Update to provisional aged solar reflectance of roofing products

2013 Energy Efficiency Building Standards Staff Workshop

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Overview

- **One measure:**
  - Cool roofs
  - Section 118(i)2

Goals of proposed code changes

- Use CRRC measurements to update formula for provisional aged solar reflectance
- Reduce likelihood that provisional aged solar reflectance overpredicts measured aged solar reflectance
- Correct nomenclature for aged solar reflectance (change R_{aged} to ρ_{aged})

Proposed Code Changes

EXCEPTION to Section 118(i)1: Roofing products that are not certified according to Section 10-113 shall assume the following default aged reflectance/emittance values:

A. For asphalt shingles, 0.08/0.75

B. For all other roofing products, 0.10/0.75

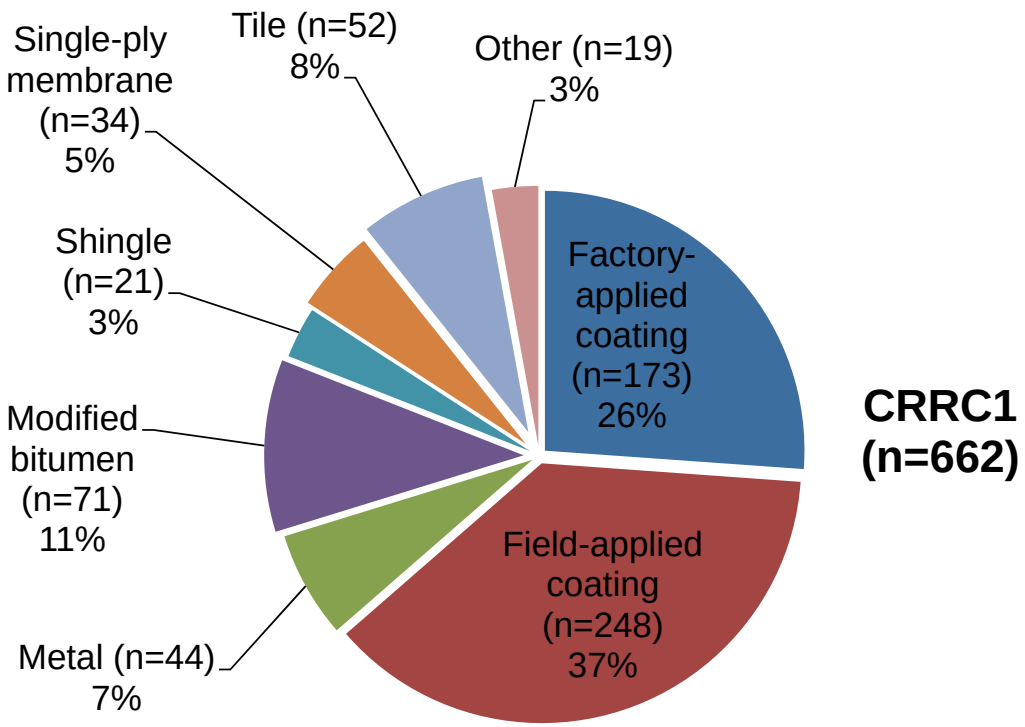
2. If CRRC testing for ~~3-year~~ aged reflectance is not available for any roofing products, the ~~3-year~~ aged value shall be derived from the CRRC initial value using the equation ~~$R_{aged} = [0.2 + 0.7[\rho_{initial} - 0.2]$~~ $\rho_{aged} = 0.2 + \beta\,[\rho_{initial} - 0.2]$, ~~W~~where $\rho_{initial}$ = the initial ~~S~~solar ~~R~~reflectance and soiling resistance β is listed by product type in Table 118-XX.

Table 118-XX Values of soiling resistance β for each product type

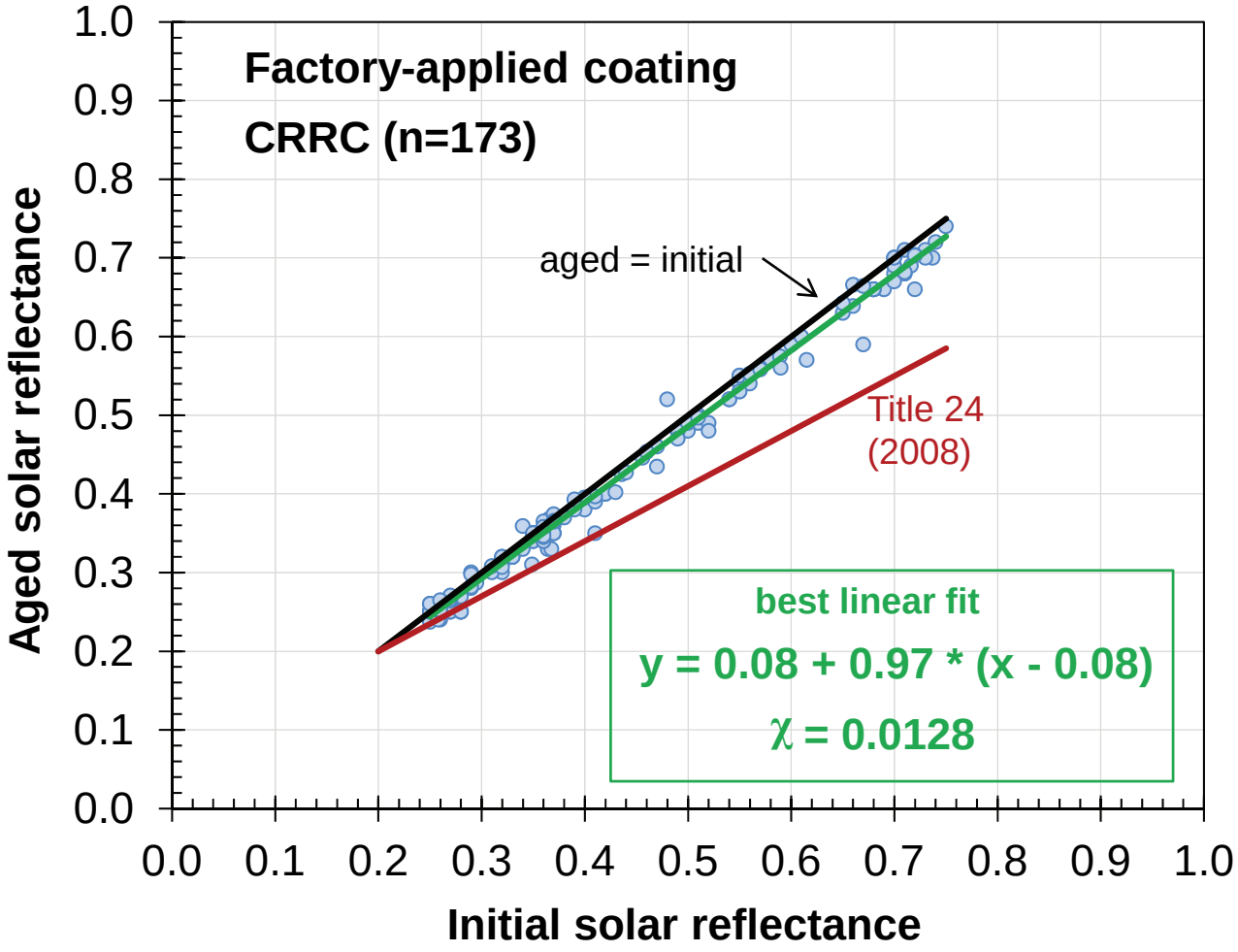
Product type	**CRRC product category**	**β**
Field-applied coating	Field-applied coating	0.65
Other	Not a field-applied coating	0.70

Basis for code change

- Rated Products Directory - US Cool Roof Rating Council (CRRC)
- Accessed April, 2011
- Edited to exclude duplicative and non-measured values

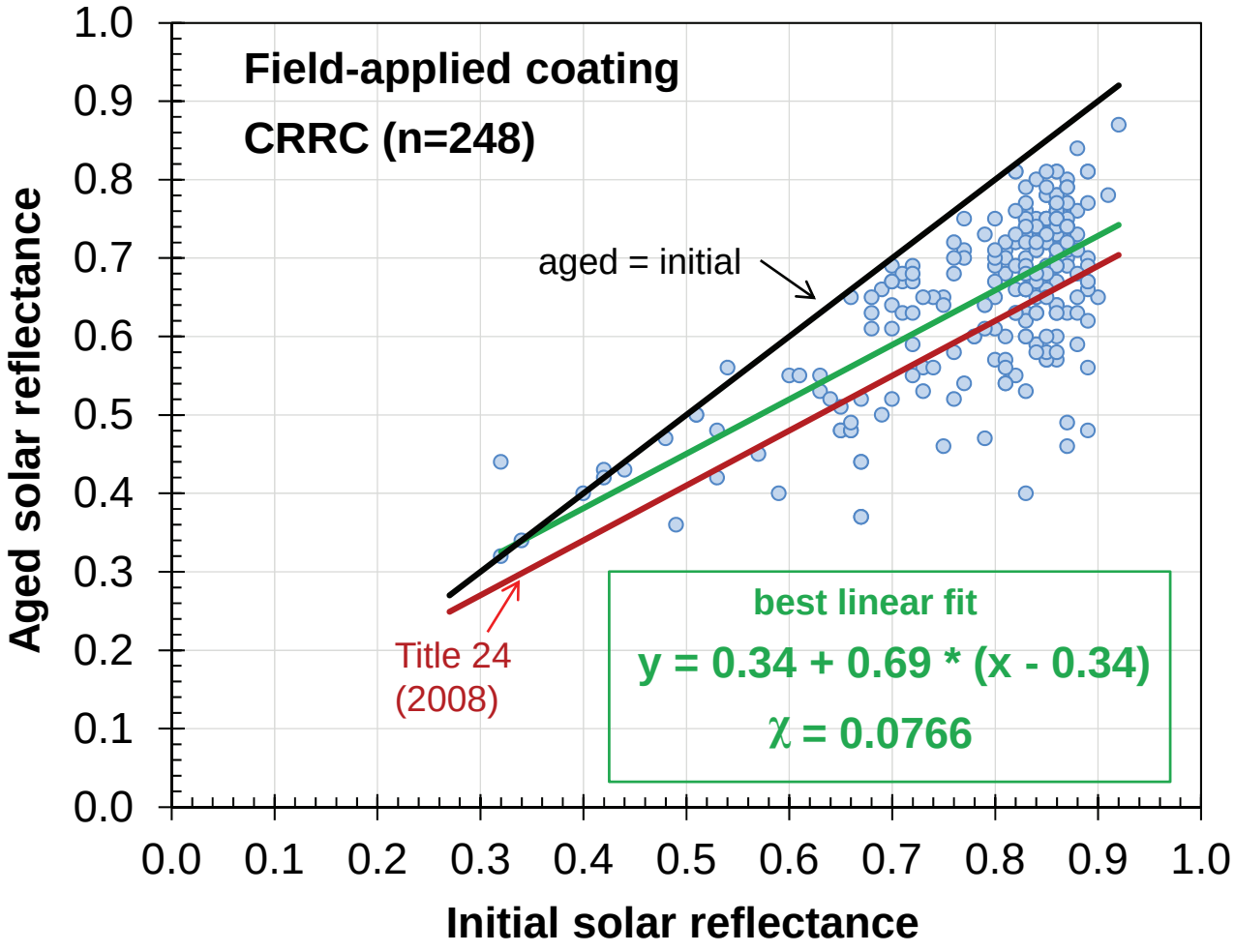


Factory-applied coating: best fit



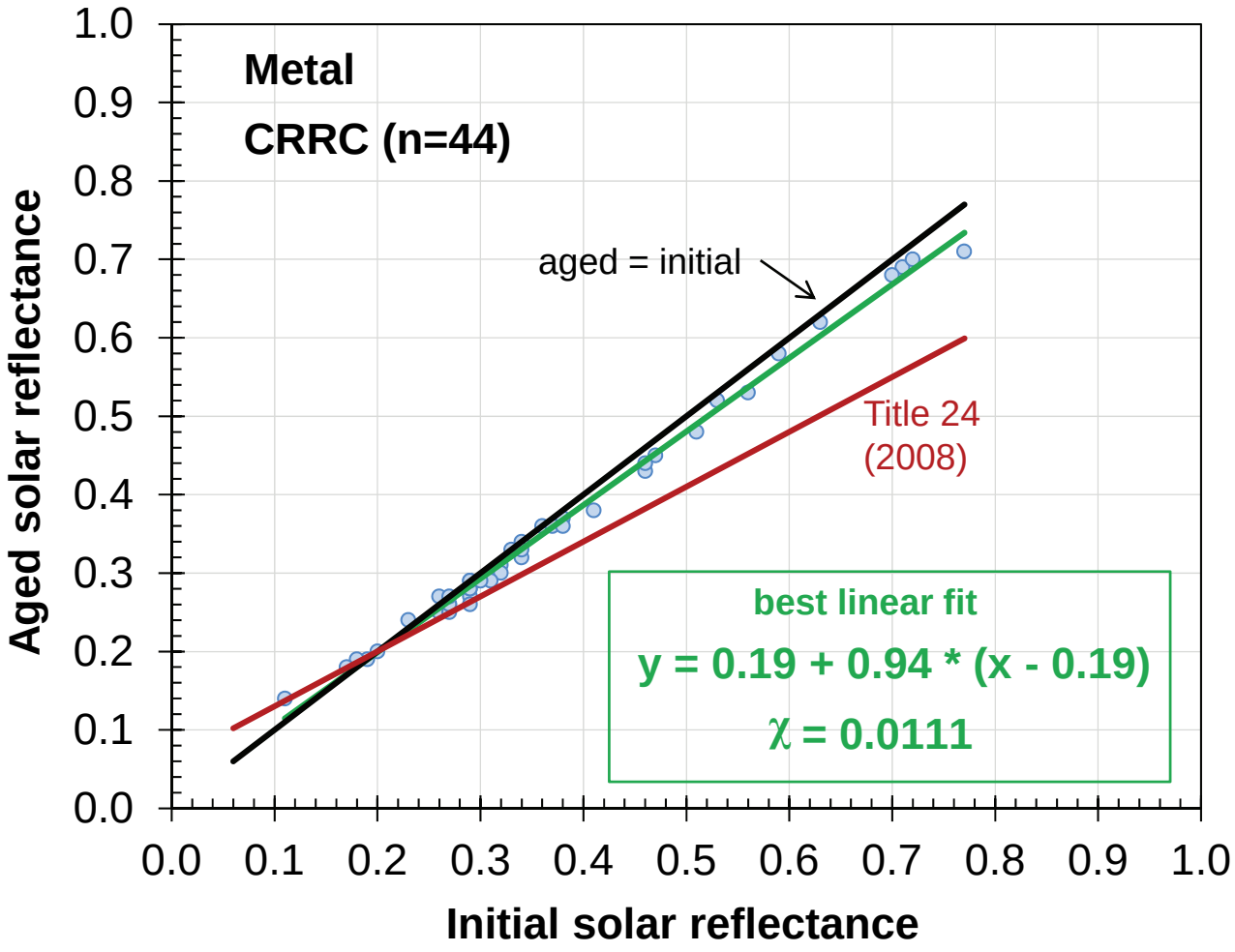
χ = root mean square error

Field-applied coating: best fit



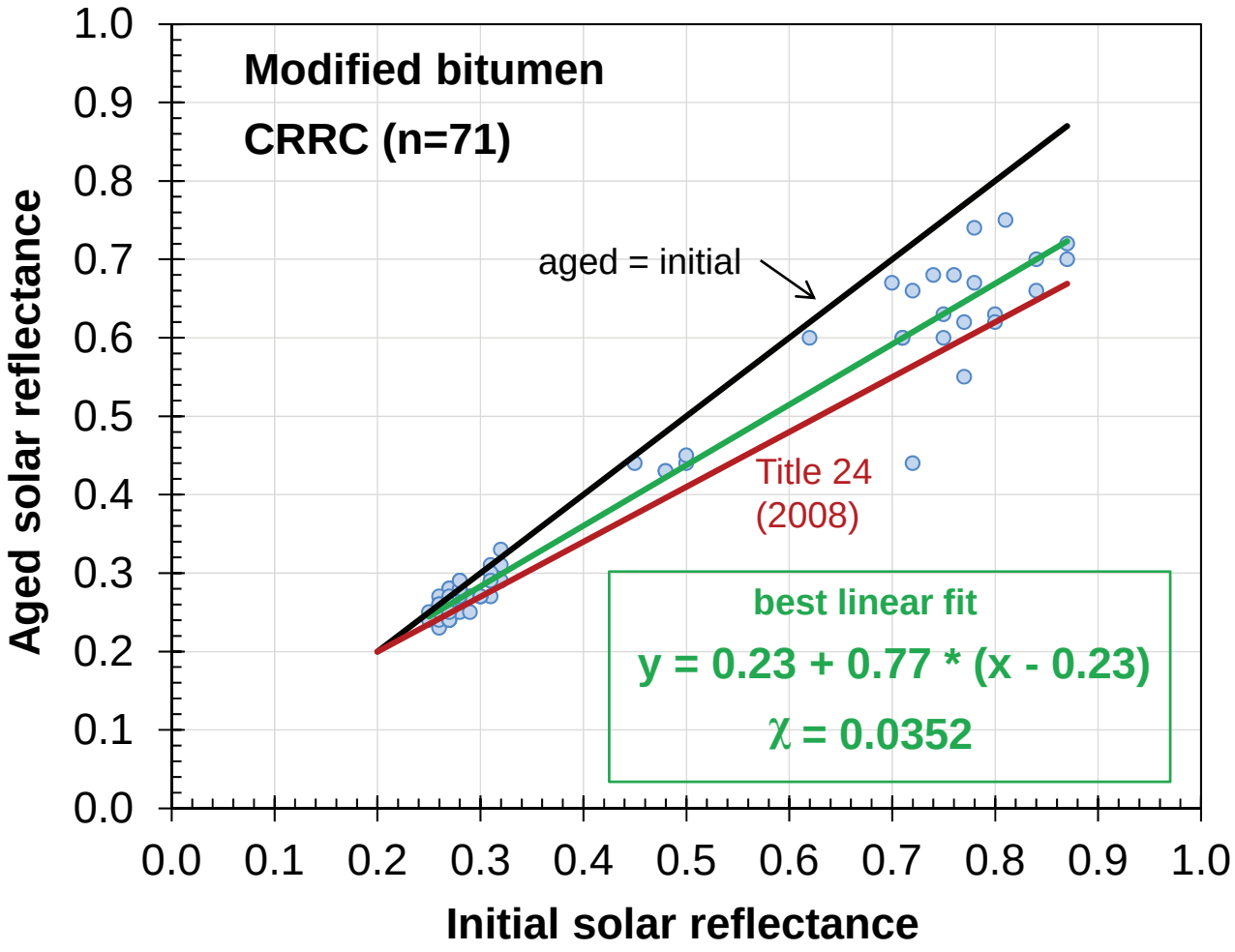
χ = root mean square error

Metal: best fit



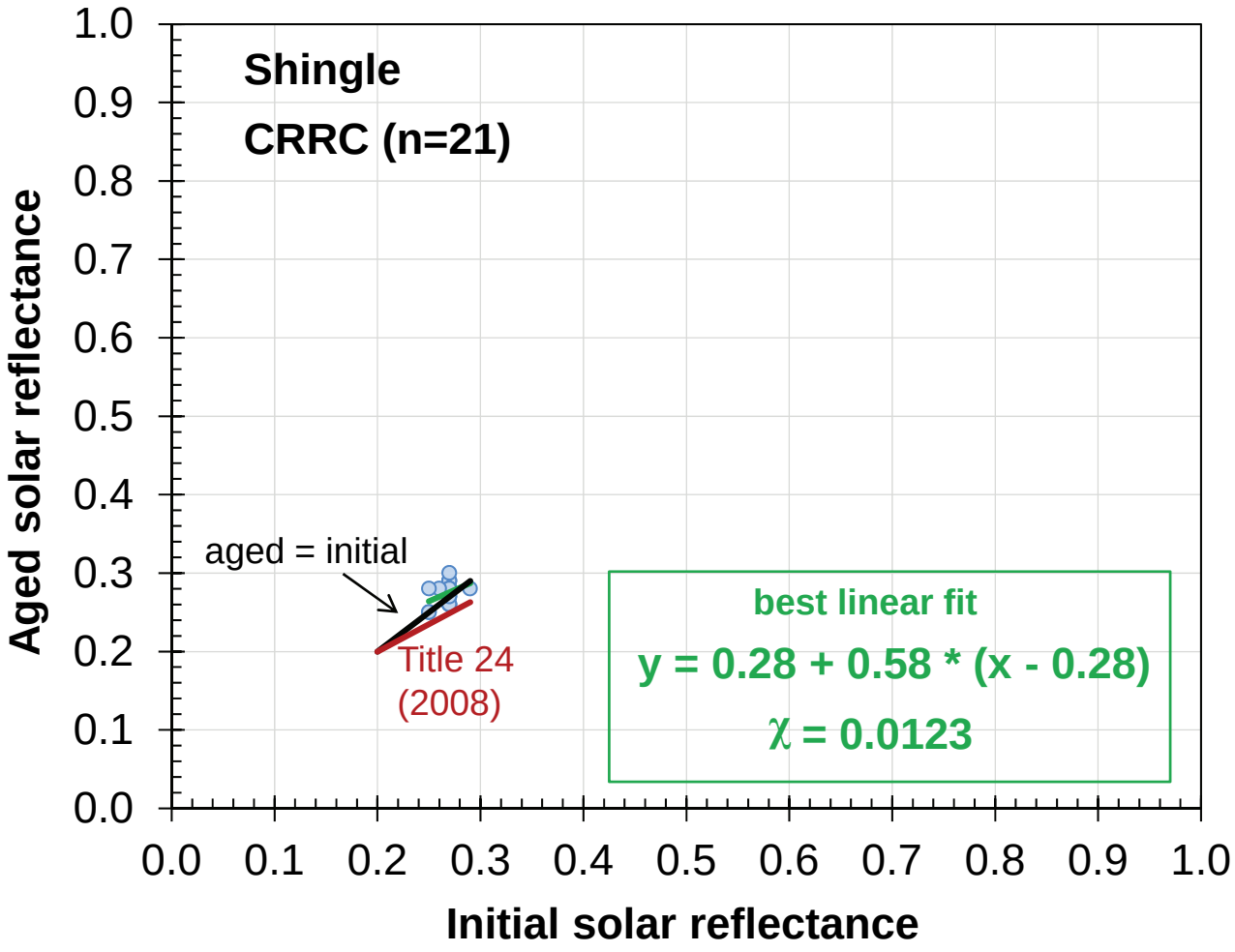
χ = root mean square error

Modified bitumen: best fit



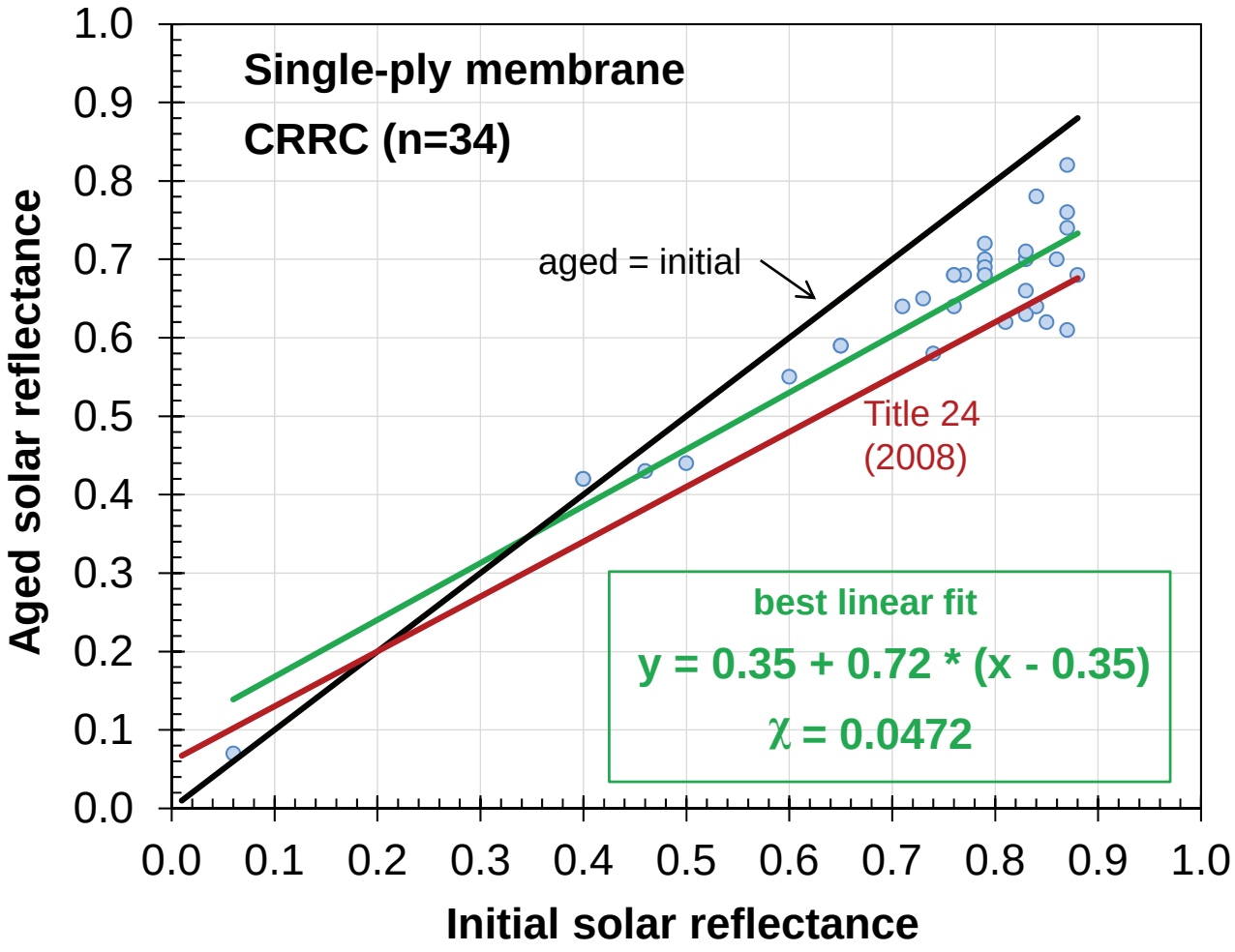
χ = root mean square error

Shingle: best fit



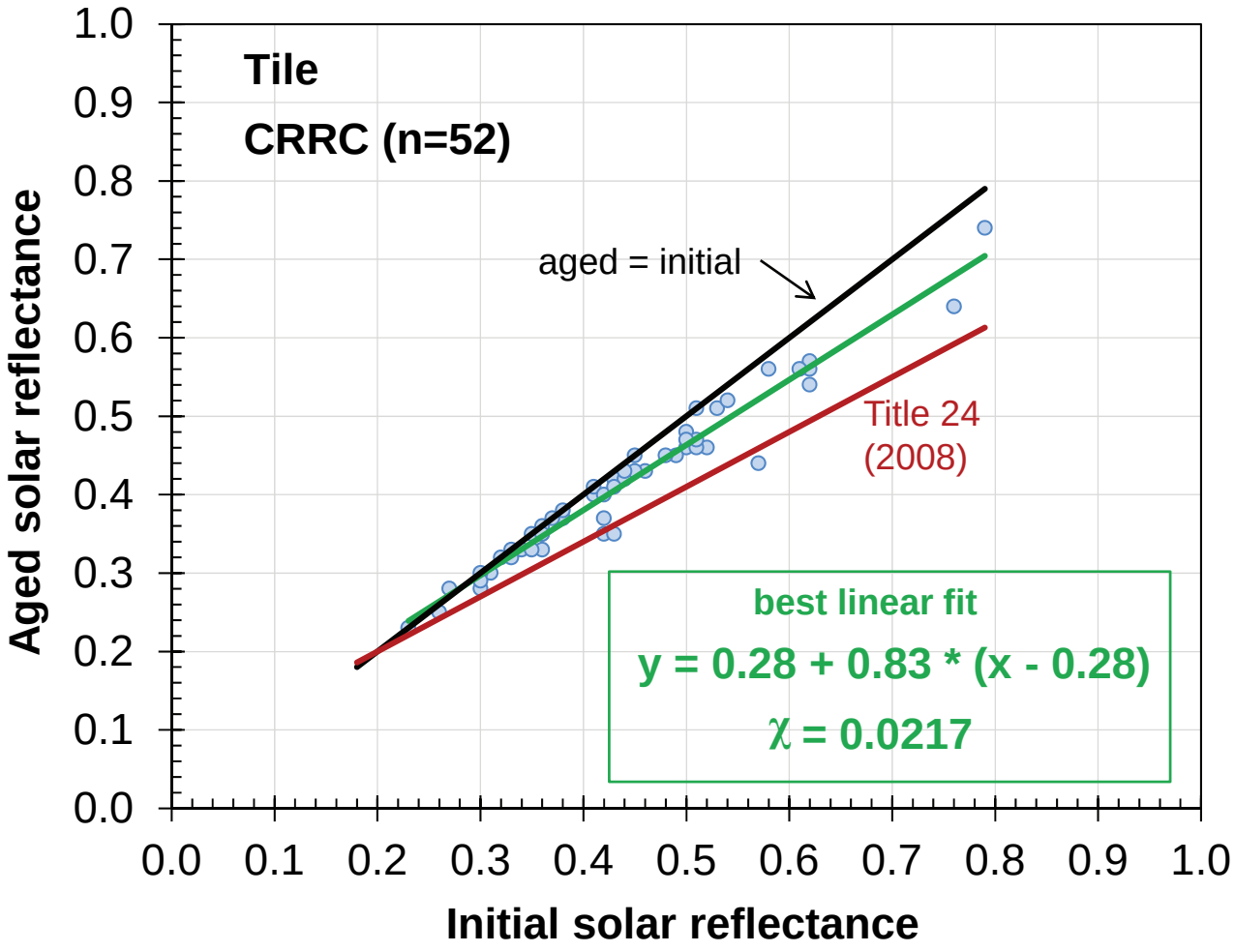
χ = root mean square error

Single-ply membrane: best fit



χ = root mean square error

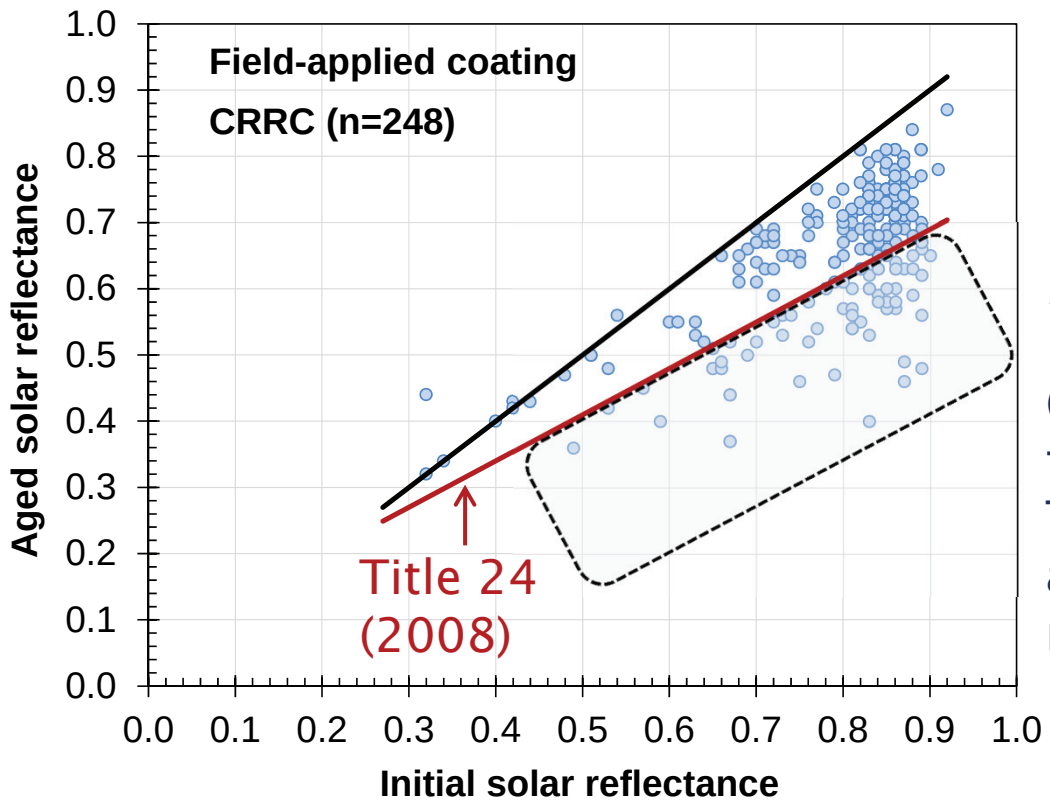
Tile: best fit



χ = root mean square error

Definition– Overprediction Rate, *F*

- Fraction of products for which predicted aged solar reflectance exceeds measured aged solar reflectance.



F=30%

(30% of products fall below the red Title 24 predictive aged solar reflectance line)

Overprediction Rate, *F*

- Overprediction rate using 2008 Title 24 equation:

$$\rho_{aged} = 0.2 + 0.7\,[\rho_{initial} - 0.2]$$

Product type	Overprediction Rate (%)
Factory-applied coating	2.9
Field-applied coating	30.2
Metal	4.5
Modified bitumen	15.5
Shingle	0.0
Single-ply membrane	17.6
Tile	5.8

New Title-24 predictive equation

- Title 24 (2008) equation for provisional aged reflectance, ρ_{aged} :

$$\rho_{aged} = 0.2 + 0.7\,[\rho_{initial} - 0.2]$$

- New proposed equation:

$$\rho_{aged} = 0.2 + \beta\,[\rho_{initial} - 0.2]$$

  - $\rho_{initial}$ = initial solar reflectance
  - β is resistance to soiling, listed by product type in proposed Table 118-XX
  - β chosen to limit overprediction rate (policy decision)

Soiling resistance (β)

- β values yielding specified overprediction rates for each product type

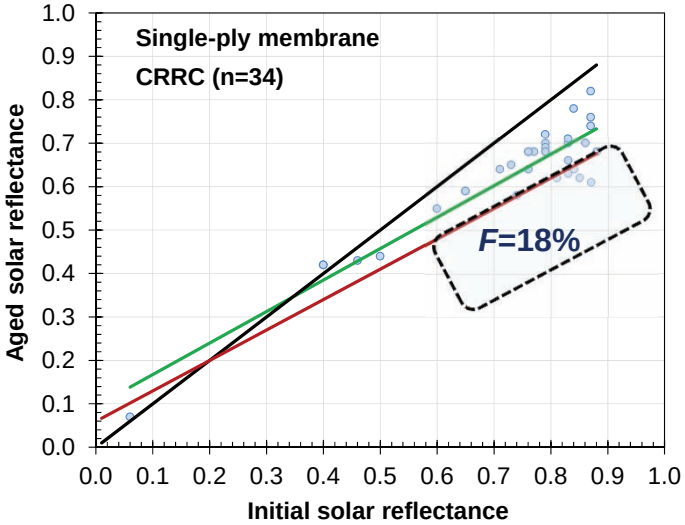
$$\rho_{aged} = 0.2 + \beta\,[\rho_{initial} - 0.2]$$

	F = 5%	*F* = 10%	*F* = 15%	*F* = 20%	*F* = 30%	*F* = 40%	*F* = 50%	*F* = 60%	*F* = 70%	*F* = 80%	*F* = 90%
Factory-applied coating (n=173)	0.73	0.82	0.85	0.88	0.91	0.94	0.95	0.96	0.98	NA	NA
Field-applied coating (n=248)	0.52	0.59	0.62	0.66	0.69	0.75	0.80	0.82	0.85	0.88	0.93
Metal (n=44)	0.71	0.81	0.83	0.85	0.88	0.90	0.92	0.96	0.97	NA	NA
Modified bitumen (n=71)	0.57	0.61	0.66	0.70	0.73	0.75	0.78	0.82	0.88	0.95	NA
Shingle (n=21) *	0.85	0.85	0.85	0.88	NA	NA	NA	NA	NA	NA	NA
Single-ply membrane (n=34)	0.61	0.68	0.68	0.70	0.78	0.80	0.83	0.84	0.85	0.87	0.90
Tile (n=52)	0.68	0.80	0.81	0.83	0.87	0.90	0.91	0.93	0.94	NA	NA

* Values for shingle should not be used due to low sample size

Selecting an overprediction rate *F*

- Minimizing overprediction rate helps ensure long-term aged solar reflectance will meet prescriptive requirements
- <u>But</u> zero overprediction rate would give too much weight to outliers (possible measurement errors in existing database)
- Compromise: select moderate overprediction rate (F = 18%)
  - Corresponds to $F_{\text{Title24(2008)}}$ for single-ply membrane (has 2nd highest rate of overprediction)



Soiling resistance (β) [i/iv]

- Suggested values for β
  - Limit overprediction rate *F* to 18%
  - For each product type
    - Find $\beta_{F=18\%}$ from table of β versus *F*

Product type	$\beta_{F = 18\%}$
Factory-applied coating (n=173)	0.87
Field-applied coating (n=248)	0.64
Metal (n=44)	0.85
Modified bitumen (n=71)	0.70
Shingle (n=21) *	0.85
Single-ply membrane (n=34)	0.70
Tile (n=52)	0.83

Soiling resistance (β) [ii/iv]

- Suggested values for β
  - Limit overprediction rate *F* to 18%
  - For each product type
    - Find $\beta_{F=18\%}$ from table of β versus *F*
    - Let $\beta' = \beta_{F=18\%}$ rounded to nearest 0.05

Product type	β'
Factory-applied coating (n=173)	0.85
Field-applied coating (n=248)	0.65
Metal (n=44)	0.85
Modified bitumen (n=71)	0.70
Shingle (n=21) *	0.85
Single-ply membrane (n=34)	0.70
Tile (n=52)	0.85

Soiling resistance (β) [iii/iv]

- Suggested values for β
  - Limit overprediction rate *F* to 18%
  - For each product type
    - Find $\beta_{F=18\%}$ from table of β versus *F*
    - Let $\beta' = \beta_{F=18\%}$ rounded to nearest 0.05
    - If $\beta' < 0.70$, we recommend $\beta = \beta'$
    - Otherwise, we recommend $\beta = 0.70$ (same as 2008 Title 24)
  - That is, products with low resistance to soiling are assigned a new β

Product type	β'
Factory-applied coating (n=173)	0.85
Field-applied coating (n=248)	0.65
Metal (n=44)	0.85
Modified bitumen (n=71)	0.70
Shingle (n=21) *	0.85
Single-ply membrane (n=34)	0.70
Tile (n=52)	0.85

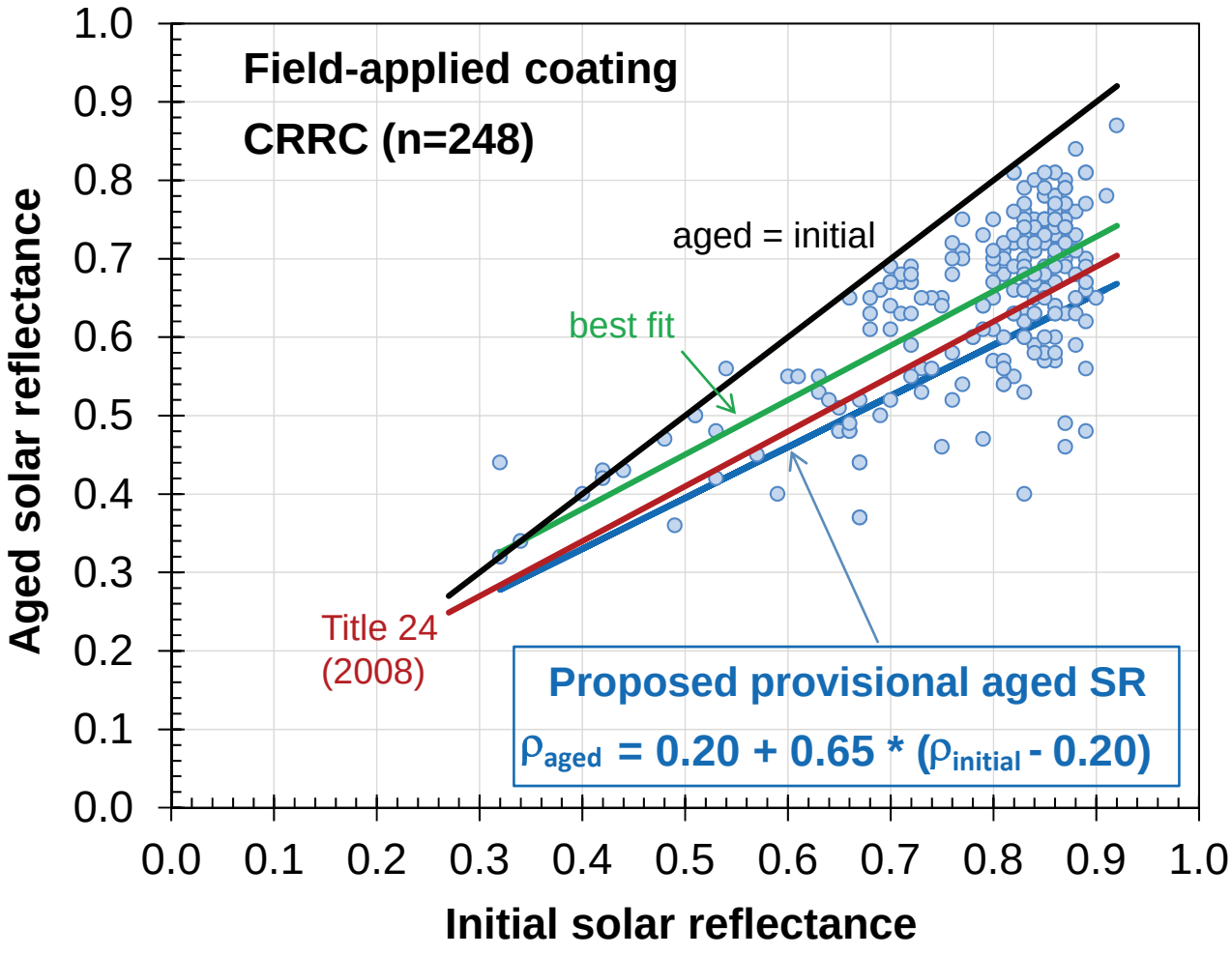
* insufficient data

Soiling resistance (β) [iv/iv]

- Suggested values for β

Product type	**CRRC product category**	β
Field-applied coating	Field-applied coating	0.65
Other	Not a field-applied coating	0.70

Field-applied coating: proposed formula



Questions

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QUESTIONS & COMMENTS

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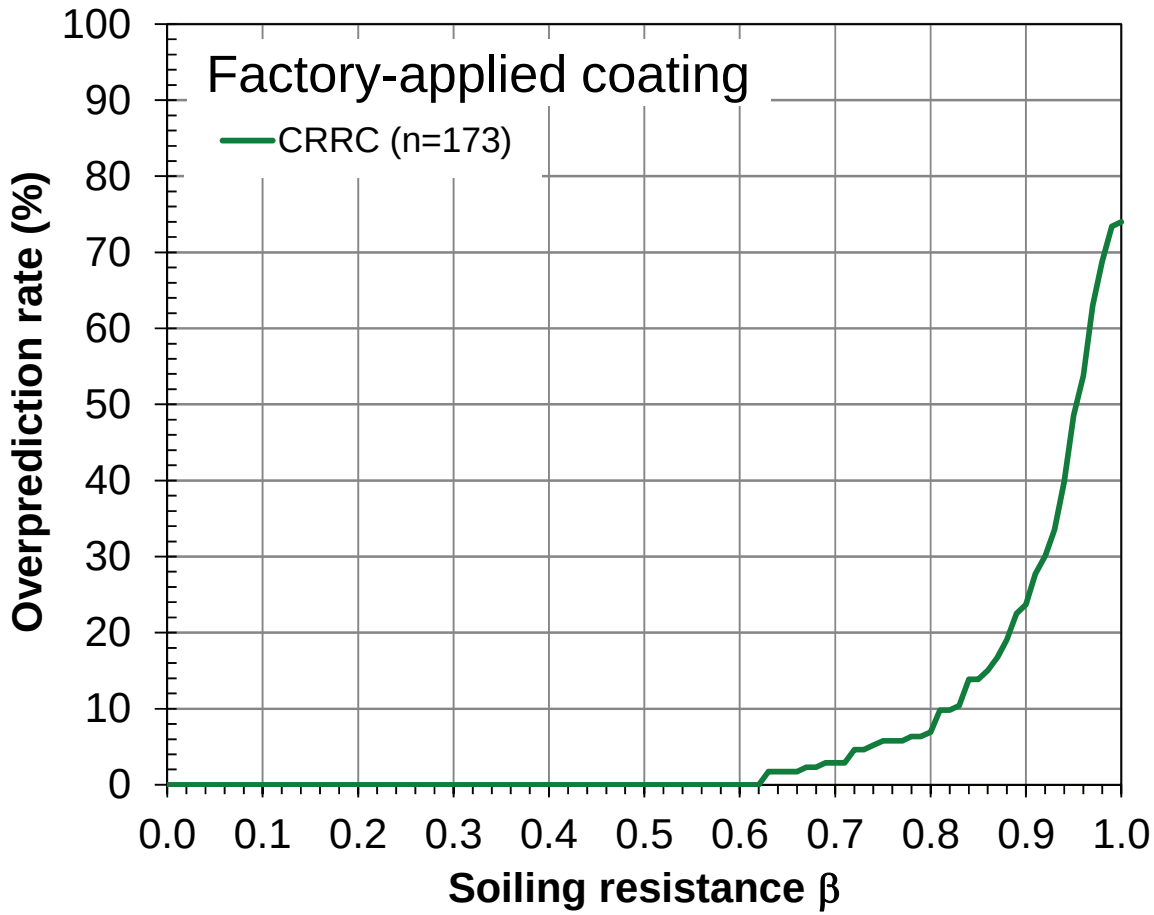
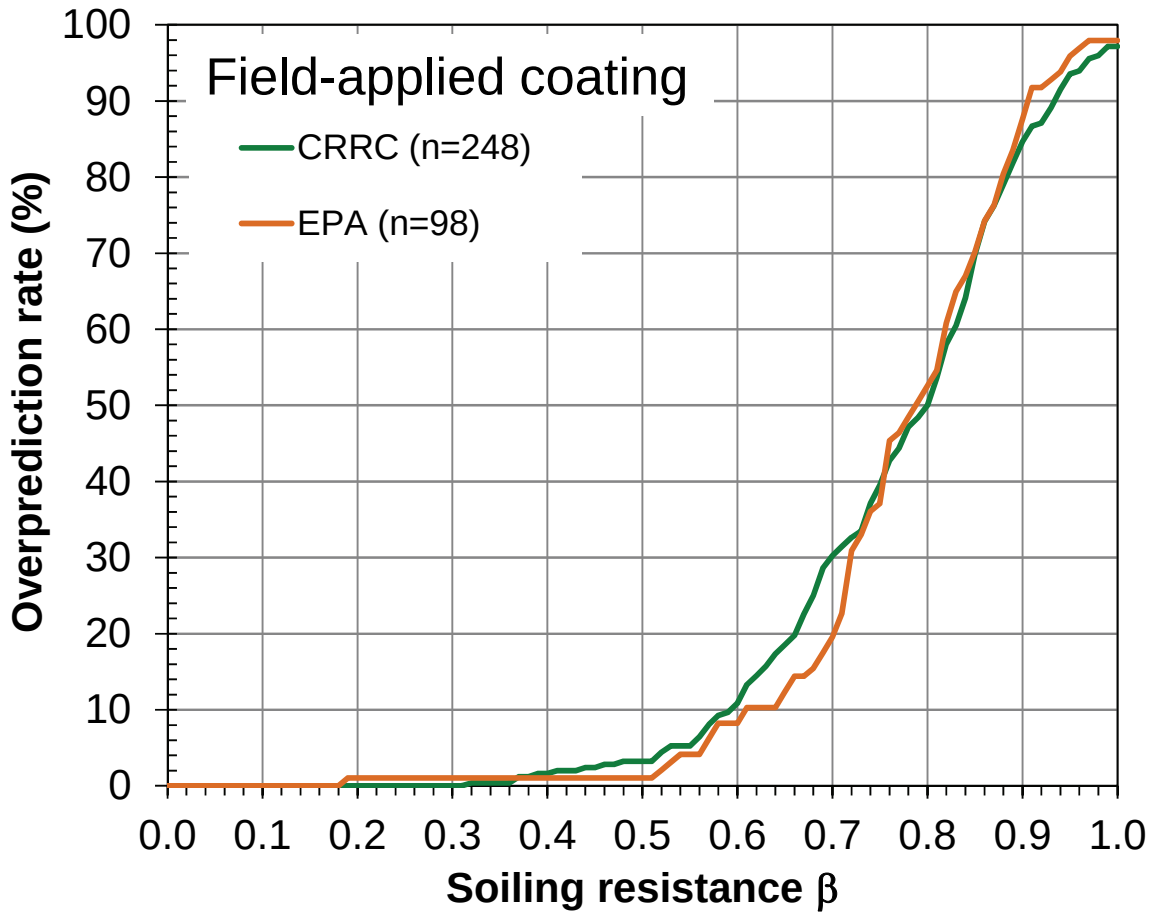
Supplemental Slides

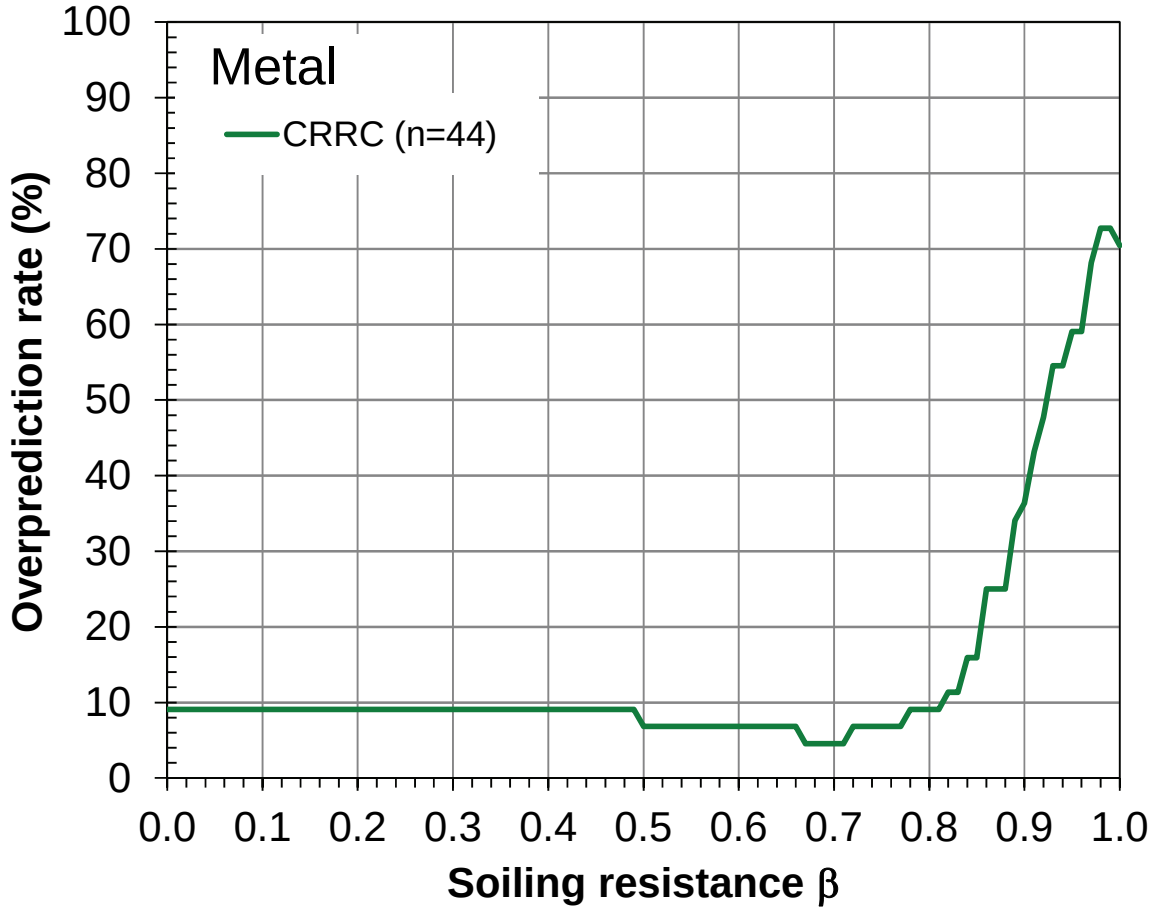
Overprediction rate *F* vs. soiling resistance β: Factory-applied coating



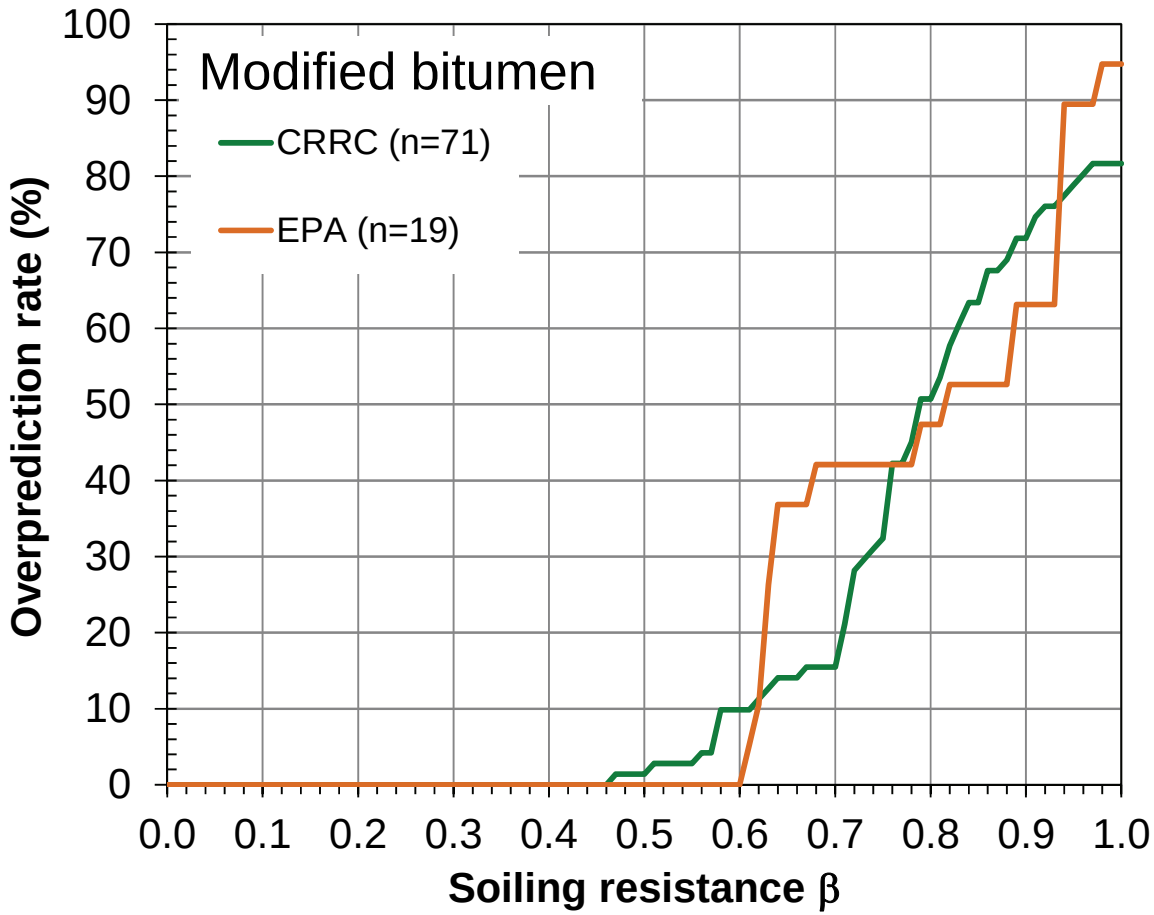
Overprediction rate *F* vs. soiling resistance β: Field-applied coating



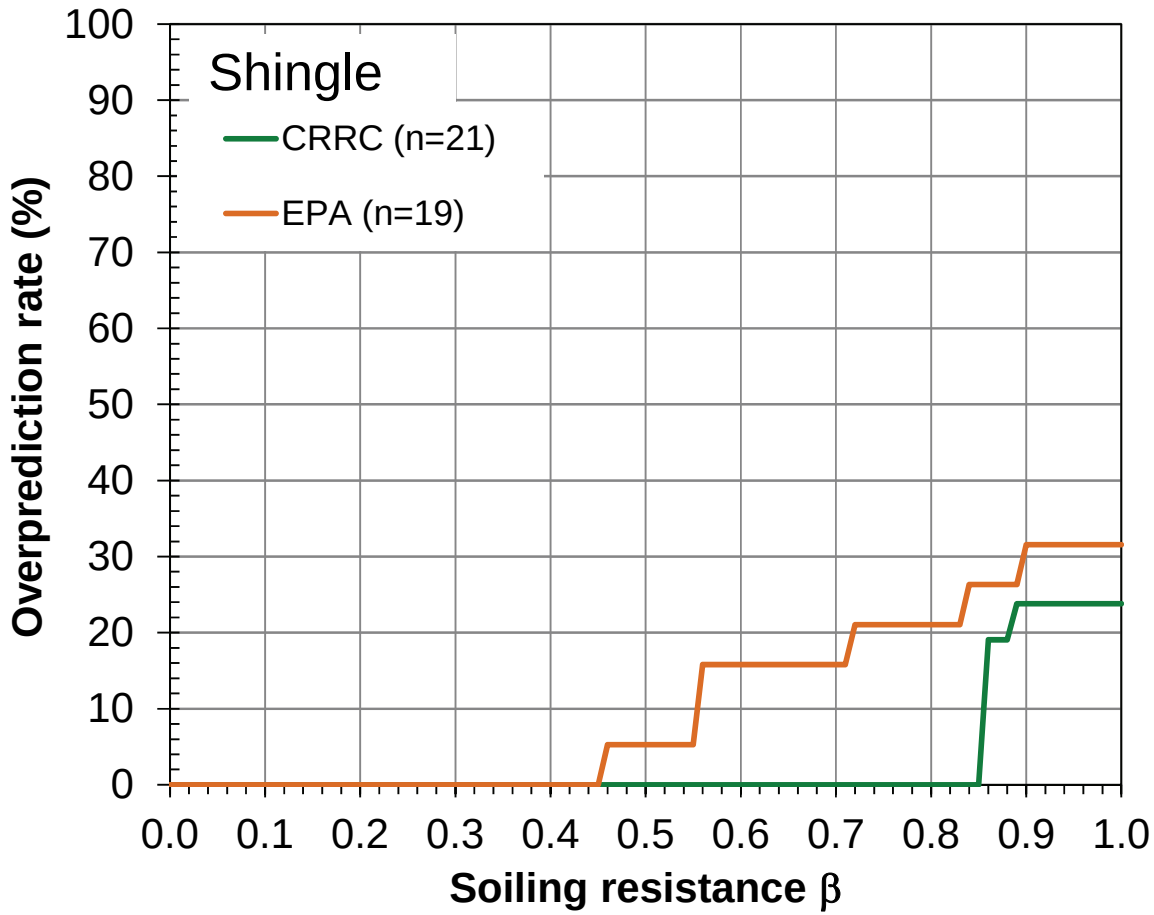
Overprediction rate *F* vs. soiling resistance β: Metal



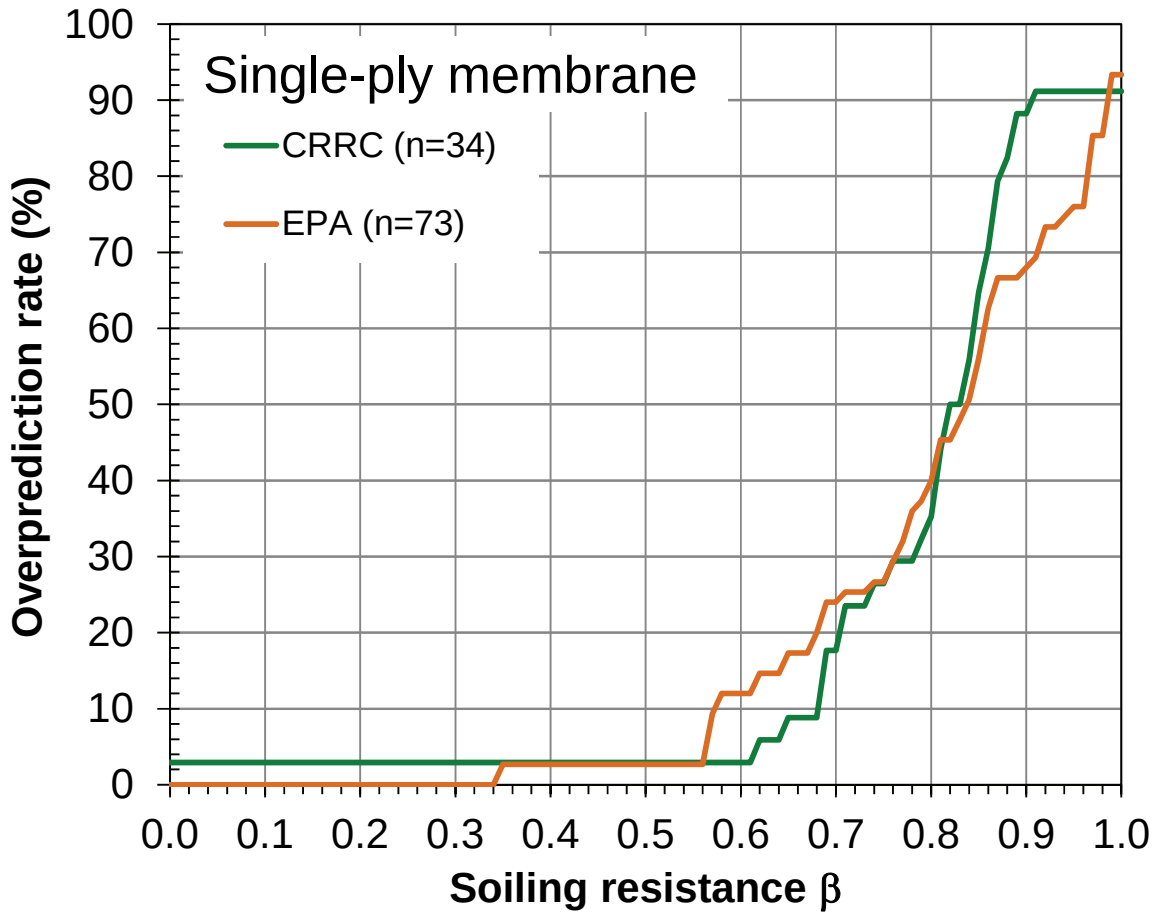
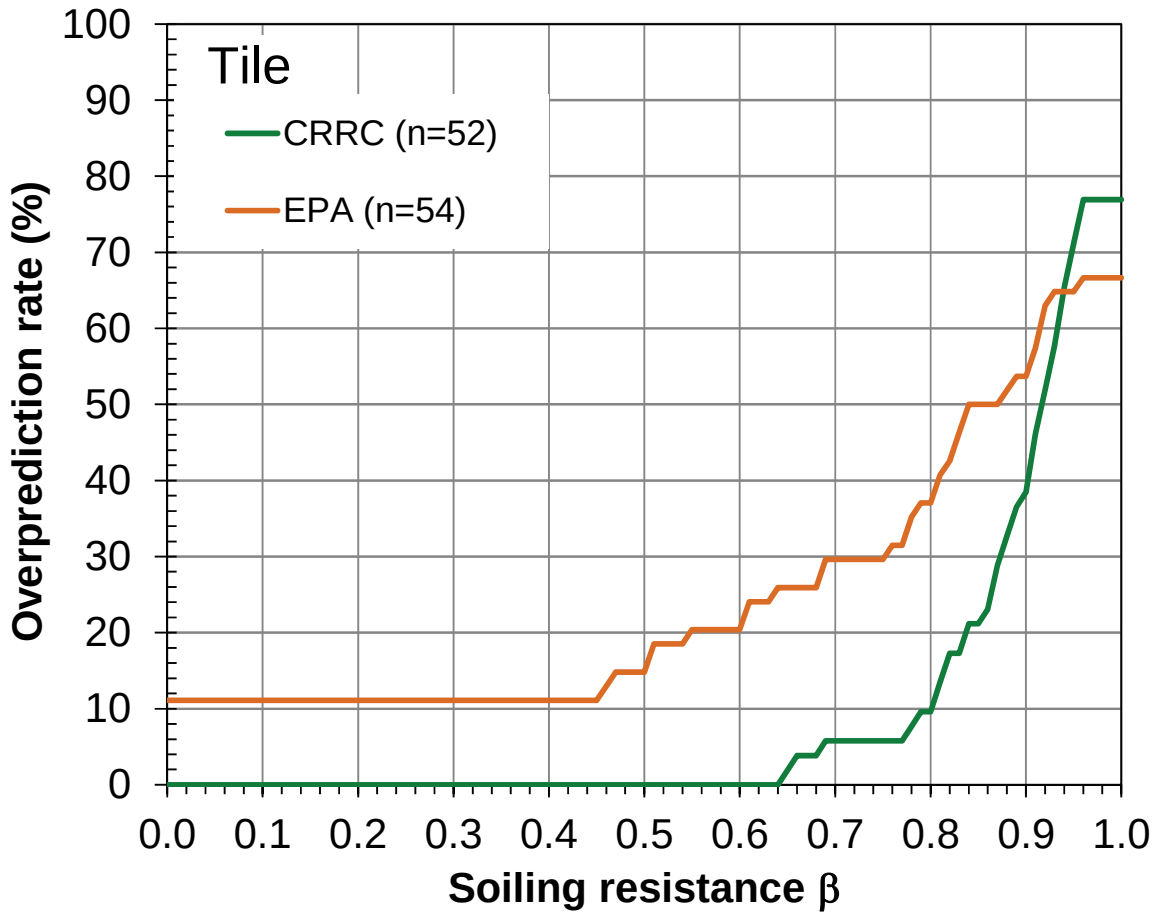
Overprediction rate *F* vs. soiling resistance β: Modified bitumen



Overprediction rate *F* vs. soiling resistance β: Shingle



Overprediction rate *F* vs. soiling resistance β: Single-ply membrane



Overprediction rate *F* vs. soiling resistance β: Tile