

SOILING MEASUREMENTS: OUTDOORS AND INDOORS

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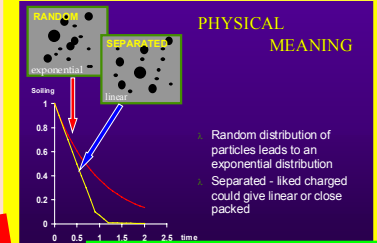
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SOILING: Refers to the accumulation of particles on surfaces

1. **Outdoors:** mainly black fine particles on vertical/horizontal surfaces
2. **Indoors:** mainly dust on horizontal surfaces both polished and rough

Seemingly random particle accumulation in an exponential manner



Soiling (R = reflectance)

$$R_t = (R_0 - R_\infty) \exp(-k.t) + R_\infty \text{ or } R_t = R_0 - (R_0 - R_\infty) (1 - \exp(-k.t))$$

R_0 = Reflectance of unsoiled material; R_t = Reflectance of soiled material at time t ; R_∞ = Reflectance of soiled surfaces after infinite time; k = soiling rate (time constant of the soiling process)

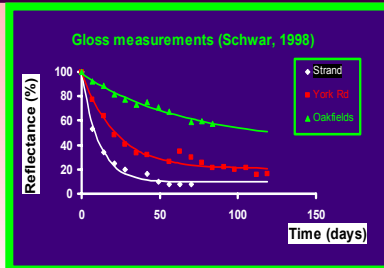
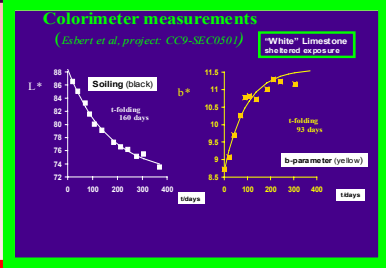
R_∞ - AN INTERESTING PARAMETER
It probably relates to

- Colour of soiling material
- Orientation of surfaces
- Amount of pollution
- Resuspension/rain washing

OUTDOOR SOILING

Usually (Black) Soiling: visual nuisance from the darkening of surfaces by the accumulation of carbonaceous fine particles from incomplete combustion of fossil fuels. However, soiling may consist of darkening of light surface, light coloured deposits on dark surface or changes in surface gloss.

Soiling measurement: as diffuse reflectance or sometimes specular reflectance (gloss).



White Tower (S-E corner)
TOWER OF LONDON

Colour changes (colorimeter tristimulus) : Variation of L^* (lightness) with time through deposition of dark particles . Changes in b^* occur at a different rate, possibly sulfation. L^* = lightness (100 = white, 0 = black); b^* : + yellow, - blue

Gloss changes: measurement of the reduction in $45^\circ/45^\circ$ reflectance with time of exposure caused by the deposition of dust

INDOOR SOILING

Dust indoors is measured using both sticky and shiny (glass slides) surfaces. Shiny surfaces mimic polished furniture, but may lose larger particles over time



MEASURING DUST ACCUMULATION INDOORS



Because we want to know the accumulation of both fibres and dust particles we often have to resort to image analysis

SEMPER Images



	Coverage (%)	Counting	Slits
SEMPER	⊙	⊙	⊙
Adobe photoshop	⊙⊙	X	X
MIN software	⊙	⊙	⊙

⊙ : Excellent / ⊙ : Good / X : Not available

Exposure at Osterley Park House showing : Coverage by dust particles: 0.67%, Coverage by fibre: 1.44%

INDOOR PARTICLES

These can be very large and settle on horizontal surfaces and over time may cement to fibres or other hard materials



Although dust indoors also accumulates in an exponential way and is related to visitors numbers current cleaning regimes allow only small coverage of the surface (~3%) so in a year accumulation can be treated in a linear manner