

# bmcs course

brittle/matrix cementitious  
composite structures

roadmap, organization

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Abedulgader Baktheer  
Institute of Structural Concrete



oricrete: Yoshimura vault, RWTH Aachen  
(2015)



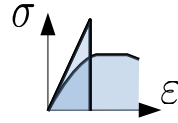
Jena, Germany, Dyckerhoff-Widmann  
(1922-1923)

*the roadmap*

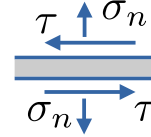
# local - global

material

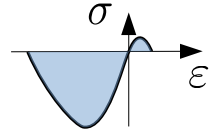
reinforcement



bond



matrix

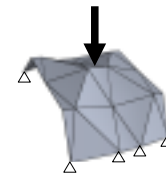


form

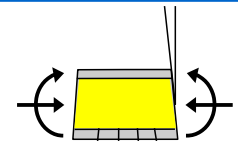
slab



folded shell



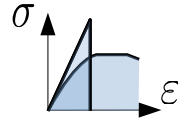
sandwich



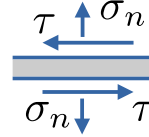
# interaction of mechanisms

material

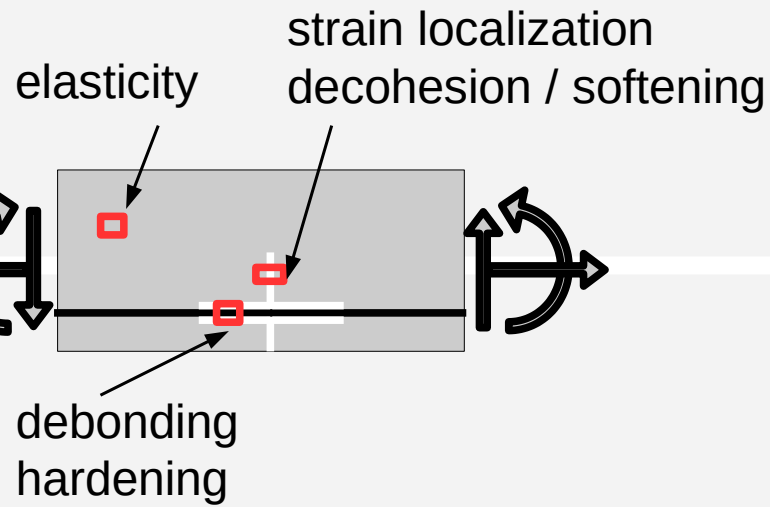
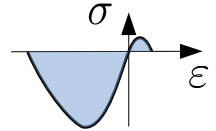
reinforcement



bond



matrix

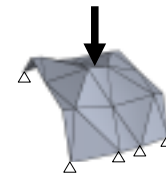


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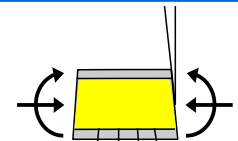
slab



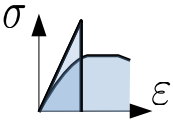
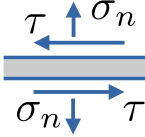
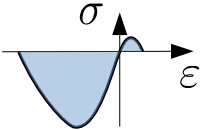
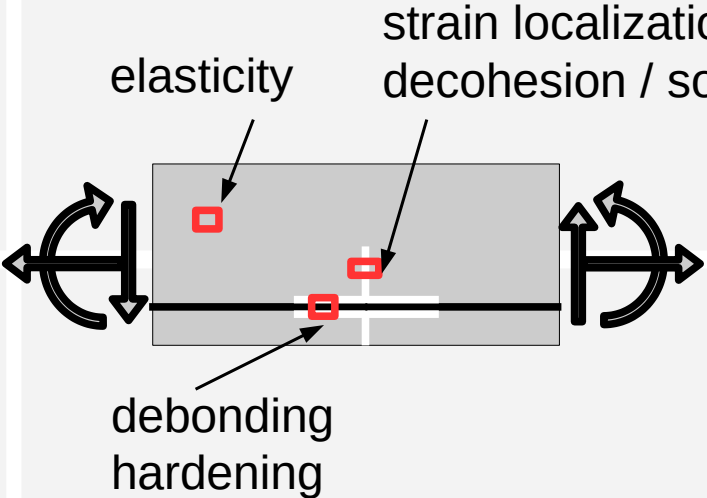
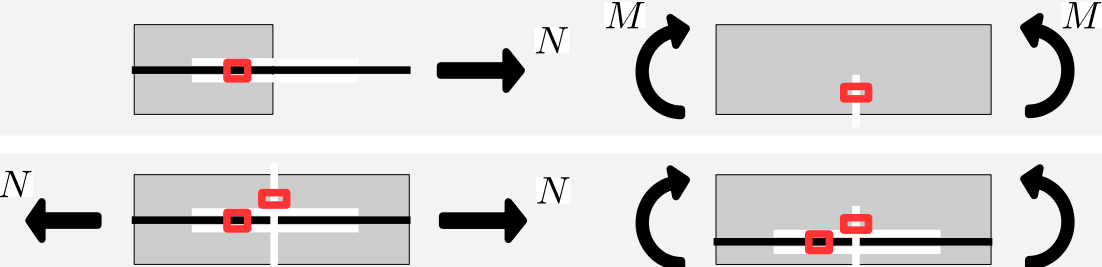

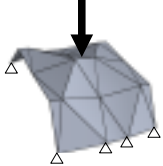
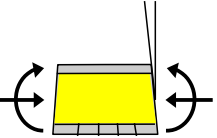
folded shell



sandwich



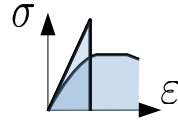
# elementary - complex

material	<div>reinforcement</div>	<div>bond</div>	<div>matrix</div>
cross section	<div><p>elasticity</p><p>strain localization decohesion / softening</p><p>debonding hardening</p></div> <div><p><math>N</math> <math>M</math></p></div>		
form	<div>slab</div>	<div>folded shell</div>	<div>sandwich</div>

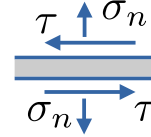
# local - global

material

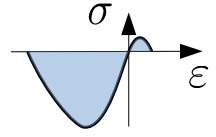
reinforcement



bond



matrix

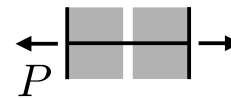


cross  
section

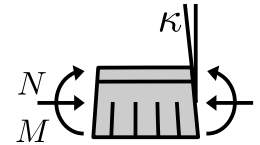
pullout



crack-bridge



moment-  
curvature

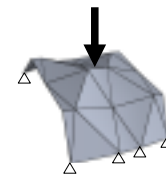


form

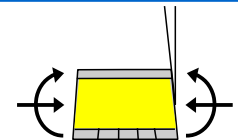
slab



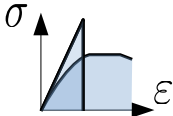
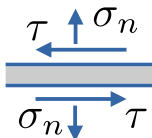
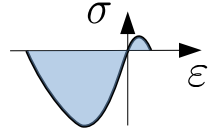


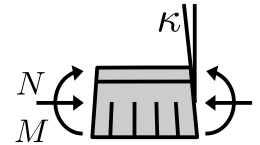
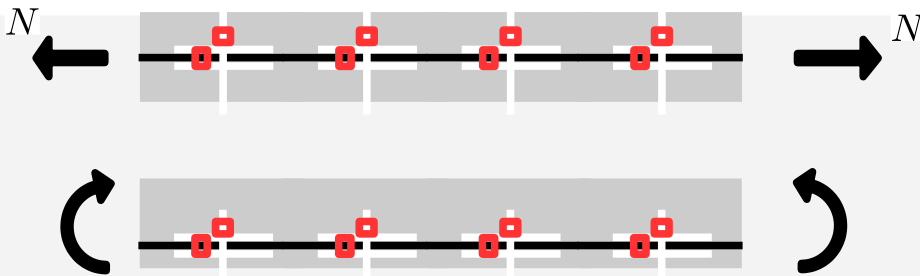
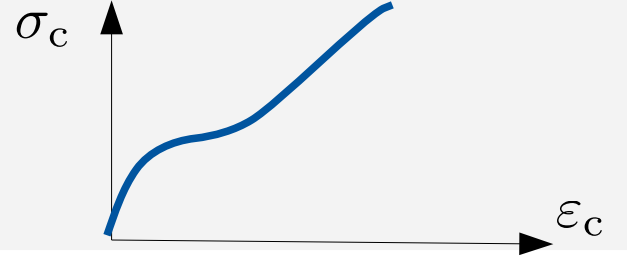

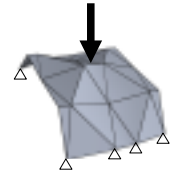
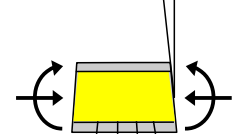
folded shell



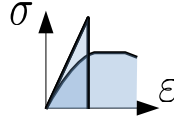
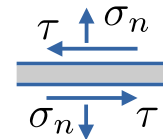
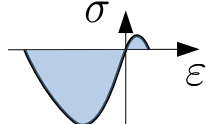

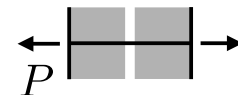
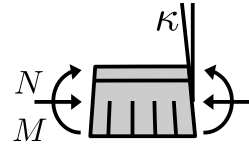

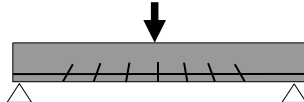


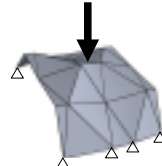
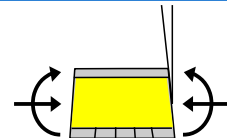
sandwich



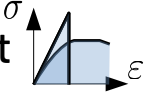
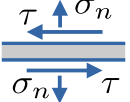
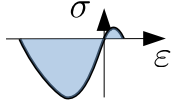


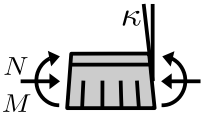

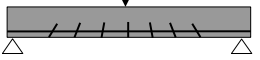

# interaction of mechanisms

material	<div>reinforcement</div>	<div>bond</div>	<div>matrix</div>	
cross section	<div>pullout</div>	<div>crack-bridge</div>	<div>moment-curvature</div>	
zone	<div></div>			<div></div>
form	<div>slab</div>	<div>folded shell</div>	<div>sandwich</div>	

# elementary - complex

material	<p>reinforcement</p> 	<p>bond</p> 	<p>matrix</p> 
cross section	<p>pullout</p> 	<p>crack-bridge</p> 	<p>moment-curvature</p> 
zone	<p>tension - fragmentation</p> 	<p>bending</p> 	<p>compression - stability</p> 
form	<p>slab</p> 	<p>folded shell</p> 	<p>sandwich</p> 



material	reinforcement 	bond 	matrix 
cross section	pullout 	crack-bridge 	moment-curvature 
zone	tension - fragmentation 	bending 	compression - stability 

# 9 Lectures, 3 seminars, 8 guided tours

04/14/23	Lecture	Prof. Chudoba
04/21/23	Lecture	Prof. Chudoba
04/28/23	Lecture	Prof. Chudoba
05/05/23	Lecture	Prof. Chudoba
05/12/23	Exercise	Dr. Baktheer
05/19/23	Lecture	Prof. Chudoba
05/26/23	Lecture	Prof. Chudoba
06/09/23	Lecture	Prof. Chudoba
06/16/23	Lecture	Prof. Chudoba
06/23/23	Exercise	Dr. Baktheer
06/30/23	Lecture	Prof. Chudoba
07/07/23	Exercise	Dr. Baktheer
07/14/23	Exam	Dr. Baktheer

- **Tour 1: Mixture rule**  
effective composite stiffness
- **Tour 2: Constant bond**  
friction, pull-out, crack-bridge, multiple cracking
- **Tour 3: Nonlinear bond**  
hardening, softening -> failure modes: anchorage, cracking
- **Tour 4: Plastic bond behavior**  
irreversibility, energy dissipation
- **Tour 5: Damage bond behavior**  
2D sheet debonding
- **Tour 6: Energy supply, storage and dissipation**
- **Tour 7: Concrete cracking and yielding**  
bending of a cross section
- **Tour 8: Beam deflection**  
comparison with EC2 and Model Code

## Explain → Observe → Exercise

- **Explain:** lectures, videos with slides
- **Observe:** virtual experiments
  - what happens if you change something?
  - what is the model validity = quality?
- **Exercise:** book of examples [relevant for exam]

# Organization

- 3 SWS – 8 CP
  - homework assignment and colloquium – 2 CP
  - exam – 6 CP
- Hybrid lectures
  - Meeting every week with explanation of video content
  - Individual study using videos / jupyter notebook
- Consulting hours to exercise videos on a weekly basis

# What counts

## Seminar work

- read a scientific paper related to BMCS
- examine/validate/discuss particular issues described in the paper
- seminar work will be launched after the fifth lecture (6 weeks)
- reports either written or as a video presentation

## Exam

- written exam at the last date of the course

