

Structural Engineering 1 – June 2006



University of South Australia

If you are required to use a calculator,
please note the make and model here:

Calculator Make:

Calculator Model:

2006 Mid Year Examination

Student ID Number

Student ID Number

Family Name	
Given Names	

Division of ITEE

School of Natural and Built Environment

Course Name Structural Engineering 1

Subject Area CIVE Catalogue Number 2003

Examination Day Friday Examination Date 30th June 2006

Examination Time 2.00 pm Length of Exam 3 hours

Examination Venue: Ridley Centre

Instructions to Candidates

- a) Attempt ALL questions.
- b) Marks for questions are shown in brackets.
- c) You may use the following books/information:
 - a) SAA HB2.2 – Australian Standards for civil engineering students Part 2: Structural Engineering 2003 edition
 - b) Onesteel 300 plus “Hot Rolled and Structural Steel Products”, Third edition (photocopy)
 - c) A total of 2 double sided A4 pages with any notes, formulae, information etc you desire to include

Conduct in examinations

- Students are responsible for finding out their examination times and locations and for travelling to the venue. Examination times and locations are published on the University web site and advertised on the student portal. It is recommended that students arrive at least 15 minutes prior to the advertised start time.
- Students who arrive up to 30 minutes after the published start time will be permitted to enter the examination room but will not be allowed any additional time to complete the examination.
- Students who arrive more than 30 minutes after the published start time will not be permitted to enter the examination room and will receive a zero mark for that assessment.
- All students must bring with them, and display on their desk:
 - their student identification card: or
 - an alternative form of photographic identification such as a passport or driver's license. If a student does not provide acceptable photographic identification the invigilator will compare the student's likeness with University records in order to verify the student's identity;
- Where applicable, students must also display on their desk:
 - an approved disability access plan; and/or
 - an ENTEXT Card (for students who are entitled to extra time but have not been issued with an indicator on their student identification card)
- Unless otherwise specified in the course information booklet or as an agreed provision under Section 3: Moderation and Variation, a student must not take into the examination room any item with the potential to provide them or another student with an advantage, including but not limited to:
 - text books or any other book including dictionaries
 - calculators
 - mobile telephones, personal digital assistants, messaging devices or any other electronic device
 - notes, or other written documents
 - devices or personal items
 - examination answer booklets, attendance slips or scrap paper
- Any items specified as being allowed in the course information booklet must not be enhanced or tampered with in any way that provides an additional advantage to the student or any other student.

Procedures during the examination

- Every student must complete the attendance slip provided.
- The examination starting time may include a designated reading time for students. During this reading time, students are not permitted to write in the examination booklets but may complete attendance slips, fill in details required on the front cover of examination booklets, and make notes on loose-leaf paper provided. An invigilator will announce when the reading time has elapsed, after which students may write in the examination booklet.
- No student will commence writing answers until authorised by an invigilator. All students must stop writing when instructed by an invigilator. At the end of the examination all students must remain seated until all examination booklets have been collected.
- During an examination students are not permitted to speak to or communicate with any other student, or give or receive any form of assistance, academic or otherwise.

Procedures for leaving the examination room

- Students are not permitted to leave the examination room in the first 30 minutes after the published starting time or during the last 10 minutes of any examination.
- After the first 30 minutes of the examination has lapsed, a student can request to leave the examination room for a short break. When approval is given by an invigilator, the student will be supervised during the period of absence.
- Students wishing to permanently leave the examination room must hand all examination booklets to the invigilator who will endorse the booklets as correctly identifying the student. Students cannot remove any examination answer booklets, scrap paper or attendance slips from the examination room.

Breaches of examination procedures

- A breach of the examination procedures may constitute academic misconduct. Procedures are deemed to be breached even if it cannot be demonstrated that the student gained an advantage from the breach. For example, if a student takes a mobile telephone or device into the examination room but does not switch it on or remove it from their pocket, it may still constitute academic misconduct although the intent is recognised in determining an appropriate outcome.
- Breaches of the examination procedures will be recorded under Section 9: Academic Integrity of this manual whether they constitute academic misconduct or not.

Procedures for breaches that cause disruption to an examination

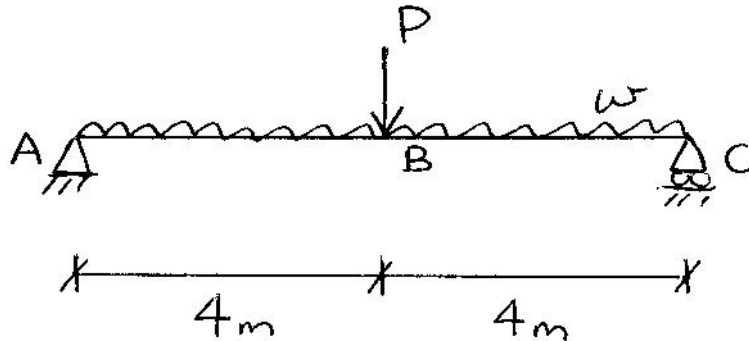
- Any student disrupting the examination can be instantly dismissed from the examination room at the discretion of the chief invigilator. Where dismissal is the appropriate course of action, the chief invigilator will document the incident and provide a report to the Head of School or Director: Regional Engagement or nominee.
- The Head of School or Director: Regional Engagement or nominee will investigate the incident as either:
 - academic misconduct by following the procedures for formal inquiry set out in Section 9: Academic Integrity, or
 - misconduct under Statute 7: Student Misconduct.
- Where dismissal is not deemed appropriate by the chief invigilator, the student will be permitted to remain in the examination, and clause 6.6 will apply.

Procedures for breaches that do not cause disruption to an examination

- If a breach is detected that does not cause disruption to the examination, or is assessed by the chief invigilator as not warranting dismissal from the examination room, the invigilator will tell the student that the breach has been detected and will be reported.
- The invigilator will document the incident and will provide a copy of this report to the Academic Integrity Officer at the relevant school within 5 working days of the incident.
- If the Academic Integrity Officer considers that the breach constitutes academic misconduct, they will investigate the incident by following the procedures for managing alleged academic misconduct set out in Section 9: Academic Integrity.
- If the Academic Integrity Officer considers that the breach does not consider academic misconduct, they will provide academic counselling to the student.

PART A: Steel Design

QUESTION 1



The beam pictured above is simply supported on columns at A and C. It is laterally restrained at A, B and C. It is made from Grade 300Plus steel. The applied, unfactored loads are:

$w_G = 10$ kN/m including self weight of the beam

$w_Q = 12$ kN/m from a non-storage live load

$P_G = 0$ kN

$P_Q = 50$ kN from machinery

- a) Draw separate Shear Force and Bending Moment Diagrams for the uniformly distributed loads (udl) and point load on the beam 6 marks
- b) Determine a suitable beam size based on the following two separate serviceability requirements:
- Deflection under the serviceability udl must be $\leq L/300$
 - Deflection from the machinery load alone (unfactored) must not exceed 5 mm for satisfactory operation of the machinery.
- Note that the deflection at midspan under a central point load is given by:

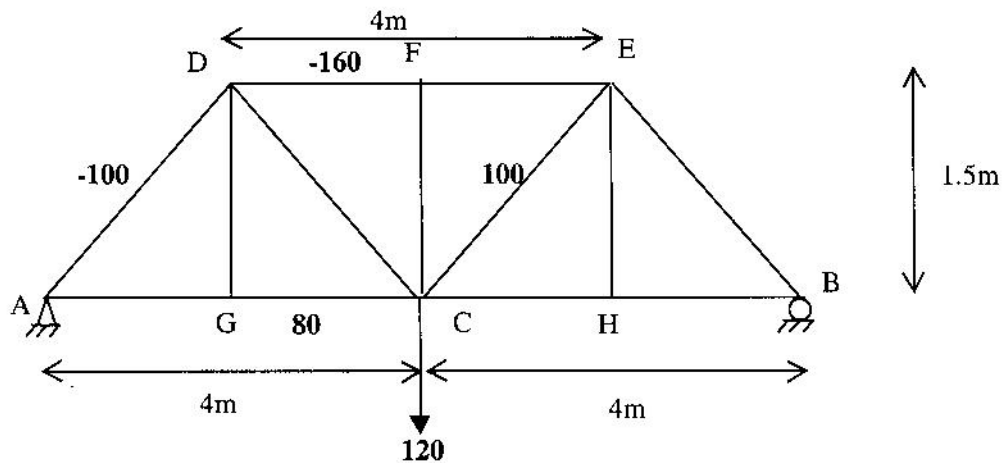
$$\Delta = \frac{PL^3}{48EI}$$

6 marks

- c) Check the beam size determined from (b) is adequate for section and member moment capacity. Assume that the beam is **not** fully laterally restrained. [If you have not been able to complete (b) then assume a 530 UB 92 for this part]. 12 marks
- d) Check the shear capacity of the beam. Check that the combined shear and bending capacity is Ok at point B, using the interaction method. 6 marks

Total = 30 marks

QUESTION 2



The truss pictured above carries an ultimate load of 120 kN at point C. The corresponding internal forces (in kN) of the truss are shown next to selected members (tensile forces positive). All members of the truss can be assumed to be pin jointed at each end and fabricated from equal angle sections, Grade 300Plus. Assume all connections are made with single lines of M20 bolts.

- a) Check whether a 100 x 100 x 10 Grade 300Plus equal angle section is suitable for all compression members.

12 marks

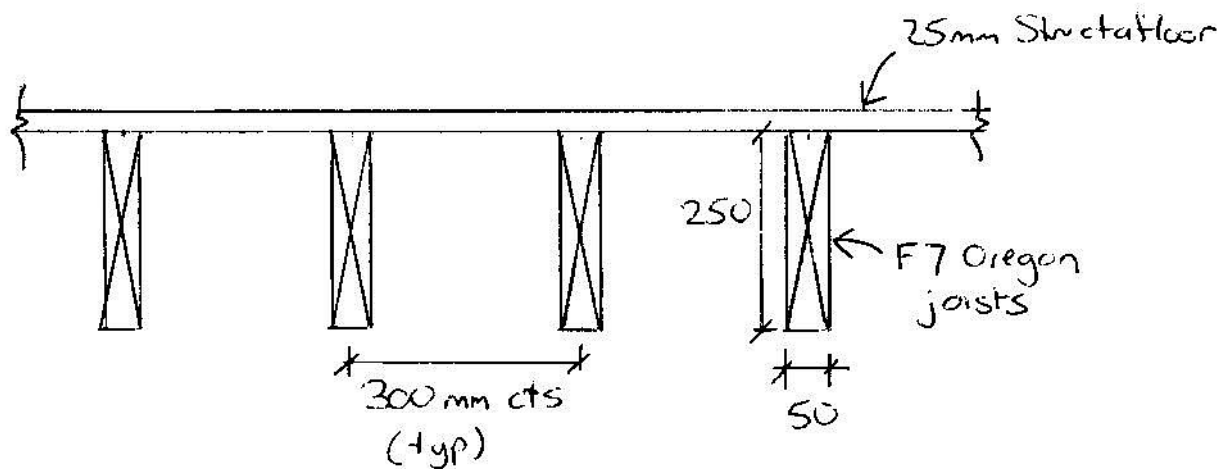
- b) Check that this member is also suitable for the tension members in the truss

8 marks

20 marks

PART B: Timber Design

QUESTION 3



You have been asked to check whether the existing floor in an office building in Adelaide will be suitable for use by aerobics classes on a regular, weekly basis. Although the floor live load will be increased from 3 kPa to 5 kPa, the original building plans show that this part of the building was previously used for storage, so the floor may be adequate. Design information includes:

- Joists are 250 x 50 F7 Oregon (North American Douglas Fir) at 300 mm cts
- Joists span 4m between simple supports.
- The floor is internal and the joists have been in place for 15 years.
- Flooring is 25 mm Structafloor (a sheet panel flooring system), fixed to the top edge of every joist with nails at 300 mm cts. [The flooring itself is shown to be adequate by the manufacturer's data]
- Dead load from self weight of flooring, joists etc = 0.6 kPa (unfactored)
- Live load = 5 kPa (unfactored)

a) Check the joists are adequate for bending

18 marks

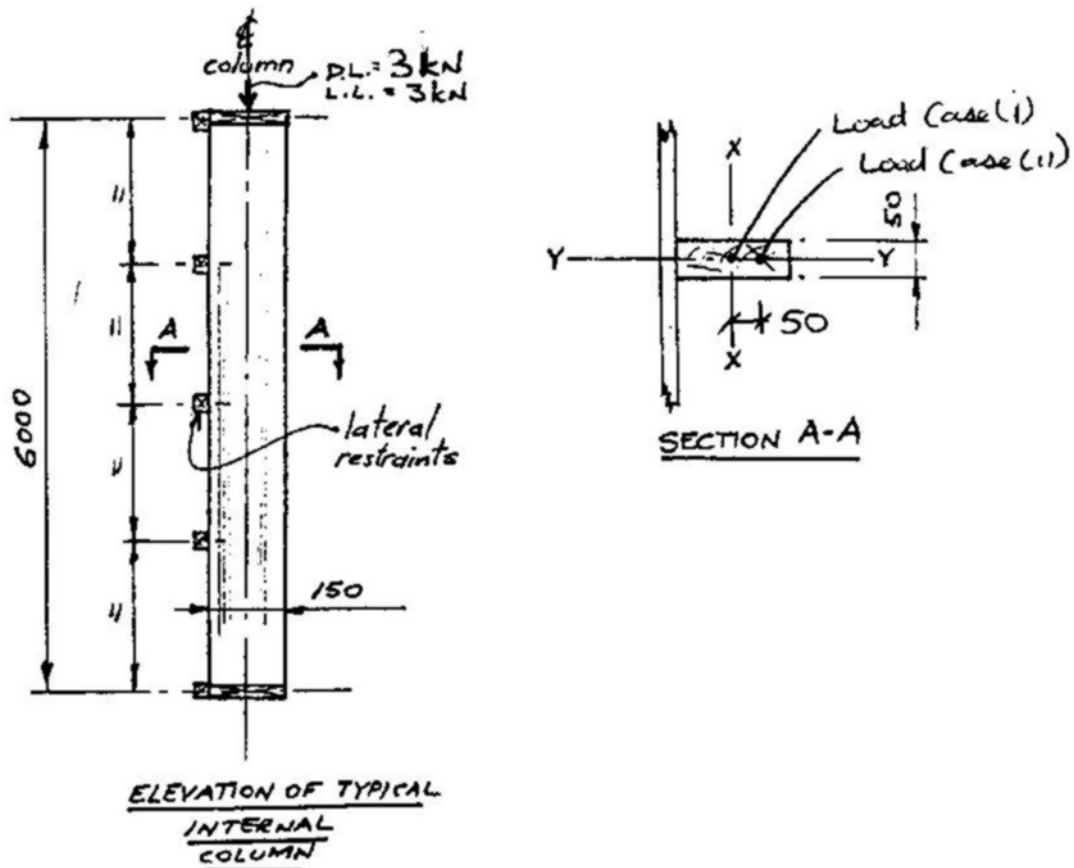
b) Check that the joists are adequate for serviceability by satisfying each of the following criteria:

- Total deflection under all loads must be $\leq L/300$
- Dead load only deflection must not exceed 12 mm absolute maximum to avoid damage to the ceiling hung below

12 marks

Total = 30 marks

QUESTION 4



A storage shed is constructed in Melbourne using 150 x 50 F11 unseasoned Jarrah columns, 6 m high and spaced 3 m apart (Jarrah is a hardwood). Each column supports a dead load of 3 kN (unfactored) and a live load of 3 kN (unfactored). The live load occurs during construction and maintenance. The columns are fully enclosed within the building.

Each column is laterally restrained about the minor (Y-Y) axis by 5 girts at 1500 mm cts. Columns are effectively restrained in position and direction at the top and bottom.

- Determine whether the columns are adequate when the loads are applied concentrically – Load Case (i)
10 marks
- Check that the columns are still adequate when the loads are applied with an eccentricity of 50 mm from the x-x axis, along the y-y centreline – Load Case (ii)
10 marks

Total = 20 marks