write the question numbers answered on the front cover of each booklet.

Lodging of paper with Baillieu Library:

This exam paper can be lodged with the Baillieu Library after the completion of the examination period.

Question 1. Reinforced Concrete: (Total 20 %)

Question 1 and 2 to be answered in the ONE 14 page separate booklet.

- (a) The engineering drawings provide detailed structural information so that the contractor is able to construct the building. One of the drawings in the structural set usually contains a "Column schedule". With the use of annotated sketches, indicate the necessary information that must be provided on a column schedule drawing.

(5 %)

- (b) Additives are used in concrete mix designs for varying purposes. The Australian Standard AS 1478.1 uses codes for the admixtures types. Explain the code "HWRRe". List the two main characteristics of this admixture and indicate its application

(4 %)

- (c) A continuous span reinforced concrete slab is 150mm thick and is reinforced with RF918 fabric in the bottom, and RF1018 fabric in the top. Cover to the reinforcement is 20mm minimum.

If the steel fixer has placed the bottom reinforcement upside down in the slab, what is the percentage loss of strength in the positive moment capacity of the slab ?

(4 %)

- (d) A "Balanced failure condition" is the preferred design option for engineers. If beam depths are restricted due to head height, "Compression failure" of the concrete becomes a major concern. With the aid of an annotated sketch and brief notes, describe the options available to the engineer to overcome this failure mode.

(4 %)

- (e) The connection between a reinforced concrete central services core and the reinforced concrete suspended slabs is usually detailed by the engineer as a formed rebated connection. Using EITHER one of the two patented systems listed below, describe the key features and components of this structural connection. Labeled diagrams should be used to illustrate your answer.

- The Danley " REBOX " rebating system
- The Acrow " RIPBOX " continuity box

(3 %)

Question 2. Composite Construction (Total 25 %)

- (a) Profiled galvanised steel decking is often used to its optimum advantage in steel frame buildings because full advantage can be taken of sheet continuity to increase slab load capacity. The resultant slab can also be made composite with the steel beams. This means that composite action can be achieved in two (2) ways.

Describe in point form, with the aid of annotated diagrams, the following:

- (1) How composite action is achieved within the slab.
- (2) How composite beam action is achieved.

(9 %)

Question 2. Composite Construction (cont'd)

- (b) The progressive strength design method for composite columns can be achieved by utilising two different methods of construction. The steel column can be further reinforced and then encased in concrete or alternatively a steel tube section can be concrete filled, (with or without additional reinforcement).

For the concrete filled steel tube design:

- (1) Highlight the key aspects that improve the structural performance by this composite action.
- (2) List the construction advantages this design method has over the more traditional concrete encased method.

(6 %)

- (c) Briefly describe the method of fixing shear studs through profiled steel decking to steel beams, including the necessary equipment for their installation. Sketches may be used to illustrate your answer.

(5 %)

- (d) The new Australian Composite Construction Code AS2327 requires the use of "BHP Deckmesh" or similar profiled reinforcement, when steel profile decking is used in a slab acting compositely with a steel beam. With the aid of sketches, briefly describe the stresses in the slab and indicate how the reinforcement is placed to overcome these stresses.

(5 %)

Question 3. Concrete Surface Finishes (Total 10 %)

Questions 3 and 4 to be answered in the ONE 7 page separate booklet.

You are the designer for a large distribution centre for the "Woolworths" brand company. The complex consists of two buildings, a large warehouse and an office complex. The client, "Woolworths", has requested a highly visible complex with a major portion of the external cladding to be in

“Off-form” concrete. Precast concrete panels are the preferred option.

The normal standard dull grey concrete is not acceptable.

Describe the surface finishes including any colour that you would adopt for each building and provide a brief outline specification to achieve your selected surface finish and for production of the precast panels.

(10 %)

Question 4. Sprayed Concrete: (Total 15 %)

- (a) Which ingredient in the concrete mix design reduces rebound?
List two other benefits that this ingredient produces for the mix.

(3 %)

- (b) How would you check the compressive strength and density of concrete in a shotcreted retaining wall?

(2 %)

Question 4. Sprayed Concrete: (Cont'd)

- (c) Briefly describe the construction method and processes typically used to prevent embankment corrosion / degradation when the finished product must be similar in character to the existing soil / rock embankment. Sketches may be used to help explain your answer.

The landscaping project completed on sections of the Eastern Freeway Extension is typical of this construction method and may be useful in formulating your answer.

(7 %)

- (d) A basement retention system comprises precast concrete soldier piles with 200mm thick concrete infill panels between the piles. The infill panels are reinforced on both sides with N16 bars at 150mm centres vertically and N16 bars at 300mm centres horizontally. The infill panels are to be shotcreted.

Draw up a checklist of items that need to be addressed in order to limit potential problems that may occur with the shotcrete application.

(3 %)

Question 5. Prestressed Concrete : (Total 30 %)

Question 5 to be answered in ONE 14 page separate booklet

- (a) (1) List the two most common sizes of prestressing strand used in post-tensioned construction and the approximate breaking load in kN.

- (1 %)
- (2) What percentage of the breaking load are the strands usually subjected to during initial stressing?
(1 %)
- (b) Approximately how much stronger is a 12.7mm diameter pre-stressing strand when compared to a normal 12mm diameter reinforcing bar assuming the areas of each are the same?
(2 %)
- (c) A one way continuous post-tensioned slab and band beam structure is proposed for a new office building. Due to town planning conditions, there is a constraint on building height and therefore the following maximum slab and beam depths have been adopted for construction.
- Slab 185mm thick
 Band Beam 400mm thick x 2400mm wide
- Using approximate methods, what likely spans could be achieved with these concrete profiles for both the slab and the beam?
(2 %)
- (d) At the live and dead end anchorage locations, the concrete is subjected to very high stresses during stressing.
- (1) Illustrate by way of a sketch, the two possible ways the concrete may fail in the vicinity of the live end anchor during stressing.
(2 %)
- (2) At the dead end "onion" type anchor, a length of free strand is normally provided. Explain why this is required.
(2 %)

Question 5. Prestressed Concrete : (Cont'd)

- (e) (1) In post-tensioned construction, at what concrete strength do we normally apply the final stress?
(1 %)
- (2) In a post-tensioned pour, before placement of the concrete can occur, list four items that should be checked by the site foreman or builder prior to calling the engineer for an inspection.
(1 %)
- (f) Transfer beams are most often post-tensioned and are most commonly used to support large loads from upper level floors, where columns supporting these floors cannot extend through to the foundations. Why are these beams sometimes progressively stressed?
(3 %)
- (g) Describe the differences between balanced loads and the ultimate loads in the design of post-tensioned members.
(2 %)

- (h) Load balancing is commonly used by structural engineers for the design of post-tensioned beams and slabs. An office building contains a rectangular beam 1,000mm wide x 600mm deep, simply supported between precast panel walls with a span of 8.4m. The beam supports a central concentrated load of 180 kN and comprises a single duct with 4/12.7mm diameter strands. The strands have an eccentricity from the neutral axis of 200mm at mid-span. The strands at the ends are located at the neutral axis.
- (1) Sketch an elevation of the beam indicating the profile of the duct, the location of the duct at mid-span and at the ends. (Neglect self weight effects)
(2 %)
 - (2) Name three special conditions that exist at the load balance stage.
(1 %)
 - (3) The beam is designed to be load balanced for the concentrated load only. If at this load balanced stage the stresses are 3.15 Mpa, calculate the prestressing force required for this stage.
(2 %)
- (i) Explain why steel with a low yield stress is not used in pre stressed construction.
(2 %)
- (j) In the design of pre-stressed and post-tensioned members, losses must be taken into account when determining the level of prestress force required.
- (1) Which loss contributes the greatest amount to the losses that occur immediately in post-tensioned construction?
(1 %)
 - (2) If a beam is load balanced for its self weight only, explain why at the time of stressing there is most likely to be an upward camber.
(3 %)

This is the end of the examination