Belgian Road Research Centre
Together for sustainable roads

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Practical approach for quality screening of reclaimed asphalt materials based on a mechanistic approach

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- Background – research gap

- RA materials

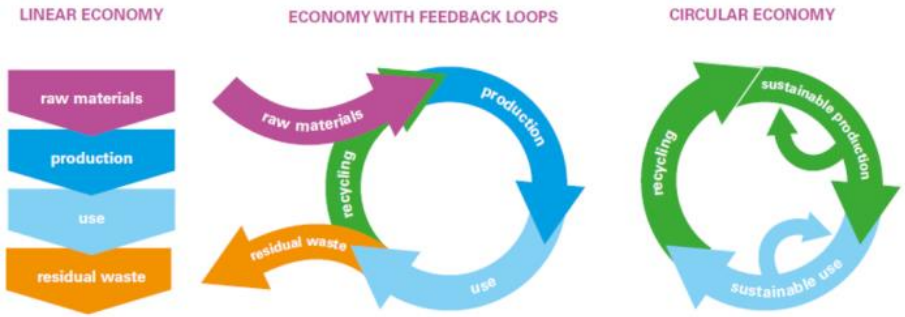
- CBI approach

- CBI results (vs other properties)

- Concluding points

Reclaimed asphalt (RA)

- Reuse of RA in Belgium since late ’70s (multi-recycling)
- **Enhance recyclability**
  - Increase (re)use of reclaimed asphalt (RA) (also in surface layers)
  - Retain/increase durability while enhancing circularity
  - Environmentally friendly bituminous mixtures and testing techniques.



Source: Rli, Circular Economy: From Wish to Practice

Research gap

- RA ageing state → based on the RA binder properties
- In Europe, is based on pen value (or $T_{R\&B}$)
- Penetration test limitations on very aged RA binder (pen < 10)
- **Discriminative enough?**
- Bulk (RA) response is preferred over binder response solely
- **Need for a mechanistic test**

RA materials

- **RA collection → 7 different RA materials**
- NMAS 10 mm (6 RA's) / NMAS 14 mm (1 RA) ("white")
- RA binder penetration between 7 and 20 x 0.1mm
- 2 were further aged (FA) → TS 12697-52 (RILEM protocol)

IDT principle for RA characterisation

Test description:

- Indirect tensile test **(IDT/ITS) principle**
- Specimens made of **100% RA**
- Gyratory compacted samples (@155°C) at **7% target air-voids**
- 4 replicates; dimensions Ø150 mm & H 62 mm
- Testing conditions:
  - Temperature **25°C**
  - Loading rate **50 mm/min**

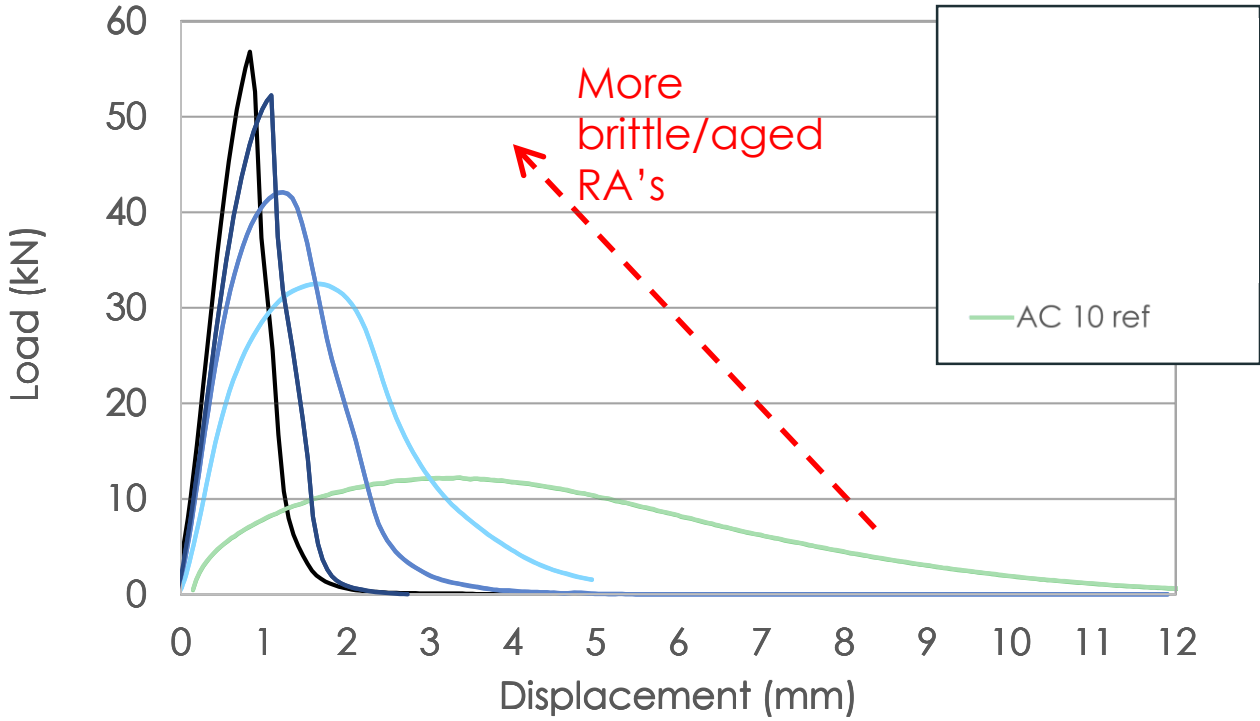
IDT principle for RA characterisation

Impact of loading-displacement **(LD) curve** on **RA ageing state**?

- **Steeper curves**
- **Higher max load**

  (strength-toughness related parameter)
- **"Narrower" bell-curve**

  (brittleness-related parameter)

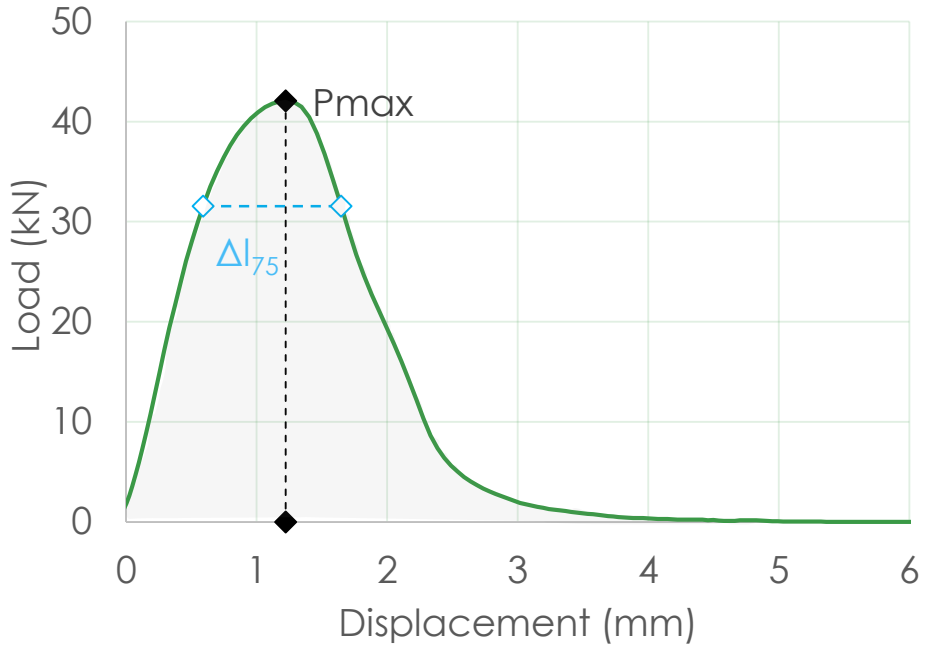


CBI approach

Cracking-based brittleness index - CBI

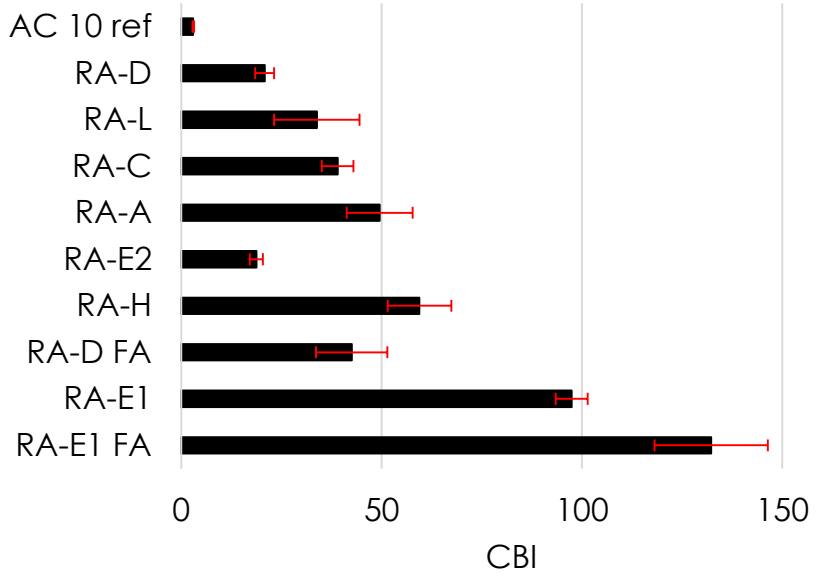
- max load – **Pmax**
- Displacement difference(Δ) or width of curve at 75%Pmax – **Δl_{75}**
- **Higher CBI values** indicate more **brittle mixture**

$$CBI = \frac{P_{max}}{\Delta l_{75}}$$



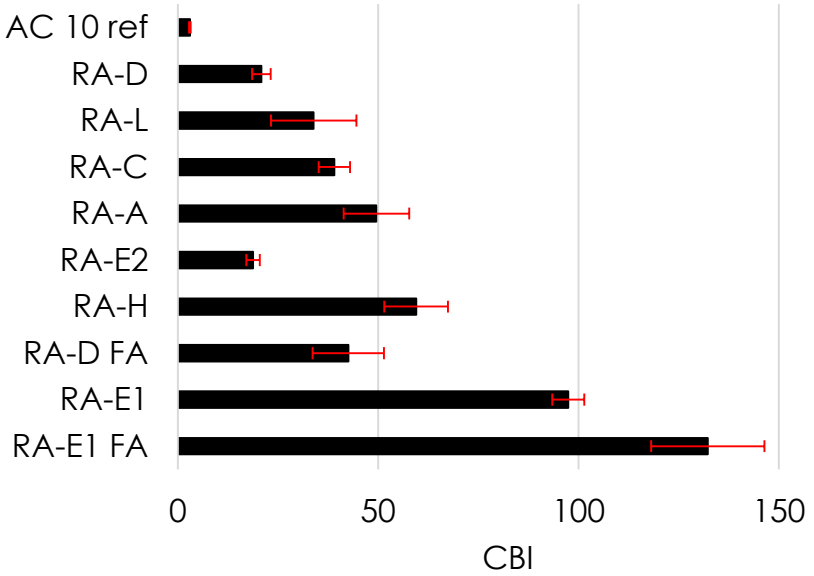
RA screening – CBI results

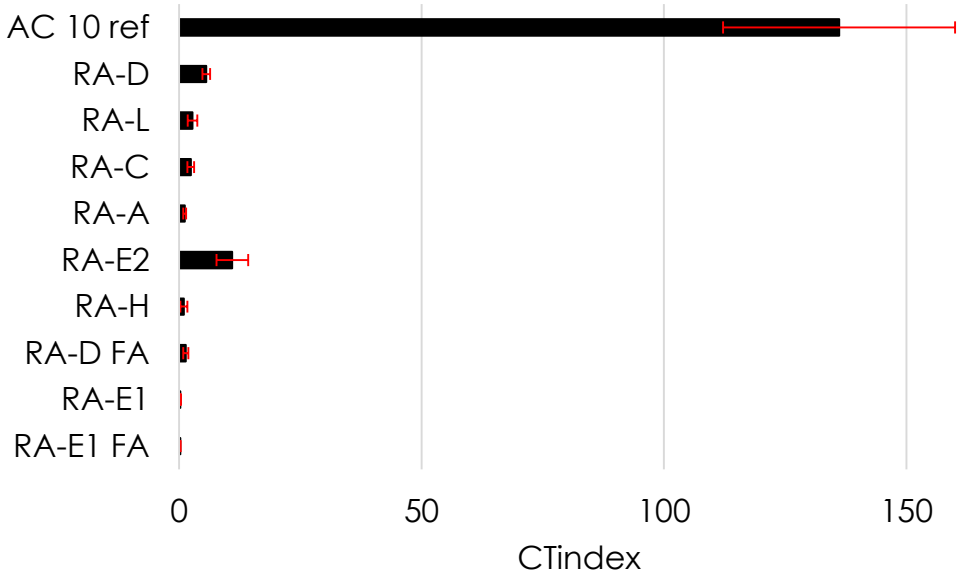
- 9 RA materials tested so far
  - 2 "further aged"(denoted FA)
- RA E1 FA (pen 7) shows highest value
- AC 10 ref (unaged) the lowest
- RA further ageing increases CBI values
- Generally ranking reflects well "binder ageing"



RA screening – CBI vs CT_{index}

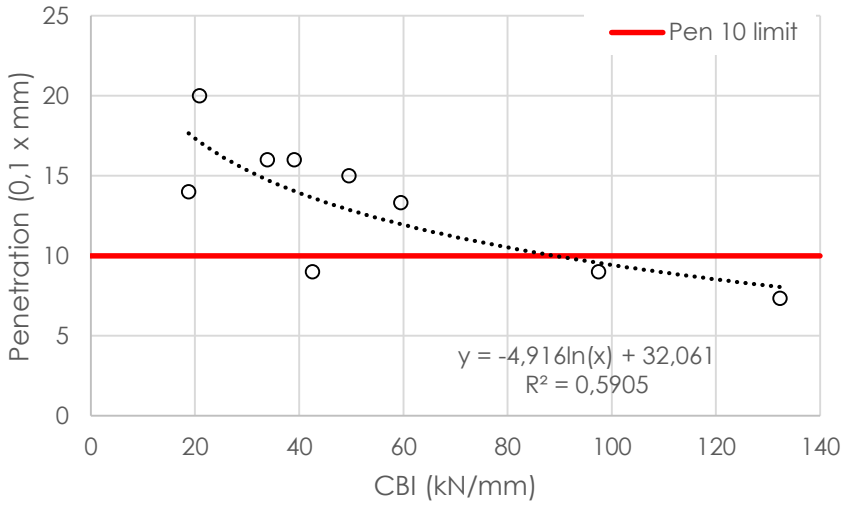
- **Low discriminating power** between RA's when using **CT_{index}**
- **CBI** allows to **screen/discriminate** more effectively

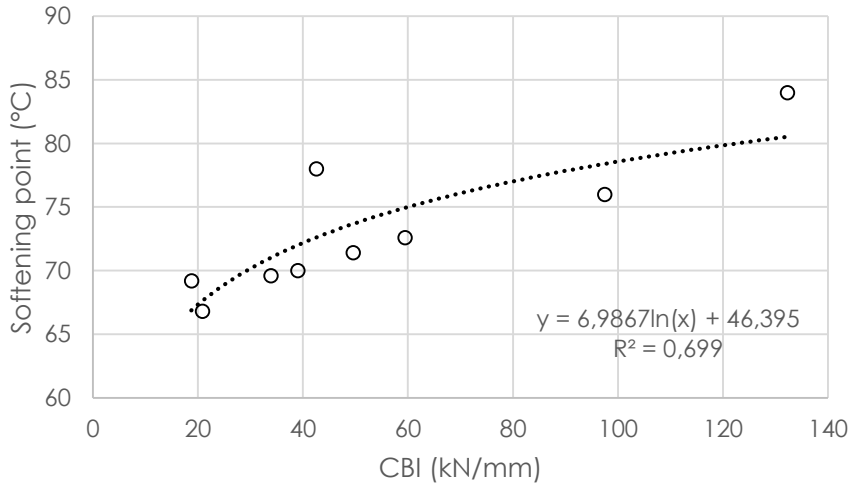




CBI vs (standard) bit. properties

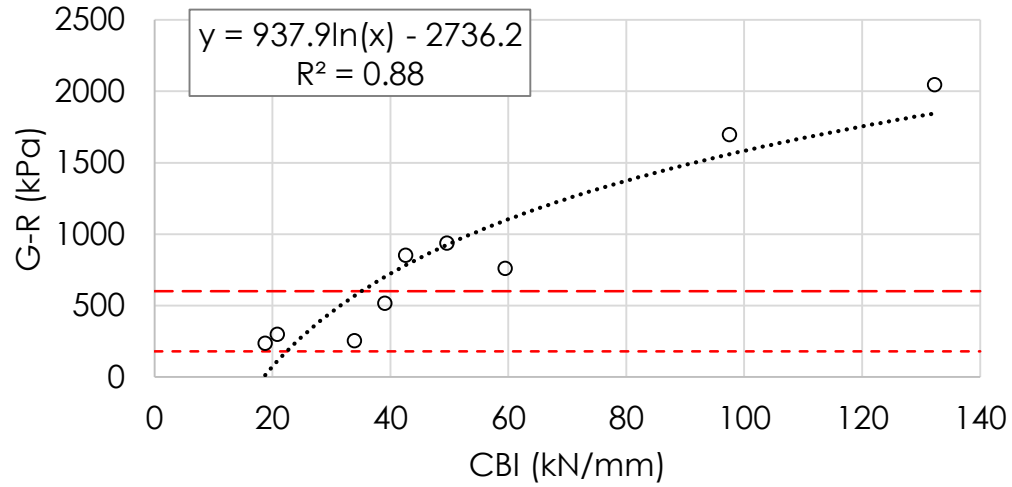
- 3 RA's fall below the pen 10 limit
  (In BE those are prohibited for re-use)
  → brittleness behaviour, however, is very different
- Correlation exists between CBI and binder properties

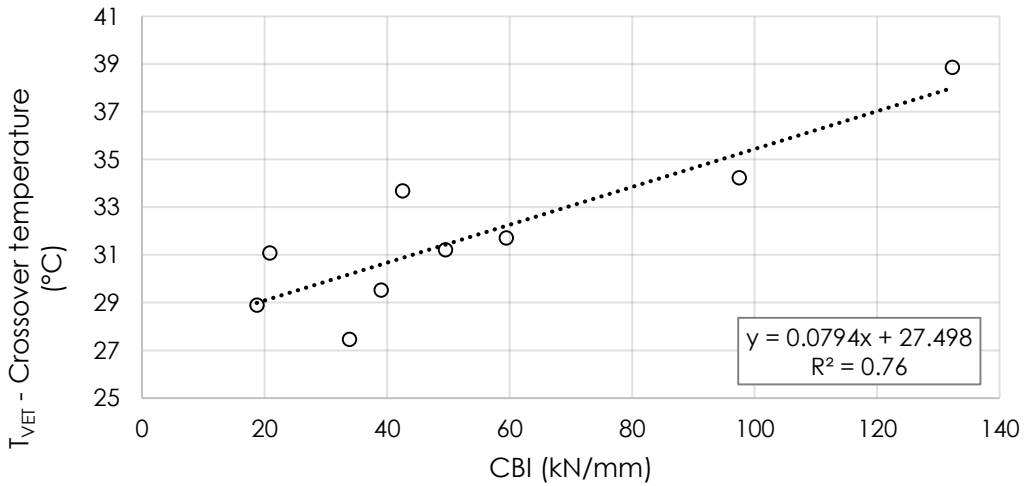




CBI vs (DSR) bit. properties

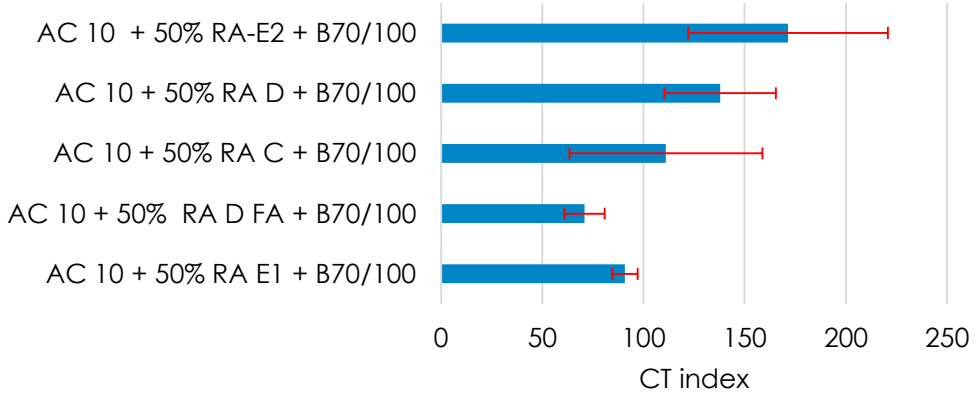
- **Higher T_{VET}** and **G-R** values indicate **more aged** and **prone to cracking** binders
- **CBI value** shows **similar tendency**
- **Binder ageing state** influential factor on **cracking** resistance → but **not the only one**
- Other parameters have an effect (binder content, filler content, filler type etc.)
- **CBI captures global response of RA**

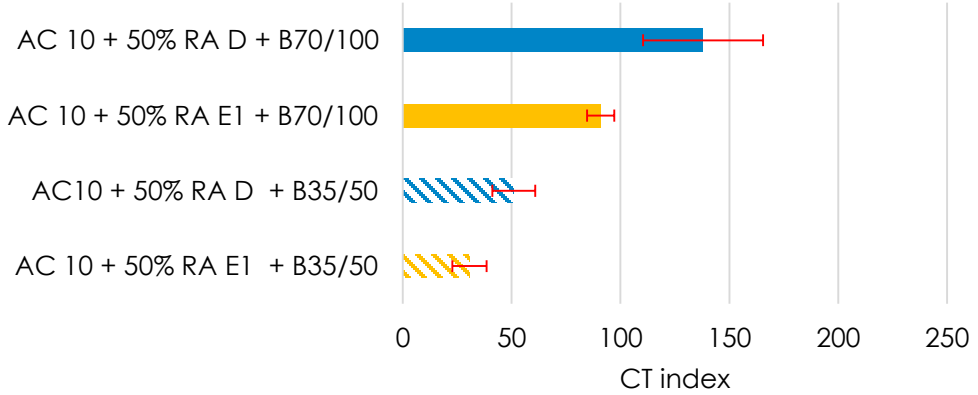




(first) Mix level validation

- 5 AC mixtures with 50% RA (binder replacement)
- higher CT_{index} values indicate less brittle and more cracking-resistant mixtures
- **CT_{index}** shows **similar tendency as CBI on RA level**
- Using a stiffer grade binder will influence cracking resistance
  → importance to compensate carefully





General take-away points:

- The **new test protocol** is able to **screen between RA's**
- **Higher CBI** values reflect RA materials with **more brittle** behaviour and **higher ageing severity**
- **Logical trend** between **RA binder properties** and **CBI**
- **CBI** captures **global response** of RA-material (not only bitumen properties); uses **common equipment** and is **solvent free method**

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