Lecture 1 Introduction

How do steel and concrete work together?

Learning goals

Explain composite action

Describe how an interface transfers force between materials.

Recognise common members

Identify composite beams, slabs, columns and walls.

Read a construction sequence

Explain why the load-resisting system changes during construction.

Discuss a structural choice

State one benefit and one design condition.

Course map and assessment

Topic	Lectures
Introduction	1
Composite slabs	2
Composite beams	4
Composite columns	6
Composite shear walls	2
Q & A	1

Attendance 20% **Final report 80%**

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Lecture 1 at a glance

Composite construction

1 Basic concepts

Steel and concrete
Composite vs mixed systems

2 Composite action

Shear connectors and slip
Full or partial connection

3 Structural members

Beams, slabs and columns
Walls and coupling beams

4 Construction stages

Gravity and lateral loads
Erection to concrete hardening

5 Design considerations

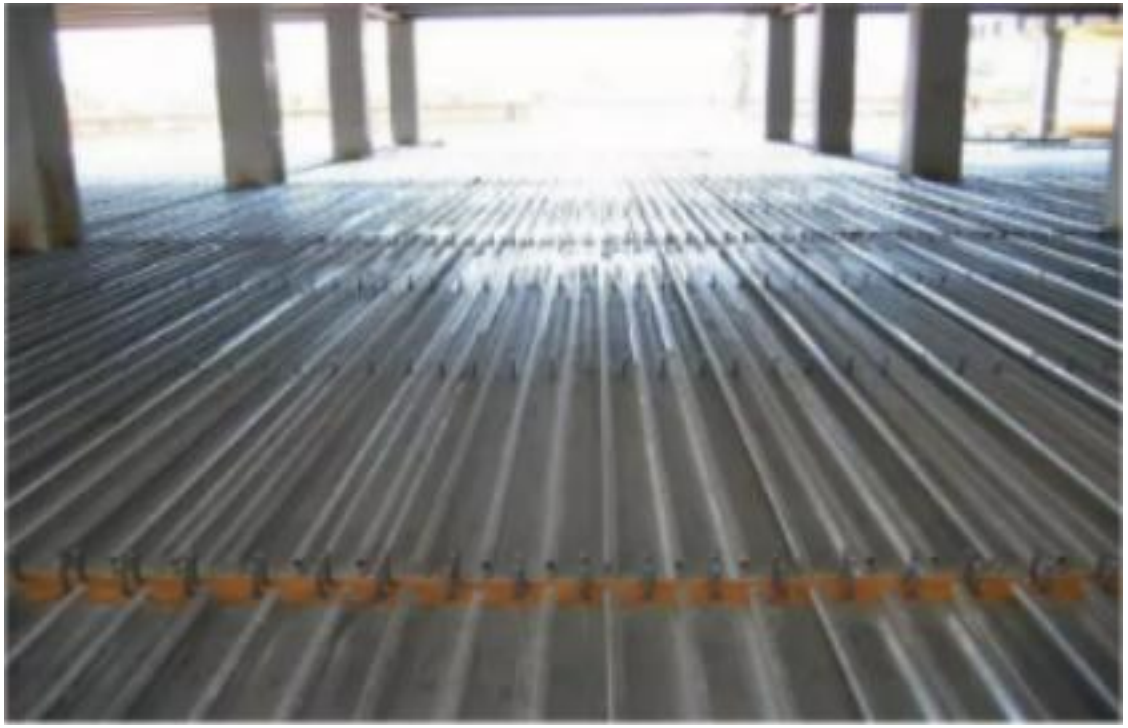
Strength and serviceability
Benefits and design limits

6 Case study and review

Rainier Square / SpeedCore
Vocabulary and concept check

We will explore how the materials work together, and how engineers use them in real structures.

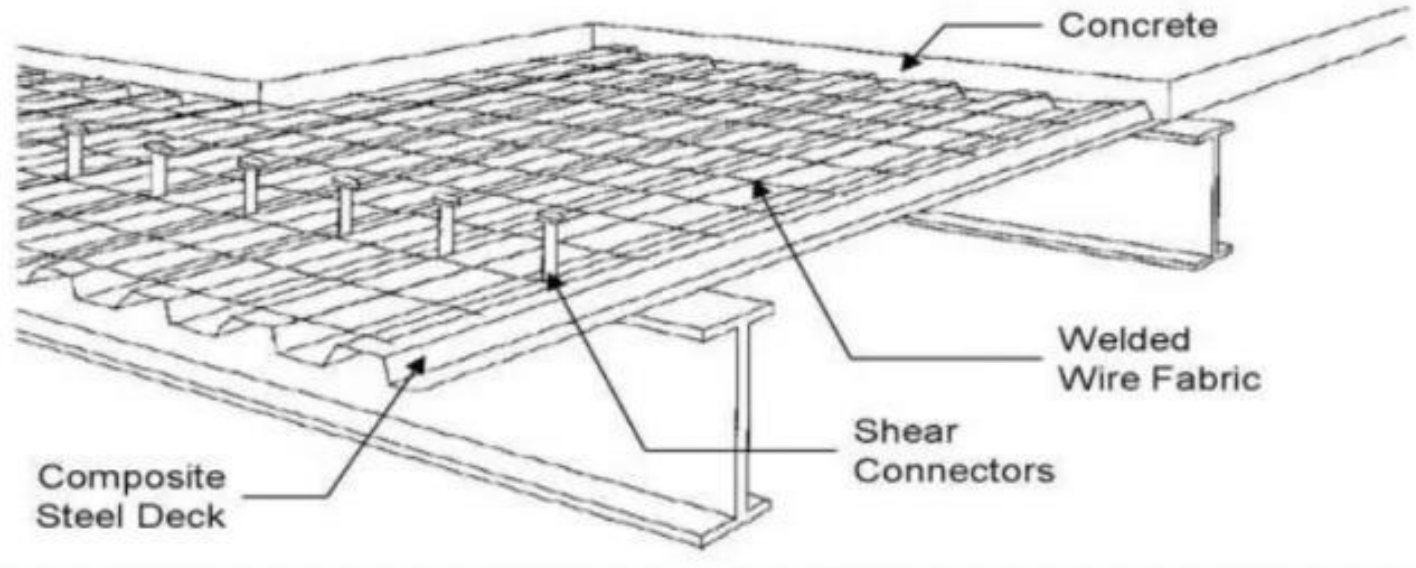
A floor before the concrete pour



Where will the concrete go?
What carries the load now?
What will change after the concrete hardens?

What is composite construction?

Steel and concrete form a structural member through force transfer across their interface.



The interface is essential to composite action.

Why combine steel and concrete?

Material	Useful properties	Design concerns
Concrete	Compression resistance Mass and stiffness	Cracking Creep and shrinkage
Steel	Tension and compression Ductile material response	Buckling Corrosion and fire

A suitable arrangement uses each material effectively.

Both materials can carry compression.

Composite members and mixed systems

Composite member	Mixed structural system
Steel and concrete act together within a member.	Different structural materials form one building system.
Example: steel beam + concrete slab with shear connectors	Example: steel frame + reinforced concrete core

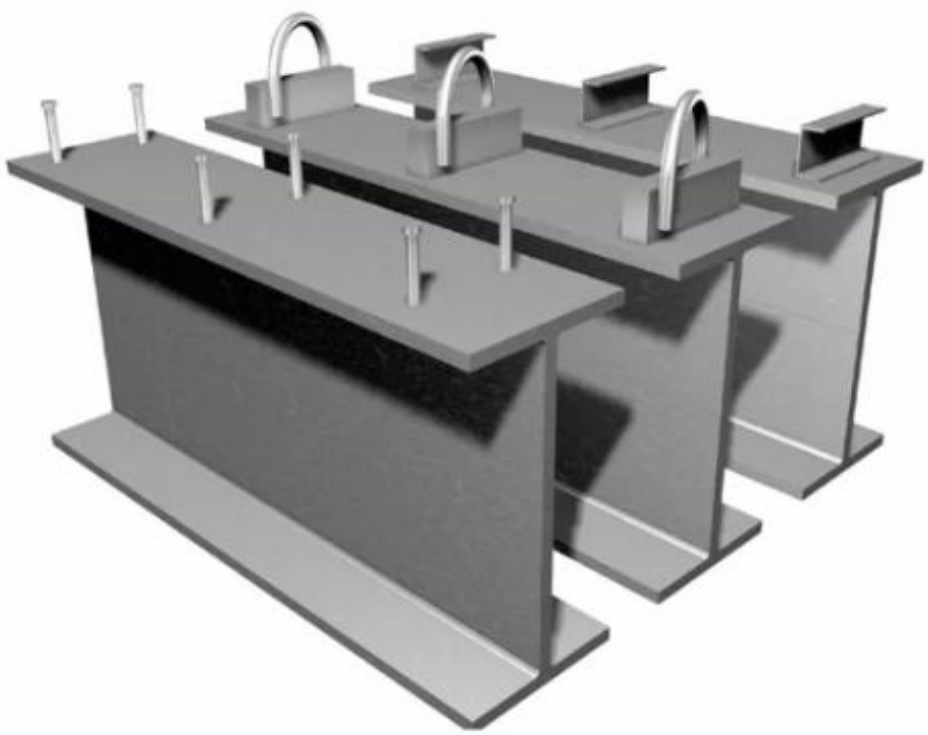
A building can contain both.

With and without composite action

Interface condition	Bending behaviour
No designed shear connection	Do not count the slab as part of the composite beam section.
Designed shear connection	The slab participates in bending with the steel beam.
Same members and span	Composite action can increase resistance and stiffness.

Vertical bearing alone does not establish shear connection.

Shear connectors



Force transfer

Connectors transfer longitudinal
shear across the interface.

Relative movement

They limit slip and help resist separation.

Connector resistance and stiffness both matter.

Shear connection and interface slip

Full shear connection

Enough connector resistance to develop the relevant composite bending resistance.

Partial shear connection

Connector resistance limits the composite contribution. Design rules set minimum requirements.

No interaction

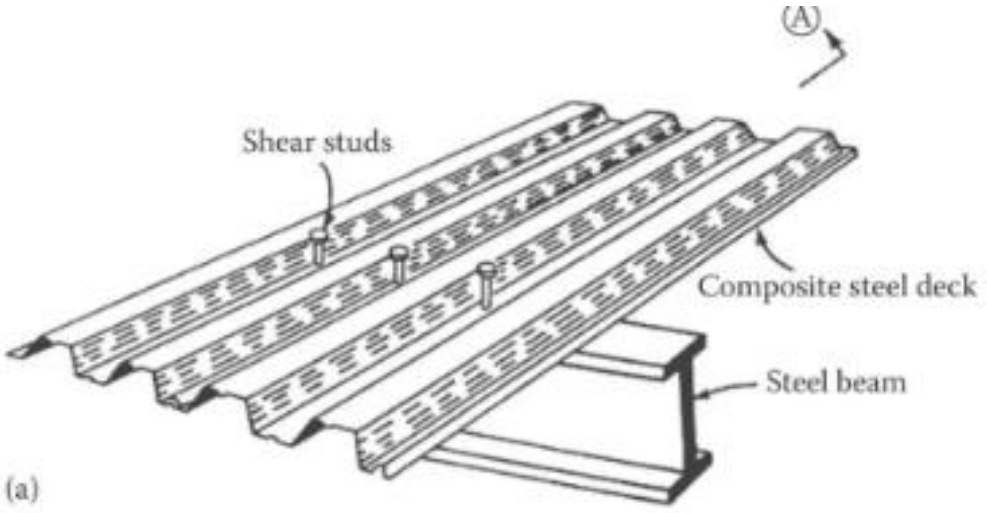
Behave separately.

Full shear connection does not mean zero slip.

Common composite members

Member	Typical arrangement	Typical role
Beam	Concrete slab + steel beam	Floor bending
Slab	Concrete + profiled deck	Floor spanning
Column	Filled tube or encased steel	Axial load and bending
Wall / core	Concrete + steel plates or embedded sections	Lateral resistance

Composite beams



Sagging bending

The slab mainly provides compression resistance.

Steel beam

The steel section carries tension and may also carry compression.

Shear connectors develop the composite section.

Composite slabs



During construction

The deck supports wet concrete as permanent formwork.

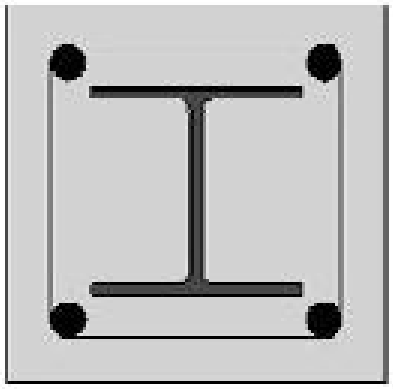
After hardening

The deck can act as tensile reinforcement in the slab.

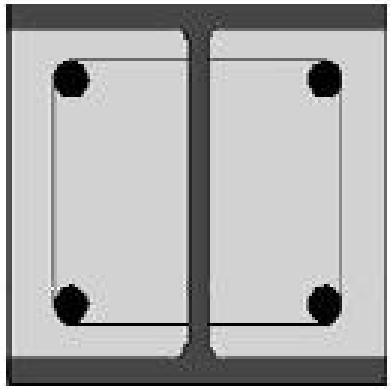
Interface transfer

Embossments and deck geometry provide mechanical interlock.

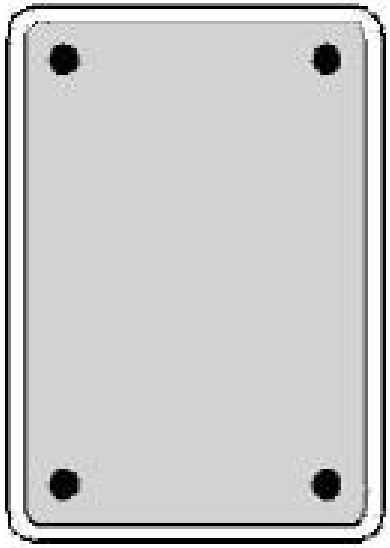
Composite columns



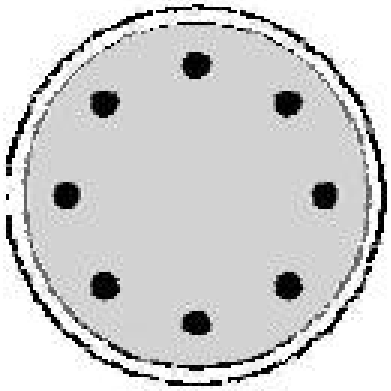
Fully encased steel section



Partially encased steel section



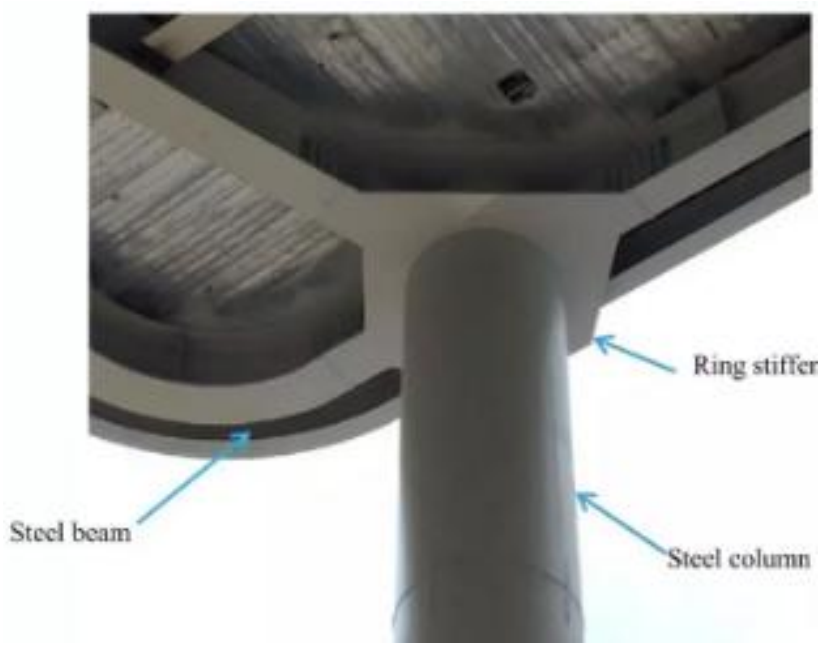
Rectangular filled steel tube



Circular filled steel tube

Steel and concrete share axial load and bending.

How composite columns cooperate



Mutual restraint

The tube can confine concrete.
The concrete supports the tube wall.

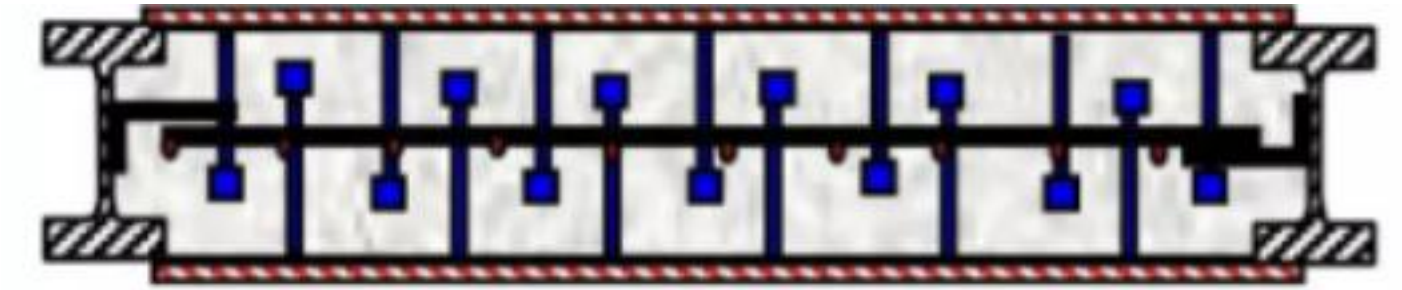
Load introduction

Connections must transfer load into the composite section.

Stability

Local and overall buckling still require checks.

Composite walls and cores



Section

Steel faceplates enclose a concrete infill.

Structural role

The walls or core resist lateral loads and overturning.

Connections and ties make the components cooperate.

Composite coupling beams



Across an opening

A coupling beam links adjacent wall segments.

At the ends

Shear, moment and anchorage require careful detailing.

Load paths through a building



Gravity loads

Slabs, beams, columns
and foundations.

Lateral loads

Floor diaphragms transfer forces
to cores, walls or bracing.

A composite floor still needs a complete stability system.

Construction changes the structure

Stage	Load-resisting system
1 Steel erection	Steel frame and temporary bracing
2 Concrete placement	Steel beams and deck carry wet concrete and construction loads.
3 Concrete hardening	Composite resistance develops as concrete reaches required strength.
4 Building use	The completed system carries subsequent loads.

Strength and serviceability

Ultimate limit states	Serviceability limit states
Bending and shear resistance Member stability Connection resistance	Deflection Vibration Cracking and slip effects
Can it resist the required loads?	Will it perform acceptably in use?

Adequate strength alone is insufficient.

Benefits depend on the project

Potential benefit	What makes it possible?
Efficient floor framing	Useful slab participation and a suitable beam arrangement
Faster construction	Prefabrication, erection access and coordinated concrete placement
Reduced structural depth	A system that meets strength, vibration and service requirements
Material efficiency	Comparison of complete solutions with the same performance targets

Details that need attention

Issue	Design or construction response
Interfaces and connections	Check force transfer, welds and anchorage.
Construction stage	Check stability, temporary supports and concrete placement loads.
Long-term response	Consider creep, shrinkage and cracking.
Fire and durability	Specify protection, cover and maintenance for the exposure.

Case study: Rainier Square, Seattle

Structural system

A steel-framed tower with
a composite steel-plate core.

Construction idea

Prefabricated steel modules
receive concrete infill on site.

Key question

How does the core change
before and after concrete filling?



SpeedCore: the construction logic



1 Fabrication

Steel plates and ties form a module.

2 Erection

Crews connect the modules on site.

3 Concrete infill

Hardened concrete joins the steel in resisting loads.

Each stage needs its own load and stability checks.

Key vocabulary

Term	Meaning in this lecture
Composite action	Materials resist load together through an interface.
Shear connector	A device that transfers interface shear.
Slip	Relative movement along an interface.
Confinement	Restraint of lateral expansion of concrete.
Propping	Temporary support during construction.

Concept check

True or false? Explain your answer.

1 Contact alone guarantees composite action.

2 Full shear connection means zero interface slip.

3 Wet concrete can govern construction-stage design.

4 A mixed system cannot contain composite members.