

The influence of weather conditions and vehicleload on the technical degradation of the Solar Road

A researche into PV integrated Road elements

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Introductie

PV integrated infrastucture can be a great step into reaching the energy transition goals in the Netherlands

Hypotheses

Hypothesis 1:

Delamination is caused by thermal expansion, and can lead to damages in combination with vehicleload.

Hypothesis 2:

There will be yield loss due to light intensity reduction caused by the toplayer, dirt on the toplayer and traffic shadow.

Results hypothesis 1 study

Theoretical approach:

Lineair thermal expansion difference between materials in the Solar Road at $\Delta 25^{\circ}\text{C}$.

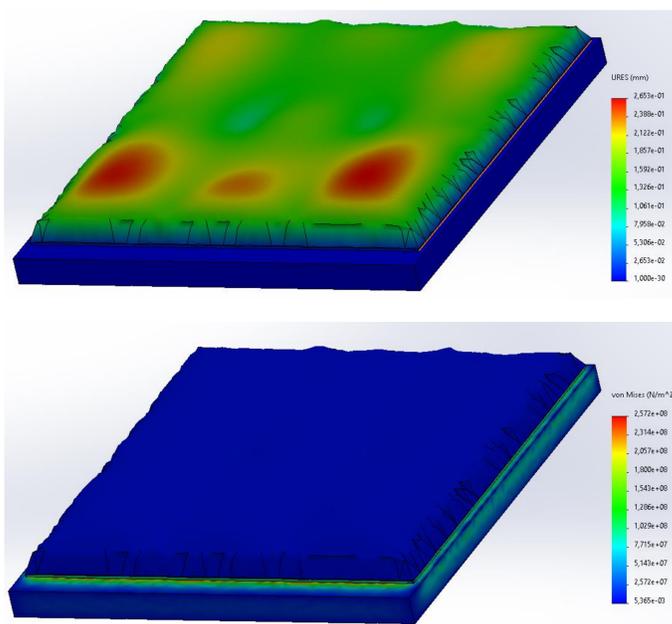
Bitumen vs. Concrete and Steel:

3,6 mm difference in thermal expansion

Epoxy vs. Concrete and Steel:

3,95 mm difference in thermal expansion

Solidworks simulation:



Results hypothesis 2 study

Measurements on the Solar Road during STC weather conditions: comparing the yield of clean toplayers and contaminated toplayers with the flashtest data.

PV-module	status toplayer	Max. power [W]	Average light intensity [W/m ²]	Yield compared with flashtest [%]	Yield reduction [%]
# 14 (2-7-2021)	Relative clean	161,2608	936	65,10064	34,89935
# 3	White stains	168,2296	1067	67,91393	32,08607
# 6	Dirty	152,7075	1031	61,64769	38,35231
# 7	Clean	166,4334	1009	67,18881	32,81119
# 14	Clean	165,7648	958	66,9189	33,0811
# 28	White stains	160,8654	948	64,94102	35,05898

A clean toplayer reduces the yield of the PV-modules by 33%, which will increase as the dirt on the toplayer increases.

The white stains do decrease the yield but it's not clear how much, because the white stains are not uniform. The yield reduction due to the white stains is low enough to be neglected.

Measurements of other students showed that the shadow of a dynamic pedestrian decreases the yield by 48,8%, and a static pedestrian by 34,4%.

Discussie & conclusie

The delamination is caused by the thermal expansion of either te epoxy toplayer and/or the bitumen. The delamination is caused by shear stress due to repeatedly expanding and shrinking, and by shear stress due to deformation caused by internal tensions

The delamination spots in combination with vehicleload have a high probability of leading to damages and an unusable road.

The toplayer will reduce the yield of the PV-modules by 33%. Which will increase over time due to dirt on the toplayer.

It is highly recommended to review the Solar Road design because the toplayer failure may cause dangerous traffic situations.