CIVL1810 Engineering Construction and Surveying

SCHOOL OF CIVIL ENGINEERING · THE UNIVERSITY OF SYDNEY · LEVEL 1

Full guide + ask Sia about CIVL1810

SIDE 1/2 DEFINITIONS · FORMULAS · DECISION RULES · COMPARISONS

EXAM REVISION SHEET

S2 2026 · Final Exam 50% · two-hour written technical problems

01 · Exam map COURSE.JSON · BRIEF

A1 10 | Q1 10 | Q2 10 | REPORT 20 | FINAL 50

ASSESSMENT	WT
Early Feedback Task	0%
Assignment 1: Technical Drawing and Research	10%
In Class Quiz 1 / Quiz 2	10% + 10%
Technical Report	20%
Final Exam	**50%**

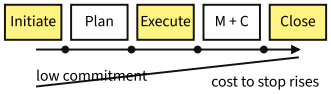
Permitted materials: not confirmed for this offering in the course materials we hold — check the exam instructions on the LMS.

FINAL SHAPE *Recent papers use a 50-mark total: one multi-part surveying computation, a formwork calculation with equations/coefficient table supplied, then construction process questions where labelled sketches carry marks.*

02 · Project decisions CH 1

Project = unique purpose + temporary start/finish + resources from several areas + uncertainty. *Stakeholder* includes anyone involved *or* positively/negatively affected.

GATES CONTROL COMMITMENT



Each phase produces evidence; the next gate consumes it before more resources are committed.

GATE RESULT	DECISION RULE
Go	authorise next stage
No go	eliminate from further review
Hold	wait for external technical/market/environment change
Recycle	return deliverables for refinement/resubmission

ANSWER STEM *Check: prior stage complete? business case still sound quantitatively and qualitatively? credible plan? Then name one decision and eliminate the other three.*

CHARTER, PLAN, CONTROL

ITEM	WHAT IT DOES
Business case	documents economic feasibility before commitment
Project charter	formally authorises work and gives the project manager authority to commit organisational resources; authorised outside the delivery team
CPMP	sets how the construction job is run, monitored, controlled and closed; must be bought into, approved, realistic and formal

03 · Estimate + control CH 2

METHOD	USE / TRADE-OFF
Analogous	actual cost of similar job; top-down, cheaper, less precise
Parametric	statistical fit to past records/variables; accuracy follows model + data quality
Bottom-up	price work packages then roll up; most accurate, most costly
Three-point	exposes uncertainty/asymmetry

WEIGHTED EXPECTED COST

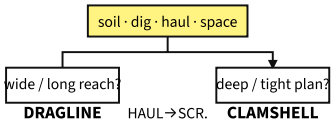
```
E = (O + 4M + P) ÷ 6
```

Scope definition controls accuracy. Estimates sharpen through the life cycle because less work remains undescribed. A material take-off counts drawing content; the bill of quantities is the itemised labour/equipment/material schedule tendered against.

Integrated change control reviews, decides, manages and communicates changes so scope/schedule/cost baselines remain meaningful. Corrective action addresses divergence already present; preventive action protects future alignment.

04 · Site + plant chooser CH 3

MATCH PLANT TO THE DIG



Selection is a condition-to-machine argument, not a catalogue recital.

PLANT	BEST FIT / LIMIT
Power shovel	cuts a face/bank; rock/stone; cannot work flat surface
Backhoe	works below machine; ordinary excavation/trenches; reach limits wide digs
Dragline	stands beside wide open cut; long reach
Clamshell	deep small footprint; all soils except rock
Scraper	excavate + load + haul + dump; long open haul
Dozer	clearing/levelling; pair haul separately if needed

CLEARANCE NUMBERS

Topsoil **300 mm**; sapling limit **300 mm girth measured 1 m above ground**; rubbish **50 m beyond periphery**. Roots: deepest of 600 mm below existing surface, 300 mm below formation, 150 mm below subgrade; refill, ram, level. Existing services: reroute/remove only on site engineer's instruction.

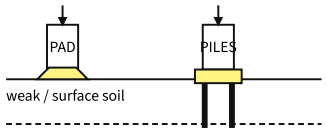
TWO INDEPENDENT COST QUESTIONS

COMMENCE THE SITE IN ORDER

05 · Foundation decision CH 4

Choose from soil · building load · design · cost · technology. Shallow systems spread load directly below column/wall; piles penetrate incompetent upper material to competent soil/rock.

WHERE DOES THE LOAD LAND?



A thin poor layer may be excavated through; persistent weak ground points to piles.

TYPE	SELECTION RULE
Pad	single column; most subsoils; not loose sand/gravel or fill
Strip	continuous below wall; modest loads on nearly any subsoil
Raft	wide base for low bearing capacity or heavy column loads; fails if weak layer continues deep
Grade beam	gathers wall load to spaced supports such as pile caps
Piles	reach past incompetent upper material; driven or bored

BLINDING — FOUR ANCHORS

```
mix ≈ 1 cement : 3 sand : 6 aggregate
thickness 50–75 mm · strength ≈ 5–10 MPa
```

Purpose: clean, level, dry platform; fill soft spots; separate bars/fresh structural concrete from soil so designed cover survives. Strength is not the objective.

DRIVEN PILES

1. Excavate to pile-cap level; remove spoil.
2. Lift preformed pile by lifting lug; position vertical.
3. Drive by drop hammer to **refusal or specified depth**; cast cap over group. Driving displaces soil; bored piles remove it.

06 · Load path CH 5

```
floor/slab → beam or wall → column → footing/foundation → ground
```

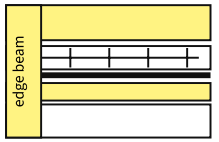
ELEMENT	TYPICAL DIMENSION
Concrete span	5–12 m
Slab thickness	160–250 mm
Column width	200–1000 mm
Wall thickness	150–400 mm

SELECTION ANSWER SCAFFOLD

1. Name the ground profile and competent founding layer.
2. Test pad/strip/raft against soil and load; say exactly why one fails.
3. Ask whether a thin poor layer can be excavated through economically.

07 · Slab-on-ground sequence CH 5

FINISHED SECTION = SEQUENCE



Sand levels and protects; membrane stops moisture; tied chairs preserve cover.

#	ACTION	REASON / CHECK
1	excavate, level, set out; remove organic matter	cut/fill creates natural + placed founding materials
2	backhoe trenches, hand clean	edge beams only on natural soil or controlled fill
3	allow services	pipe outside middle third → deepen/add steel/both
4	form wet-area recess	top set down 40–50 mm; preserve footing thickness
5	peg/fix formwork	pegs plumb, outside line by board thickness
6	screed + compact sand	accurate level; firm, non-puncturing base
7	lay/hold/seal membrane	laps ≥200 mm; seal penetrations
8	fix steel on tied chairs	pre-cut mesh; maintain cover
9	place concrete	do not flatten chairs or tear membrane
10	screed + finish	work between level dots before initial set
11	moist cure	hessian/water spray; gain strength, durability, watertightness

SEQUENCE ANSWER *Use six moves: platform → trench → services/recesses → form/bed/seal → steel/cover → pour/finish/cure. Attach a reason to each; a list of verbs is not enough.*

08 · Middle-third rule CH 5

```
beam depth d → permitted central band d/3 to 2d/3 from top
```

Pipe outside band: relocate or increase beam depth/reinforcement, or both. Wet-area recess must not thin the footing beneath it.

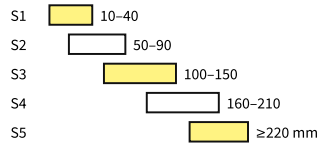
CONSEQUENCES UNDER A WORD LIMIT

CHANGE	ULTIMATE + SERVICEABILITY RESPONSE
span too long	moment/shear rise; deflection and cracking rise; deepen/add supports/revise system
floor load too high	member capacity and punching/shear challenged; vibration/deflection worsen
column will not fit plan	replace point support with a wall/transfer arrangement only after load path is re-established

09 · Concrete numbers bank CH 6

PROPERTY	VALUE / CONSEQUENCE
Aggregate	65–80% of mix volume
Water/cement	about 0.4–0.6; extra water ↑workability but ↓strength/durability
Initial set	30 min–1 h: placing/finishing window ends
Solid	about 10 h
Dense mass	7 days
Full maturity	around 28 days
Compression	30–50 MPa; up to 100 MPa high performance
Tension	only 3–5 MPa → steel carries tension
Deformed bar	nominal yield 500 MPa

SLUMP CLASS BY MEASURED FALL



Cone: 300 mm high, 100 mm top, 200 mm base. S5 is the open-ended top class.

CHARACTERISTIC COMPRESSIVE STRENGTH

```
f′c = mean - 1.64s   →   95% of results above f′c
```

Reduce variability before raising the mean: tighter batching/moisture control raises f′c without adding cement to every cubic metre.

SAMPLING LOGIC

Required count scales through three volume bands: three, six or twelve samples. Take specimens from **different mixers**; deliver to a certified laboratory within **20–32 h**. A result is representative only if both conditions hold.

TRAP *Curing is not drying. Water reacts with cement. Keep concrete moist; hot/windy conditions shorten finishing time and then accelerate water loss.*

10 · RC drawing rules CH 7

MARK	MEANING
solid line	slab edge or change in slab top
dashed line	change in soffit/bottom of slab
column mark	cross-reference to size, vertical bars, ties, type, strength in schedule
O / U	element continues over / under level shown
void symbol	requires trimmer bars per legend

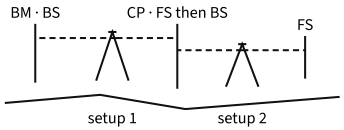
```
serviceability: total deflection ≤ span/250
incremental deflection ≤ span/500
```

DRAWING CROSS-REFERENCE ROUTINE

REINFORCEMENT CONSEQUENCES

11 · Levelling method CH 10

A CHANGE POINT IS READ TWICE



BS first, FS last; every setup has both. An IS is any detail reading between them.

FIELD PROCEDURE

- Record every staff reading in the field book.
- Equalise BS and FS distances so collimation errors cancel in subtraction.
- Keep sights under 100 m; use a firm, defined change point.
- Start and finish on a known datum/benchmark; close the traverse.

RISE & FALL	HEIGHT OF COLLIMATION
Compare consecutive readings within each setup. Prior − next >0 = rise; <0 = fall.	HC = known RL + BS. Every point RL = HC − reading; recompute after move.
Slower; includes IS in three-way check.	Faster; only two agreeing quantities, so an IS arithmetic slip may escape.

THREE-WAY CHECK

```
ΣBS - ΣFS = Σrise - Σfall = last RL - first RL
```

Arithmetic closure proves the reduction, not the observation. A settled CP, staff off vertical, long sight, or collimation with unequal distances can leave the sums correct yet the benchmark closure wrong.

MISCLOSURE *If within the job's specified allowance, distribute (commonly by setup count); otherwise re-observe. Never invent a tolerance.*

12 · Fast recall CH 6 · 8 · 9

IF YOU SEE…	RECALL
plain concrete in tension	3–5 MPa only → reinforcement
lap joint	one shear plane; P across it; eccentric
two cover plates	two planes; P/2 each; symmetric
rigid vs flexible pavement	where load distribution occurs, not a strength ranking
cracks at 3.7–6.1 m	contraction-joint spacing

PAVEMENT LAYER DECISION

Assess subgrade by **strength, gradation and drainage** when wet. Remove, replace or stabilise poor material. Quality grades upward: fine subbase → coarse base → wearing surface. Spread wheel stress below every layer's strength.

STEEL SECTION RECALL

CIVL1810 Engineering Construction and Surveying

SELF-TEST DRILLS · ANSWER PATHS · JUDGEMENT CARDS · CLASSIC TRAPS

Full guide + ask Sia about CIVL1810

SIDE 2/2 DO THE WORK · CHECK THE PATH · NAME THE TRAP

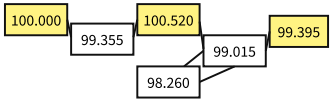
EXAM REVISION SHEET

Rule: setup → relation → substitution → units → interpretation

13 · Drill: level run CH 10 · EX 10.1

Given: BM RL 100.000 m. Readings: BS 1.485; IS 2.130; IS 0.965; FS 2.470 then BS 1.100 at CP; IS 1.855; FS 0.720.

REDUCED LEVELS — TWO ROUTES



CP = 99.015 m. Final RL = 99.395 m, a net fall of 0.605 m.

HEIGHT OF COLLIMATION

STEP	CALCULATION
HC_1	100.000 + 1.485 = 101.485
RL_2	101.485 − 2.130 = 99.355
RL_3	101.485 − 0.965 = 100.520
CP	101.485 − 2.470 = 99.015
HC_2	99.015 + 1.100 = 100.115
RL_5	100.115 − 1.855 = 98.260
final	100.115 − 0.720 = 99.395

RISE AND FALL

Falls: 0.645, 1.505, 0.755. Rises: 1.165, 1.135. Do not compare the FS and BS on the same CP; both observe one physical point from different setups.

```
ΣBS - ΣFS = 2.585 - 3.190 = -0.605
ΣR - ΣF = 2.300 - 2.905 = -0.605
99.395 - 100.000 = -0.605 ✓
```

DIAGNOSIS *If all three sums agree but benchmark closure is wrong, arithmetic is sound; investigate observation: unequal sight lengths + collimation, unstable CP, staff not vertical, or sight beyond 100 m.*

14 · Levelling traps CH 10

TRAP	REPAIR
BS/FS treated as point types	they are first/last readings of a setup
reuse old HC after moving	new HC = CP RL + new BS
checks close → fieldwork correct	checks only prove reduction
adjust any misclosure	only within specified allowance; else re-observe

MINI-DIAGNOSIS: +42 MM CLOSURE

A rise-and-fall book has exact three-way agreement, but the closed run returns to its starting benchmark **42 mm high**. Answer path:

1. The agreeing sums prove booking/subtraction consistency only.
2. The external benchmark exposes a physical observation error.

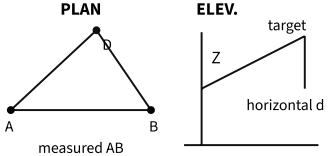
15 · Drill: angle reduction CH 11 · WORKED

At A: FL B 00°00′20″, C 41°15′00″; FR B 180°00′40″, C 221°15′40″. Zenith to C: FL 86°40′30″, FR 273°19′50″.

MOVE	ANSWER
FL angle	41°15′00″ − 00°00′20″ = 41°14′40″
FR angle	221°15′40″ − 180°00′40″ = 41°15′00″
mean	(41°14′40″ + 41°15′00″)/2 = **41°14′50″**
face sum	86°40′30″ + 273°19′50″ = 360°00′20″
index error	+20″/2 = +10″
corrected Z	86°40′30″ − 10″ = **86°40′20″**

ORDER *Subtract directions on each face, then mean the two angles. Never average raw circle readings: FR is about 180° away.*

16 · Intersection → height CH 11



Z from vertical → use cot Z

Two angles + baseline solve the plan triangle; each station then gives an independent target RL.

FOUR RELATIONS

```
∠ADB = 180° - ∠DAB - ∠ABD
AD / sin(∠ABD) = AB / sin(∠ADB)
Δh = horizontal distance × cot Z
RLtarget = RLstation + instrument height + Δh
```

1. Reduce FL/FR horizontal observations; correct each zenith pair.
2. Find third triangle angle; pair each side with its *opposite* angle in sine rule.
3. Compute RL from A and B independently; show their agreement; report the mean.

SENSE CHECK *Z < 90° means target above the trunnion; Z > 90° means below. A nearly horizontal sight has cot Z near zero. If height explodes, you probably used tan.*

17 · Surveying error map CH 10–11

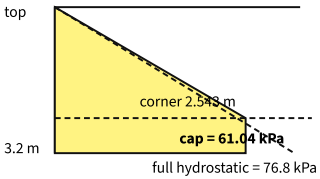
SYMPTOM	LIKELY CAUSE
two target RLs disagree	tan/cot swap, sine-rule pairing, one instrument height/index correction
zenith pair ≠ 360°	index error or transcription
level sums agree; closure fails	physical observation error

MINI-DRILL: SECOND FACE SET

18 · Formwork calculation path CH 12

1. Separate **form height** from **poured height**.
2. Convert delivery to vertical rate: `R = volume rate ÷ plan area`.
3. Select form-size coefficient: **1.5** only when breadth and width are both under 2 m; otherwise **1.0**.
4. Select cement coefficient: GP/HE 0.30; LH/SR/SL/GB 0.45. Add 0.15 once for retarder, superplasticiser, or both.
5. Use temperature coefficient: 1 at 20°C; colder >1, warmer <1.
6. Evaluate both supplied expressions and take the lesser.
7. Read the bracket as equivalent depth; draw the envelope.

WALL EXAMPLE — PRESSURE vs DEPTH



Hydrostatic line until 2.543 m, then constant; the dashed line is the uncapped case.

WORKED WALL NUMBERS

Form 0.300 m × 12 m in plan, 4.0 m tall; pour height 3.2 m; delivery 18 m^3/h; GP, no retarder/superplasticiser; density 2400 kg/m^3, represented by unit weight 24 kN/m^3 in the worked result. Plan area = 3.6 m^2, so **R = 5.0 m/h**. Hydrostatic base pressure = 24 × 3.2 = **76.8 kPa**. Supplied-rule cap = **61.04 kPa**; corner depth = 61.04 ÷ 24 = **2.543 m**.

CHECK *A valid envelope must start at zero pressure at the top, rise hydrostatically to the bracket depth, then remain at the lesser-expression cap to the poured base.*

19 · Wall vs soffit CH 12

WALL FORM	SOFFIT FORM
lateral pressure of plastic concrete	vertical load on deck
hydrostatic then capped	wet concrete + form self-weight + construction live load
pour rate, mix, temperature matter	slab thickness/density + stated load assumptions matter

Name any missing live-load quantity, state the assumed value, and say which result depends on it.

QUALITATIVE DRILL: WHICH WALL IS WORSE?

20 · Drill: three-point cost CH 2 · WORKED

Given: demolition package O = $240,000; M = $265,000; P = $400,000.

```
E = (240,000 + 4×265,000 + 400,000) ÷ 6
= 1,700,000 ÷ 6 = $283,333
```

Interpret: E is about $18,000 above M although P is $135,000 above M, because M has four times either extreme's weight. The pessimistic tail is more than five times the optimistic distance: respond to the risk, do not merely quote the point estimate.

21 · Drill: characteristic strength CH 6 · WORKED

Given: mean 41.0 MPa; s = 5.5 MPa; specified f′c = 32 MPa.

```
f′c = 41.0 - 1.64(5.5)
= 41.0 - 9.02 = 31.98 MPa
```

31.98 < 32: marginally fails. Cheapest improvement: reduce s through tighter batching/moisture control; raising mean requires more cement in every cubic metre.

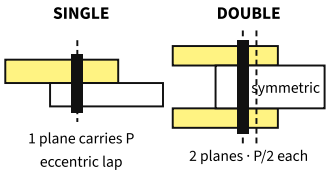
22 · Drill: pipe in beam CH 5 · WORKED

Given: 600 mm deep edge beam; 100 mm pipe centreline 480 mm below top.

```
middle third = 600/3 to 2(600/3)
= 200 to 400 mm below top
480 mm > 400 mm → outside band
```

Relocate into the band or increase beam depth/reinforcement, or both. Sketch thirds and pipe; do not state "unacceptable" without the consequence.

23 · Steel connection logic CH 8



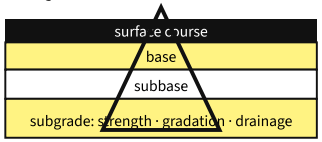
Count planes before stress. Double shear halves force per plane and removes lap eccentricity.

DETAIL	BOLT ACTION
web side plate	combined shear + tension; torsion puts bolts in tension
column base holding-down bolts	tension from uplift/base moment; compression mainly by bearing
cope corner	minimum radius avoids crack-starting stress concentration
610 UB 125	nominal 610 mm depth, 125 kg/m; actual dimension from table

CONNECTION-ANSWER SEQUENCE

24 · Pavement judgement CH 9

QUALITY FALLS · LOAD SPREADS



Layer thickness, material quality and compaction keep stress below each layer's capacity.

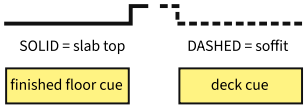
FLEXIBLE	RIGID
structure flexes	concrete panel has high modulus
base/subbase distribute much of load	panel distributes; lower layers do little
surface protects from moisture/traffic	capital + curing delay + polished aggregate are stated disadvantages

CRACK/JOINT SPACING	MEANING
10–50 m transverse, early	first unreinforced/unjointed drying-shrinkage wave
≈5 m transverse + 3–5 m longitudinal	final dry slab with temperature/moisture warping
3.7–6.1 m	typical contraction joints
1.5–3 m hairline	continuously reinforced pavement

Cracking is controlled, not promised away. Contraction joints locate inevitable shrinkage cracks; continuous steel holds many hairline cracks together.

25 · Drawing reader CH 7 · 13

WHICH SURFACE STEPS?



Resolve geometry and notes before drafting; sections cutting the same member must agree digit-for-digit.

AUTOCAD WRITTEN-ANSWER ORDER

1. Start drawing; set drawing properties.
2. Set units *before* geometry.
3. Create layers by feature/component/trade.
4. Draft concrete outline → tie offset by cover → main bars → dimensions.

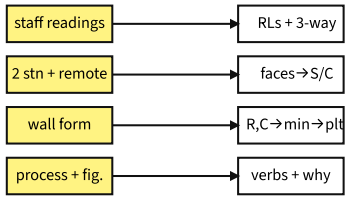
```
450×300 beam · 4N24 bottom · 3N24 top
N10 closed ties @150 mm · 135° hook
```

Architectural layers: Wall, Dim, Door, Window, FRN. Concrete detail: Concrete, Dim, Membrane, Wall, Sand, Mesh, Reo. Geometry on the wrong default layer must be reassigned object by object.

ANNOTATION-TO-TRADE DRILL

26 · Method chooser ALL CHAPTERS

IF YOU SEE X → DO Y



finish with consequence / check

Classification earns the first mark; a visible check or consequence earns the last.

IF QUESTION SAYS…	WRITE FIRST
define	term + every attribute; no story
select/justify	condition → choice → rejected alternative
explain process	sequence + purpose + labelled section
compare	same basis down both columns
calculate	relation, substitution, units, governing check
state assumptions	named missing quantity + value + result affected

27 · Classic traps FAQ · WORKED EXAMPLES

WRONG MOVE	CORRECT MOVE
soft layer → automatic piles	ask depth; excavate through thin poor layer if practical
raft always fixes weak soil	not if weakness continues below
more water fixes congested pour	order class/change placement; vibration moves mix around steel
rigid = stronger	name where load is distributed
section buckling = whole member bows	local plate instability, e.g. flange
web side plate = pure shear	combined shear + tension
curing = drying	retain water for hydration
gate hold = recycle	hold waits on world; recycle waits on team

28 · Exam-morning plan STUDY STRATEGY

1. Rehearse four survey relations and the levelling check from memory.
2. Run the formwork order aloud: R, size, cement/admixture, temperature, heights, lesser, envelope.
3. Draw three sketches: slab section, single/double shear, flexible/rigid load path.
4. Recite construction sequences in six balanced moves; attach one reason to each.

THIRTY-SECOND SUBMISSION AUDIT