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Biocrete –
Carbon Neutral Concrete

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Norsk Biokullnettverk

OPLANDSKE BIOENERGI

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Snøhetta

BETONG ØST

CON FORM

Støttet av Innovasjon Norge

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Background

- Industrial wood waste amounts to 1.0 million tons per year
- A large proportion of the wood waste goes to combustion
- The wood waste corresponds to an emission of 1.8 million tons CO_2, i.e., 40 % more than what the cement industry generates!
- The construction industry accounts for 30 % of the total wood waste

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Idea

- Wood waste can be pyrolyzed into biochar (pyrolysis is heating without the supply of oxygen)
- The biochar can be mixed into concrete to store the carbon “permanently”
- We break a waste cycle and allocate the CO_2 – benefit to the final product. The concrete becomes carbon neutral! Small-scale CCS!

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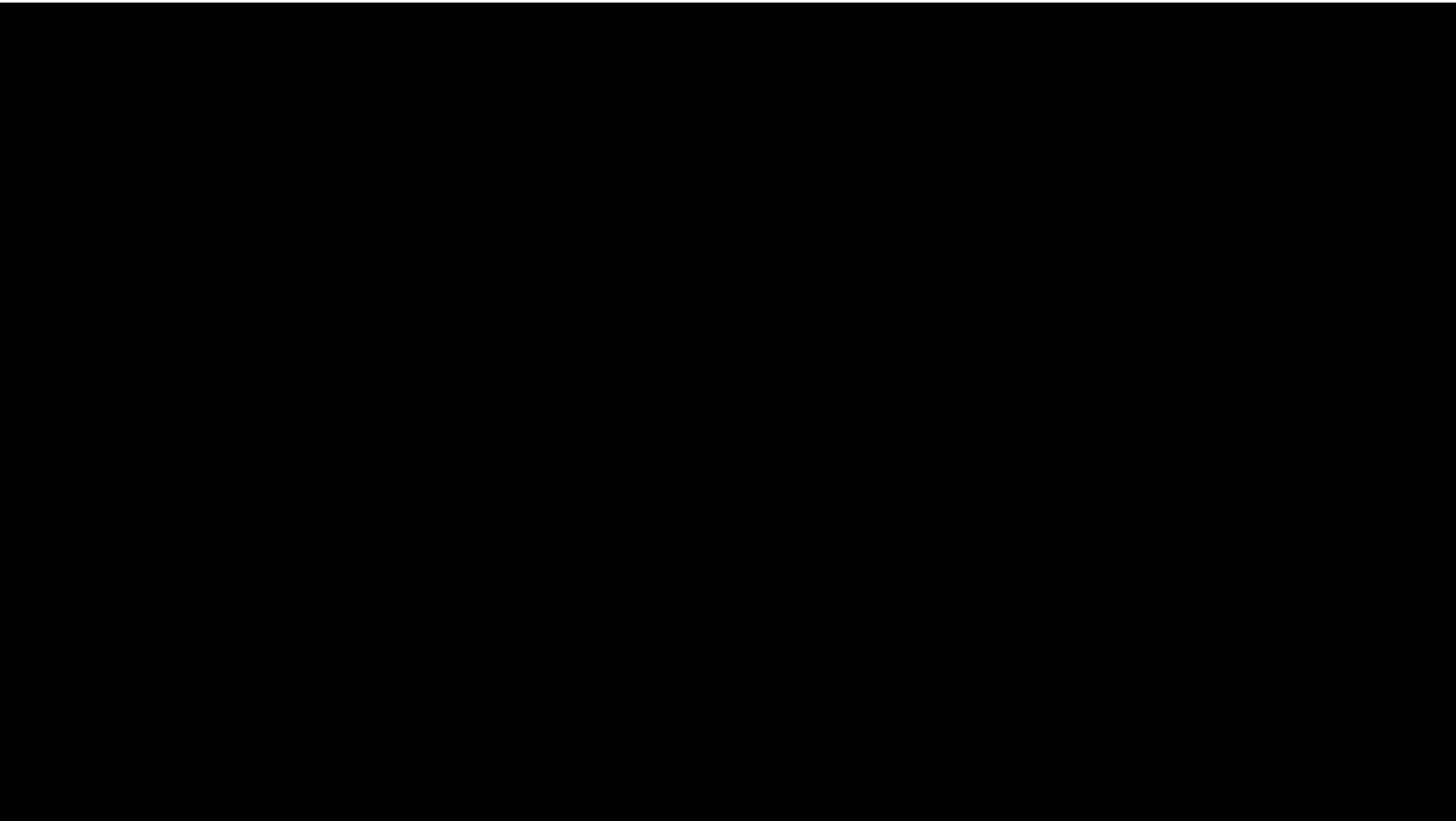
- Is this principle ok according to the LCA standards?
- How does the biochar affect the technical properties of the concrete?
- Who will invest in carbon neutral concrete? At the moment, Biocrete is about 50% more expensive



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Pretty confusing media response….

«The least thoughtful initiative I've ever heard of»

Yngve Holt, Norskog to nrk.no

«A gamechanger for the construction industry»

bygg.no

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Other applications for biochar

- Subsidy in cattle feed
  - Reduces methane emissions
  - Requires a very clean biochar, i.e. the content of heavy metals, dioxins etc. must be very low. Waste wood is unsuitable as a raw material.
- Soil improvement
  - Biochar has a large internal surface, and is therefore an effective absorbent. Favorable in sandy soils in dry areas
  - Requires a clean biochar, i.e. the content of heavy metals, dioxins, etc. must be low. Waste wood is unsuitable as a raw material.
- Reducing agent in the metal industry
  - Can replace fossil coal
- Absorbent and filter material applications

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How much biochar does it take to "neutralize" the concrete?

- The biochar contains approximately 92% pure carbon
- In combustion, 1.00 kg of carbon (C) will be oxidized to 3.67 kg $C0_2$
- A C30/37 type of concrete, Low Carbon Grade A (NB37), has a required GWP-value of maximum 200 kg $C0_2$-ekv./m^3
- Approximately 59 kg of biochar /m^3 will thus be able to compensate for the emissions from this concrete. A little more, and we've compensated for the reinforcement steel, too.

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PS! The excess heat from pyrolysis can be used as a heat source in a district heating system, or perhaps at a concrete batching plant.

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Much of the development work has been done by three eager master students at NTNU

Håkon Farestvedt Nesse

Vibeke Heitmann Solheim

Petter Wedø Gjengår

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How does biochar affect the concrete properties?

- The biochar is light and mechanically weak, this must be compensated with a slightly stronger binder phase
- The biochar has a very high water absorption but is still is a good filler material in a water-saturated state. Biocrete therefore has excellent workability properties, without additional consumption of cement!
- The concrete density is reduced from 2400 kg/m^3 to approx. 2000 kg/m^3. In structural design, Biocrete must probably be considered to be a LWAC.
- The durability properties are expected to be good due to the low permeability of the binder phase. Recent results confirm that the permeability of Biocrete is very low.
- *Is Biocrete within or outside the limits of concrete standards?*

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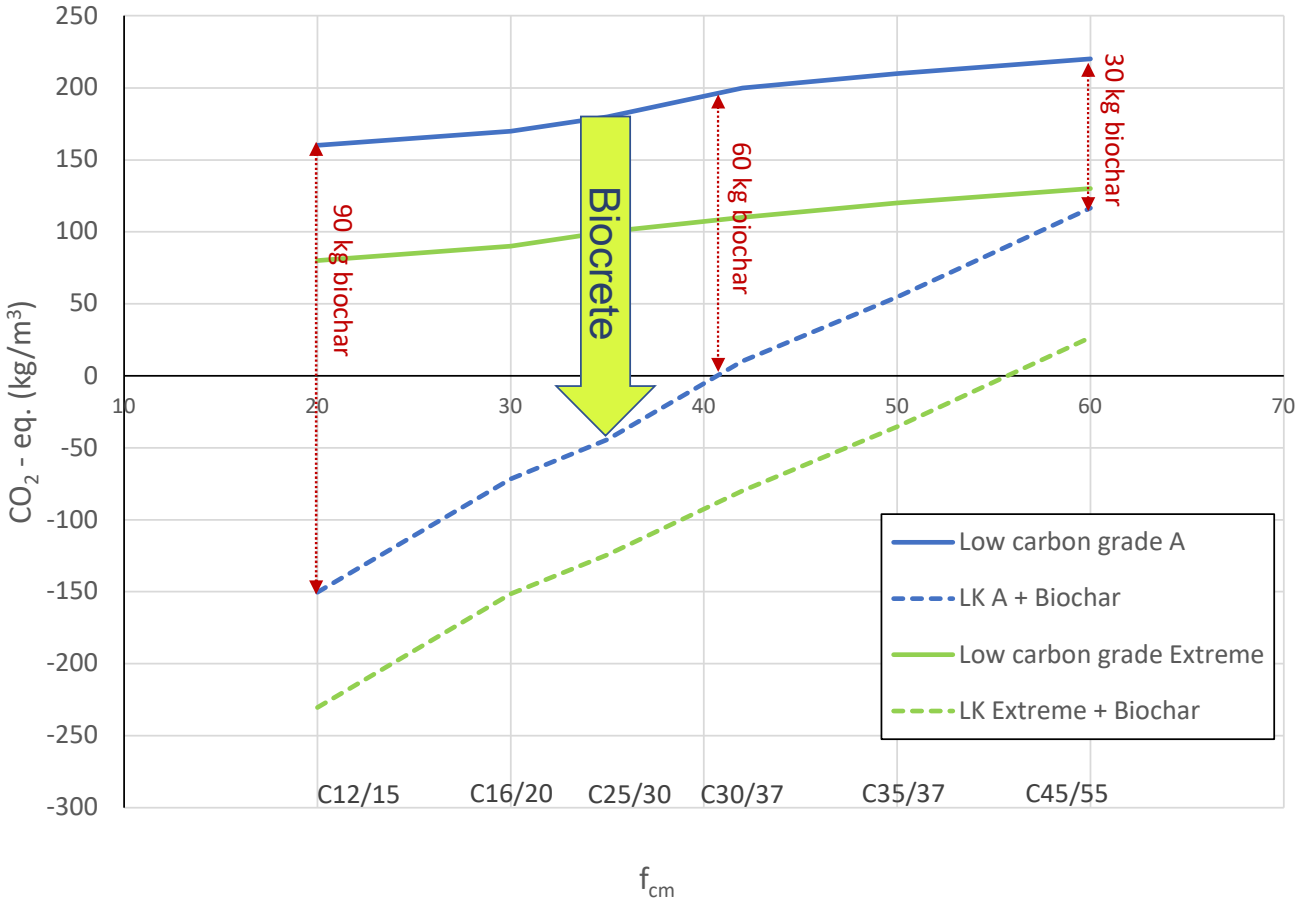
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10
20
30
40
50
60
70
CO_2 - eq. (kg/m³)
f_{cm}
C12/15
C16/20
C25/30
C30/37
C35/37
C45/55
Biocrete
90 kg biochar
60 kg biochar
30 kg biochar
Low carbon grade A
LK A + Biochar
Low carbon grade Extreme
LK Extreme + Biochar

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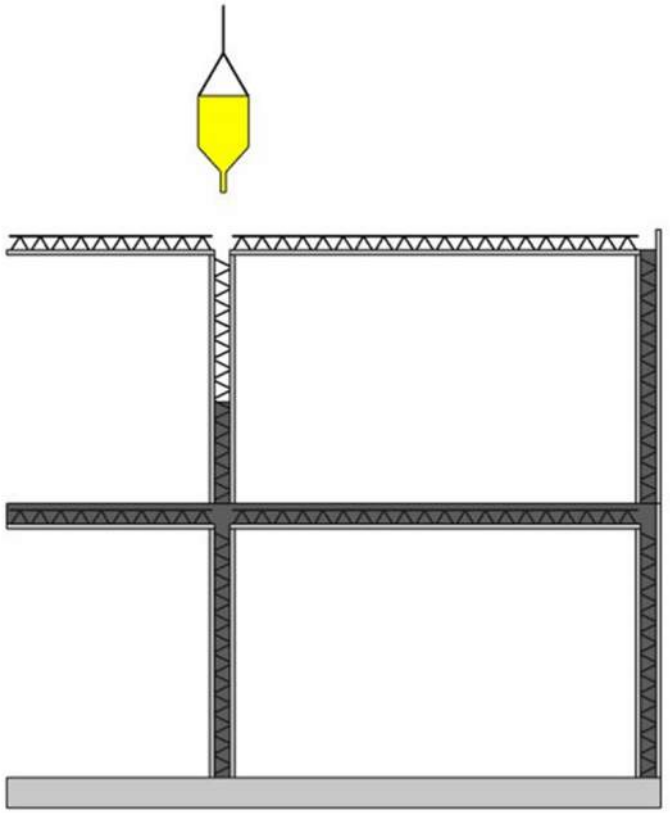
The Con-Form structural design concept

- Hybrid of precast and cast-in-place concrete
- The «sandwich» type of structural design allows a combination of high strength (flanges) and low strength concrete (cores)
- Ideal for Biocrete
- «Carbon neutral» load carrying structures are obtainable
- Full scale wall and slab production tests performed



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As designed for Biocrete…

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What next?

- More tests must be performed to demonstrate technical feasibility and reliability
- Biochar produced from wood waste must be made available
- Concrete batching plants must be modified to handle ground biochar in a dry / semi-dry state. Preliminary results indicate that this is achievable
- Who will invest in a process linked to a non-excisting market? The market must be developed in parallel with the technical concept
- We need to carry out one or more full-scale construction projects to demonstrate practical feasibility
- So far, two clients have shown serious interest.

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