



Pavement surface characteristics evolution

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Context

- Cooperation between **LCPC** and “**Autoroutes du Sud de la France**” (ASF)
- **LCPC**: French national organization for applied research and development in civil engineering
- **ASF**: private organization operating the leading motorway network in France
(around 2,700 km of toll motorway)

Context (Ct'd)

- **LCPC**: modeling the evolution of pavement performance indicators (for structure or surface conditions)
- **ASF**: optimizing maintenance management system by use of predictive pavement performance models
- **LCPC** carries out statistical analysis of the (large and well-informed) database "ArgusBase" managed by **ASF** through periodical monitoring campaigns

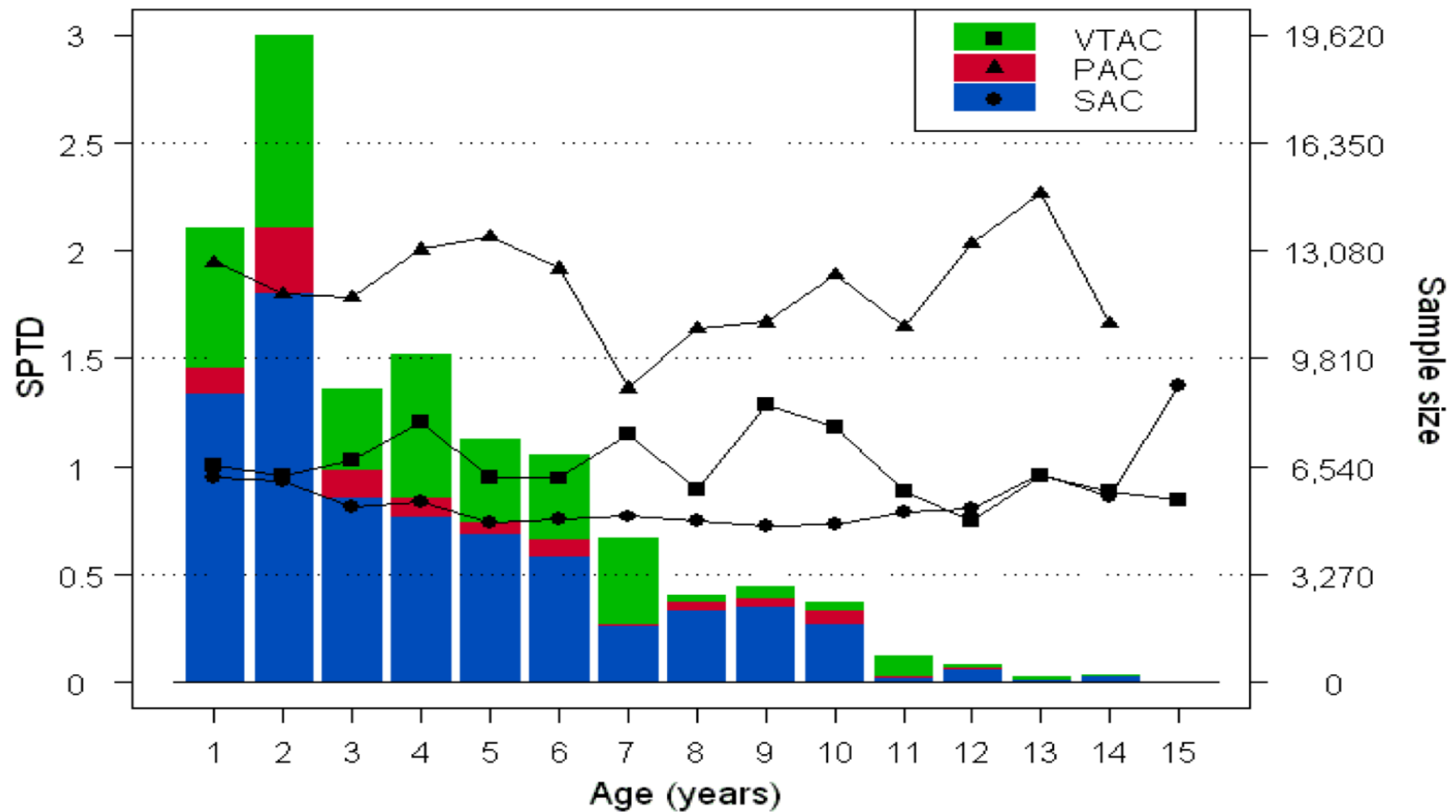
Available data

- Focus on 2 major **skid resistance (SR)** indicators evaluated on 100-metres long sections of slow lanes
- **Macrotexture**
 - capacity of the road to avoid the presence of any bulk water within the tire/pavement contact area
 - *sand patch texture depth (SPTD)*
- **Microtexture**
 - capacity of the road to avoid the presence of any residual film of water within the tire/pavement contact area
 - *coefficient of transverse friction (CTF)*

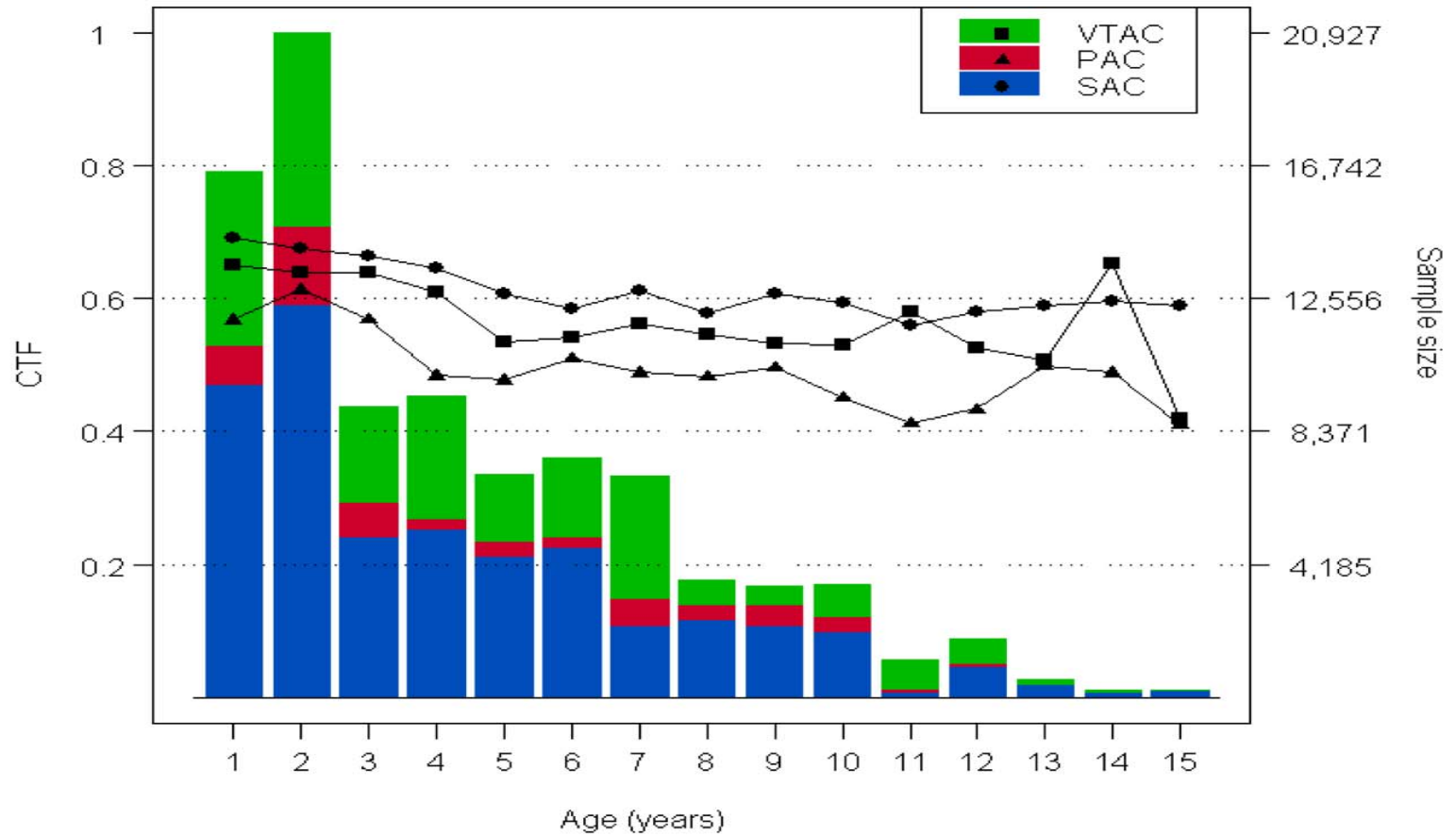
Available data (Ct'd)

- SPTD measured by Rugolaser®
on 36,500 sections (around 78,000 data)
- CTF evaluated by Scrim®
on 43,200 sections (around 92,000 data)...
- ... sections with different types of wearing course:
 - 62% are **semicoarse asphalt concrete (SAC)**
 - 33% are **very thin asphalt concrete (VTAC)**
 - 5% are **porous asphalt concrete (PAC)**

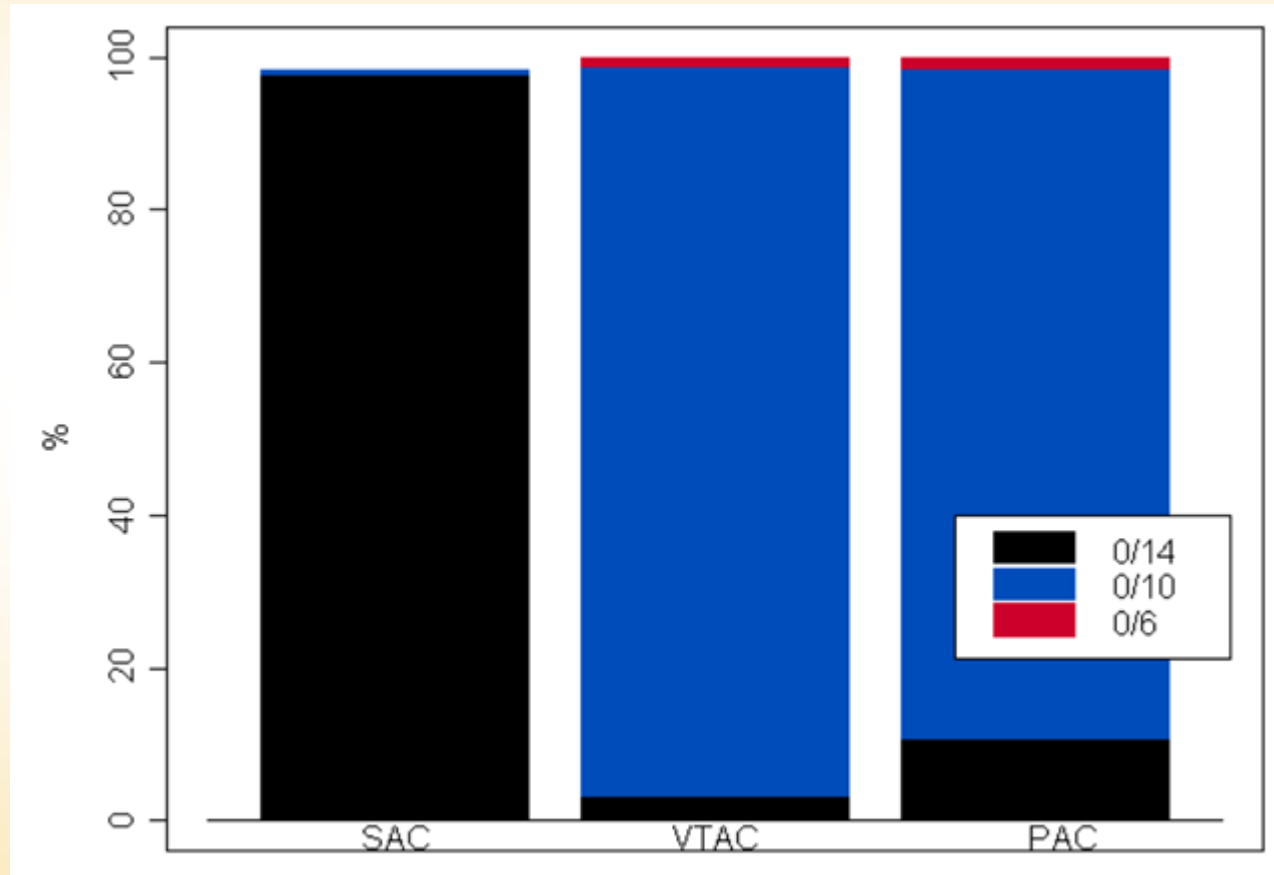
Descriptive analysis of SPTD data



Descriptive analysis of CTF data



Grading composition



ANOVA and multiple comparisons

- Statistical procedure:
 - Analysis of variance (ANOVA) for the overall difference
 - If significance, multiple comparisons for individual differences
- Difference between wearing course types
 - *SPTD*: VTAC > SAC
 - *CTF*: SAC > VTAC > PAC
- Difference between grading compositions
 - *SPTD*: coarse designs (0/14) > fine designs (0/10)
 - *CTF*: fine designs > coarse designs
 - Critical size of the 0/6 sample

Statistical model for SR evolution

- **Dependent variable:** time to reach a *given* threshold of SPTD/CTF

given thresholds: 90%, 80%, 70%, ..., 20%, 10%

- **Independent variables:**

- wearing course type
- grading composition

- **Link function:** regression model with underlying Weibull density of probability

Statistical model for SR evolution (Ct'd)

- **Censoring mechanism** if time to reach threshold is not an inspection time

Left censoring, right censoring, interval censoring

- Estimations of the two Weibull distribution parameters
- Estimations of the regression coefficients associated to the independent variables

Statistical model for SR evolution (Ct'd)

- Hypothesis tests of significant effect of the independent variables
- Goodness-of-fit analysis
- Predictions on the long term (evolution curve)
- Individualization of evolution curve for each road section (observations per section → corrective coefficient)

Definition of robustness

- Corrective coefficient is referred as **robustness of a section road** (*mechanical*, not *statistical* meaning)
- Robustness is defined for a class of pavement sections sharing all the same characteristics
(*i.e.* same values of independent variables)
- Robustness is defined as the percentage of sections with less favourable evolution of SPTD/CTF
- Robustness is constant over time

Illustration of robustness

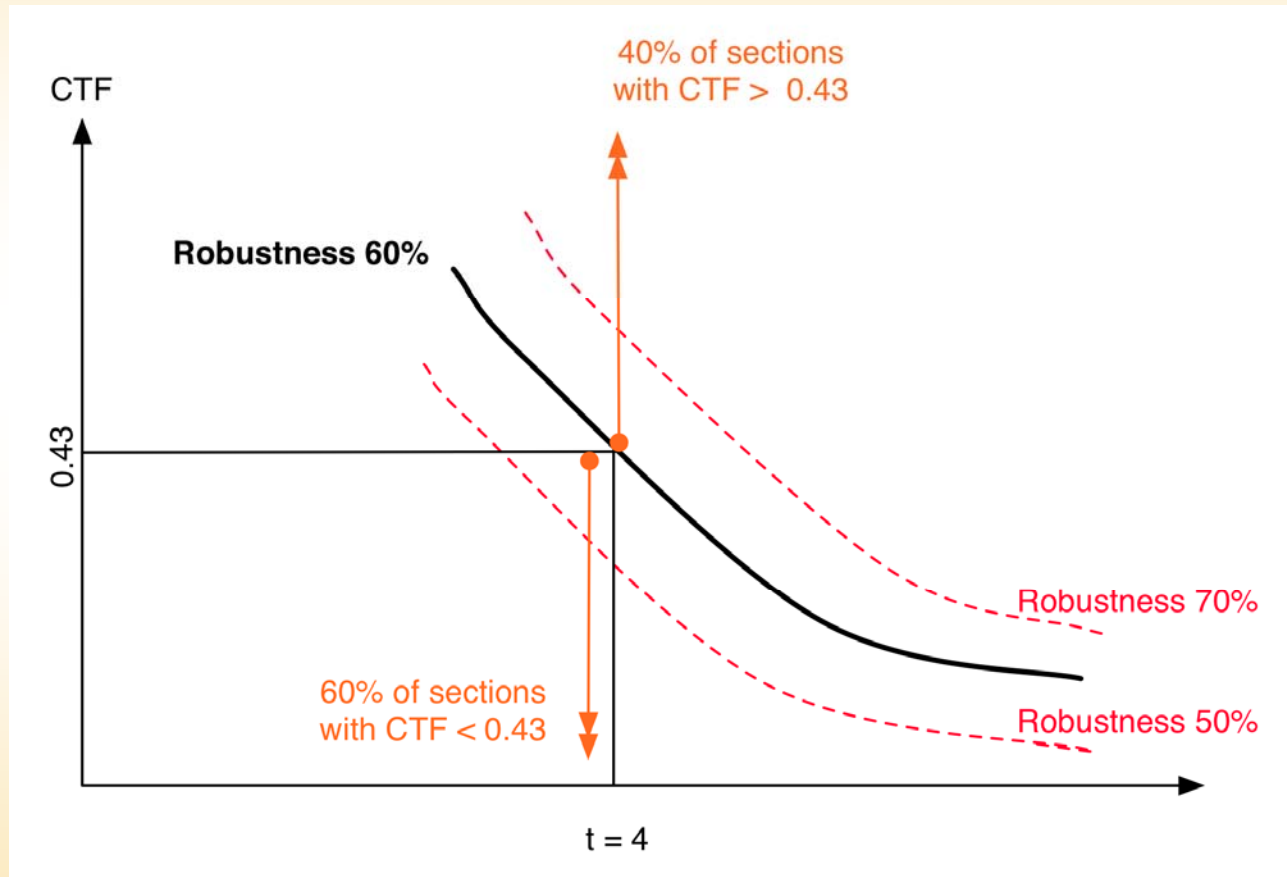
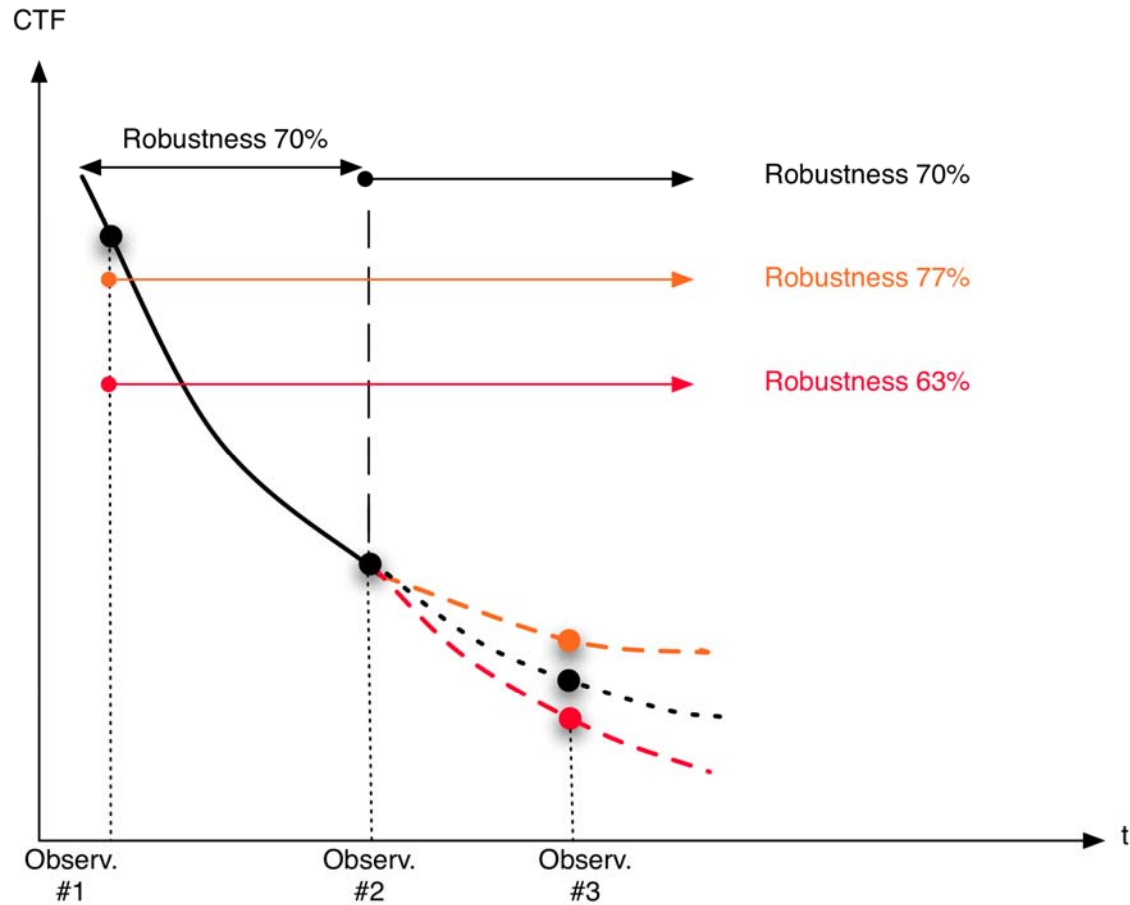


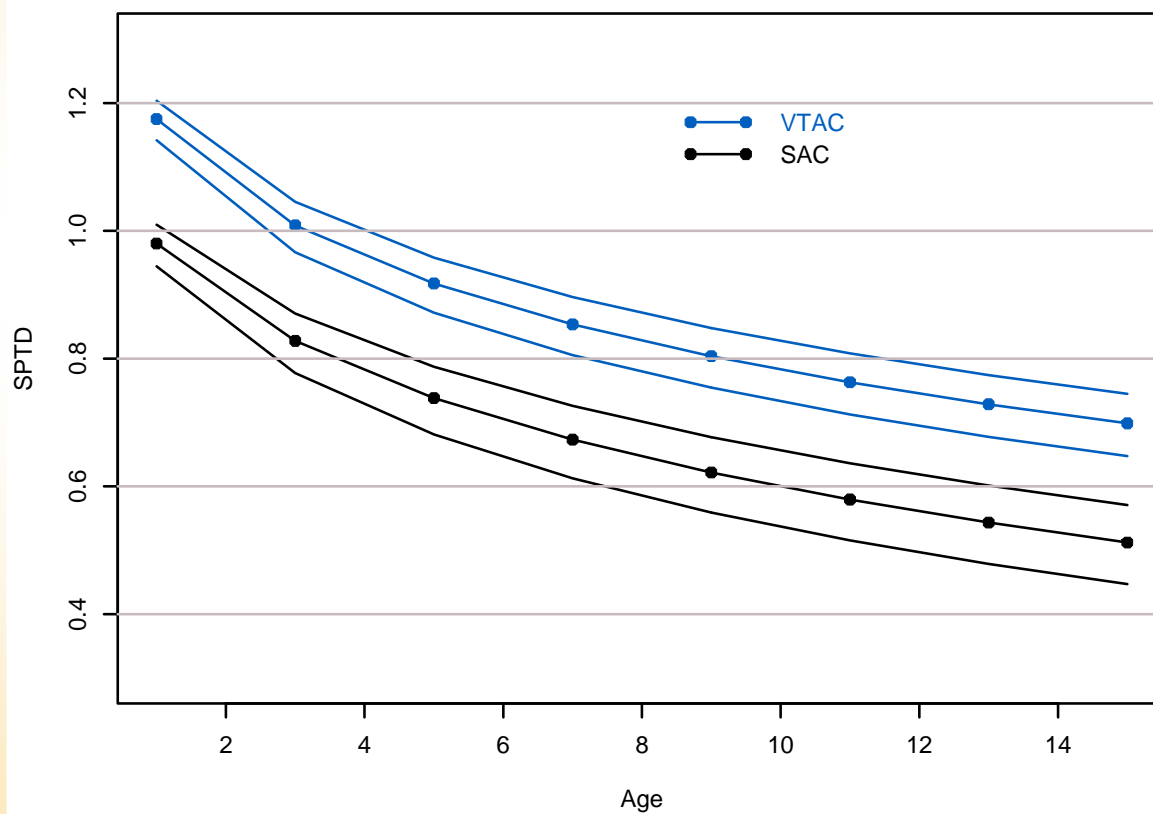
Illustration of robustness (Ct'd)



Results

- Significant difference between wearing course types concerning the evolution of SPTD/CTF
- Doubtful significant difference between grading compositions
(only for a minority of thresholds)
- Goodness-of-fit (residuals analysis) assessed

SPTD evolution



CTF evolution

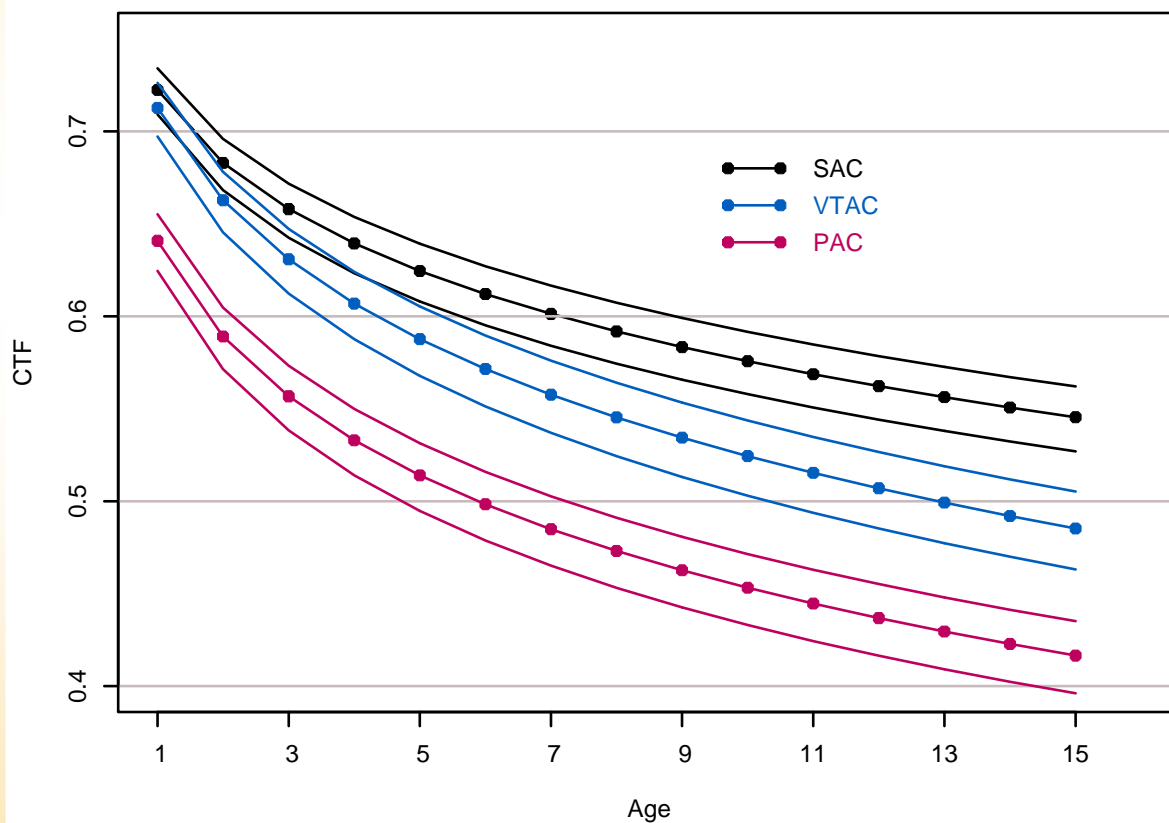
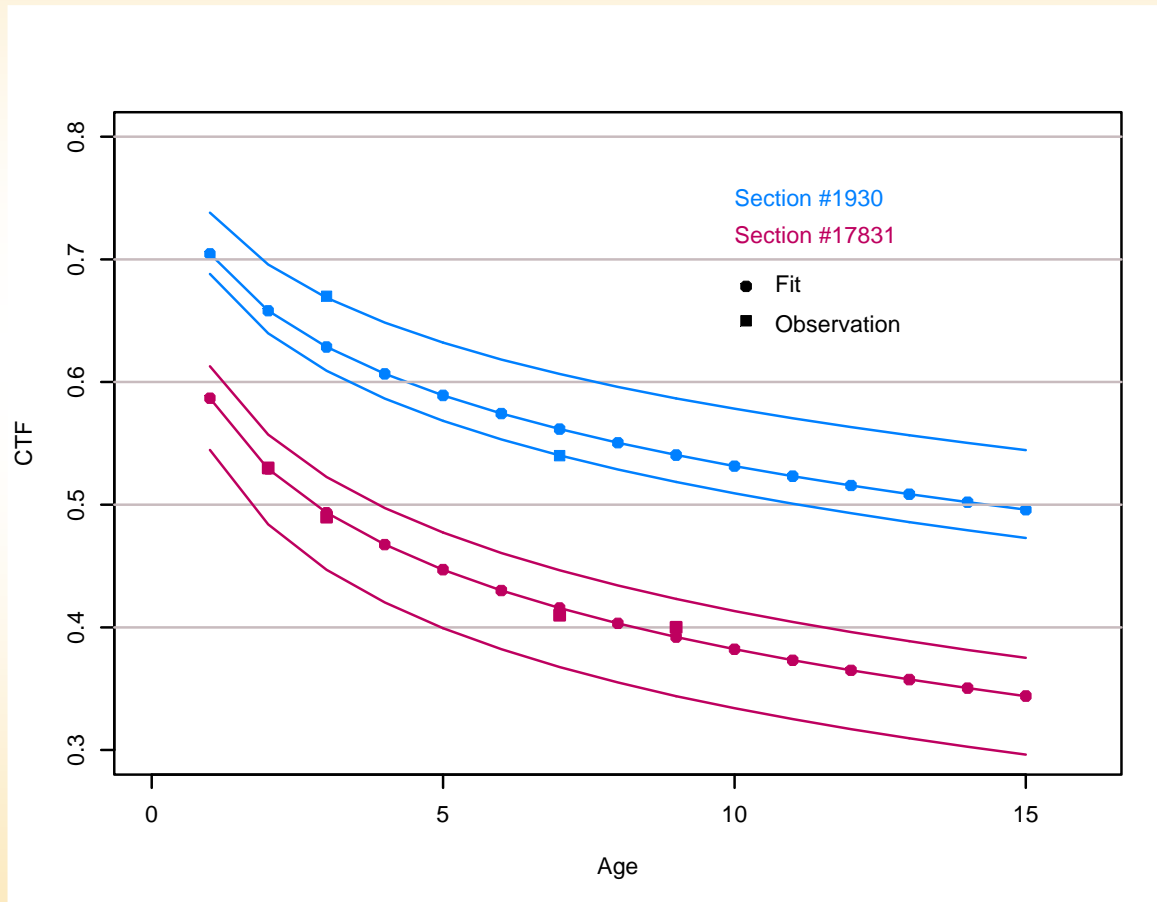


Illustration of observed vs fitted values



Conclusions

- Significant impact of wearing course types on the evolution of both indicators:
 - **SPTD** : VTAC have higher values than SAC
 - **CTF** : higher values for SAC, lowest for PAC — and VTAC in between
- Doubtful significant statistical effect of the grading characteristics (unbalanced samples)
- Fitted curves in strong agreement with observed values, allowing for predictions on the long term

Perspectives

- Include **traffic** as potential factor of the evolution of SR
 - *cumulated traffic as independent variable?*
time-related independent variable
 - *cumulated traffic as dependent variable?*
leads to very similar evolution curves
 - *class of (design) traffic as independent variable*

- Need to complete the database for grading 0/6

Perspectives

Thank you