Comparing Results of Airport Concrete Slabs Design Using Damage Models of FAARFIELD to MEPDG Concrete Fatigue Model

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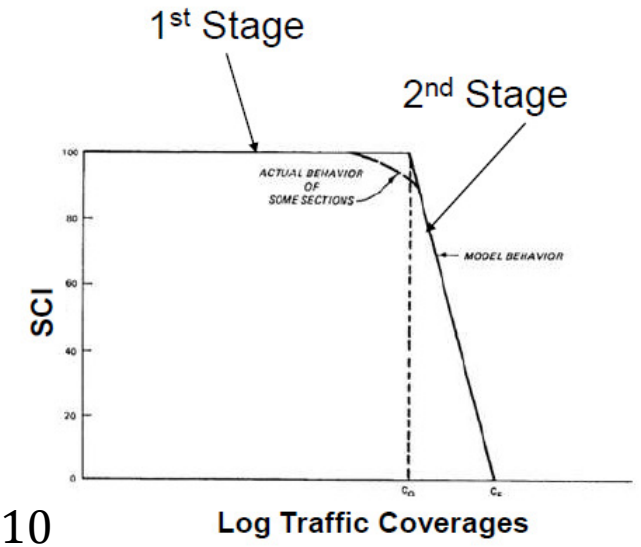
Study motivations

(undergraduate research program of USP)

- FAARFIELD, released in 2009, has a model to calculate the critical stresses at the pavement.
- The first goal was to compare these stresses with those calculated by EverFE.
- **Secondly, the point was to compare the fatigue model of FAARFIELD (two-staged) with the MEPDG (one-staged).**

Fatigue/Damage model of FAARFIELD

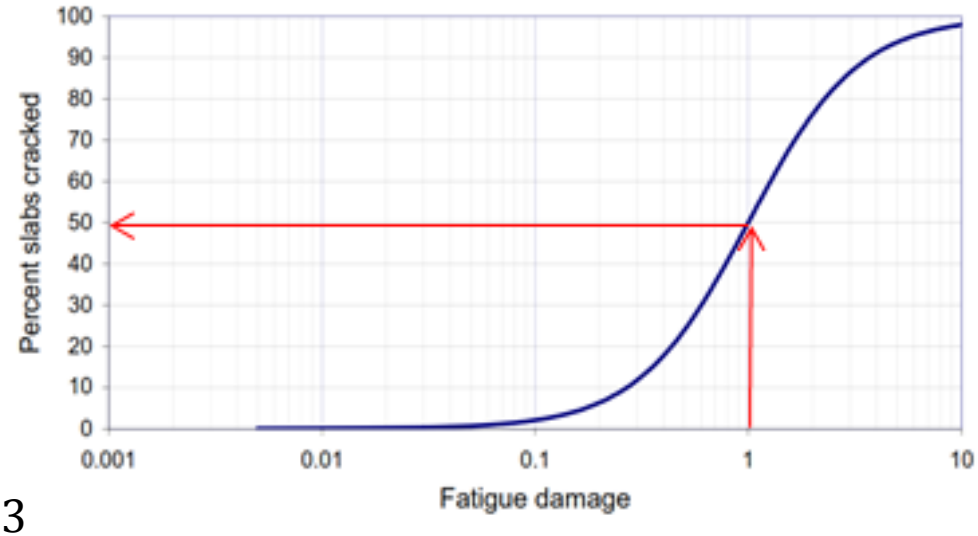
- Two-staged degradation model for the concrete slabs.
- Calibrated with full-scale test data points from the National Airport Pavements Test Facility (NAPTF).
- Degradation model uses the Structural Condition Index (SCI).
- 1st stage: begins when slabs are new and end at the first full-depth crack.
- 2nd stage: begins at this point and ends at the end of pavement service life.



Source: Brill, 2010

Fatigue/Damage model of MEPDG

- Calibrated for roads situation (low loads, high frequency, less lateral wander of wheels).
- One-staged model, not connected directly with serviceability of the pavement but to crack percentage evolution.
- Model used is calibrated to calculate the number of cycles allowed to fatigue with failure corresponding to 50% of cracked slabs.



Source: NCHRP, 2003

Methodology

- Taken an approximation of the actual mix of JFK airport (2000-2001).
- The parameters for the design of the airport plain concrete pavements were: modulus of subgrade reaction (k) of 100 MPa/m, pavement base layer of crushed aggregate with 20 cm and concrete flexural strength of 4 MPa.

Consumption of Fatigue Resistance

$$CFR_n(\%) \quad = 100 \times \left(\frac{N_p}{N_f}\right)$$

Where: $CFR_{n\%}$ = Consumption of fatigue resistance by the n^{th} aircraft

N_p = Number of operations to date (JFK Mix)

N_f = Number of admissible cycles to failure

Results

Number of admissible cycles by MEPDG and departures imposed by the JFK 2000-2001 mix.

Aircraft	Departures by JFK 2000-2001 mix			Admissible cycles (MEPDG)		
	20 years	30 years	40 years	20 years	30 years	40 years
B747-400B Combi	7.23E+05	1.08E+06	1.45E+06	3.72E+06	5.17E+06	6.51E+06
B777-200LR	1.22E+05	1.82E+05	2.43E+05	7.64E+05	9.24E+05	1.23E+06
MD11ER	2.57E+05	3.85E+05	5.13E+05	2.45E+06	3.37E+06	4.25E+06
MD11ER Belly	2.57E+05	3.85E+05	5.13E+05	3.82E+05	5.29E+05	6.67E+05
B767-300	1.80E+06	2.71E+06	3.61E+06	1.46E+08	2.24E+08	3.02E+08
B757-200	7.90E+05	1.19E+06	1.58E+06	1.58E+09	1.91E+09	2.39E+09
A320-200 Twin std	1.49E+06	2.24E+06	2.99E+06	1.77E+07	2.80E+07	3.86E+07
Sngl Whl-60	1.57E+06	2.35E+06	3.13E+06	3.27E+15	9.89E+15	2.15E+16

Results

Consumption of fatigue resistance by the n^{th} aircraft (*CFRn*) with designed life and *CFR* total.

Aircraft	CFRn (%)		
	20 years	30 years	40 years
B747-400B Combi	19.41	20.96	22.21
B777-200LR	15.92	19.73	19.82
MD11ER	10.48	11.44	12.07
MD11ER Belly	67.24	72.76	76.94
B767-300	1.23	1.21	1.20
B757-200	0.05	0.06	0.07
A320-200 Twin std	8.41	8.01	7.74
Sngl Whl-60	0.00	0.00	0.00
CFR (%)	122.75	134.17	140.04
Years before fatigue (MEPDG)	16.29	22.36	28.56

Results

Design life in FAARFIELD compared to service life calculated according MEPDG fatigue function.

Designed Life in FAARFIELD	20 years	30 years	40 years
Service Life by MEPDG	16.29 years	22.36 years	28.56 years
Service Life/Designed Life (%)	81.45	74.53	71.40

Conclusions

- FAARFIELD is more refined in terms of degradation model (two-staged).
- It is recommended that road fatigue models such as MEPDG consider other distresses to point out the end of serviceability of the pavement.