SUPERELEMENT WELDS FOR PRODUCTIVE DEVELOPMENT.

SPOTWELD FATIGUE EVALUATION.

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MOTIVATION.

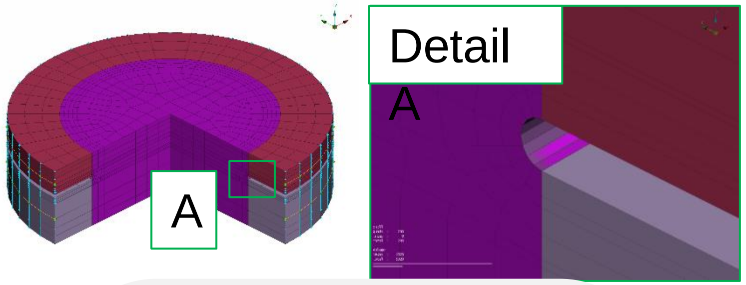
- Spotweld cracks are one of the leading failure modes during fatigue testing.
- High sensitivity of durability to spotweld modeling and underlying concept.
- Current established spotweld models
  - use nominal stress concept – state of the art, fatigue. Require mesh refinement & not applicable in NVH.
  - use force based concept - state of the art, NVH. Perform less accurate in fatigue.
- Notch stress concepts display the local stress but require fine modelling of the notch → high numerical effort.

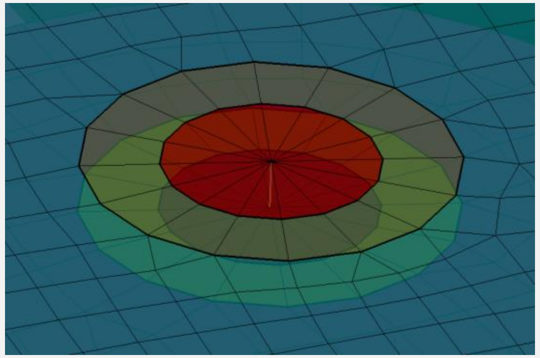
AIM.

Introduction of a spot weld model using the notch stress concept which

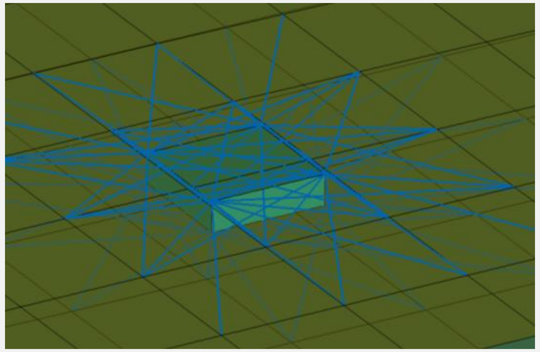
- takes the local stress into account.
- provides a common mesh for fatigue and NVH simulations.
- has an acceptable impact on NVH simulation results.
- is integrated with help of ANSA PRE PROCESSOR & META POST PROCESSOR into a FE-Workflow using superelements in order to diminish the numerical effort.

SPOT WELD MODELS.

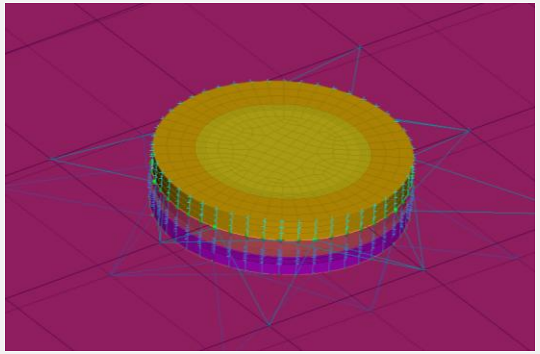




- FEMFAT SPOT - model with local refinement.
- Fatigue state of the art modeling.
- Nominal stress concept.

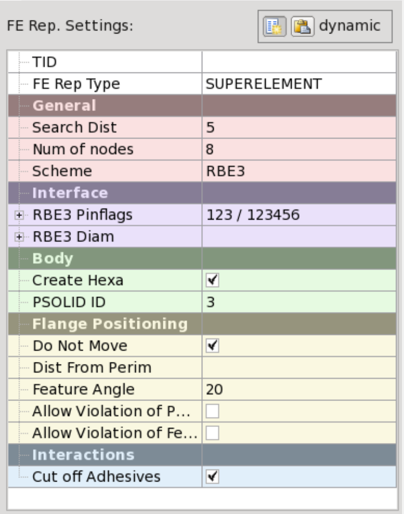


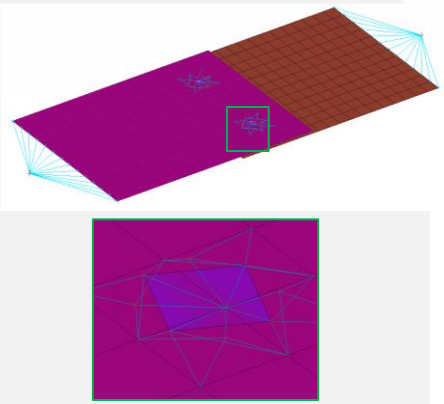
- RBE3-Hexa-RBE3 – model.
- NVH state of the art modeling
- Force based concept.



- Notch stress model with RBE3 coupling to joining partners (SE-ID).
- Variant with node coinicident model possible (SE-D).

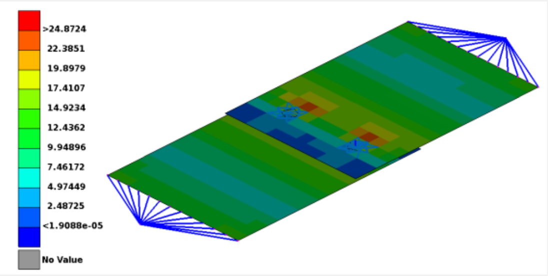
FE-PROCESS.





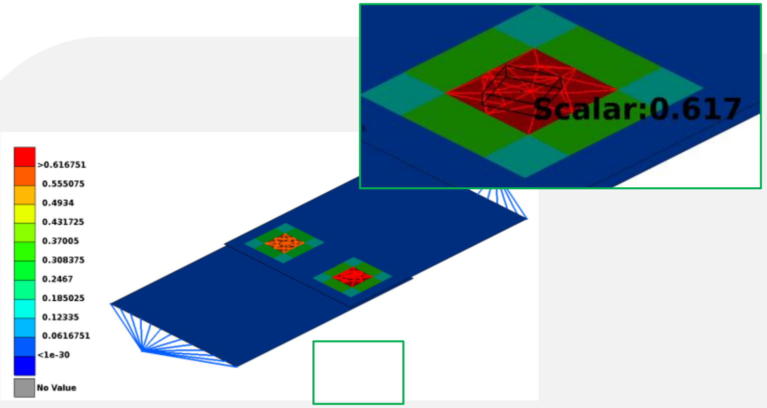
- Realization of Spot Welds by FE-Superelement via ANSA-Connection-Manager.
- Superelement properties linked by ANSA to user-database.
- Hexadron is realized as visualization & placeholder for result mapping.

Modelling



- Application of the respective load case.
- Matrices of the superlement are included from a superelement database.
- Local stresses in notch are calculated („Data Recovery“).

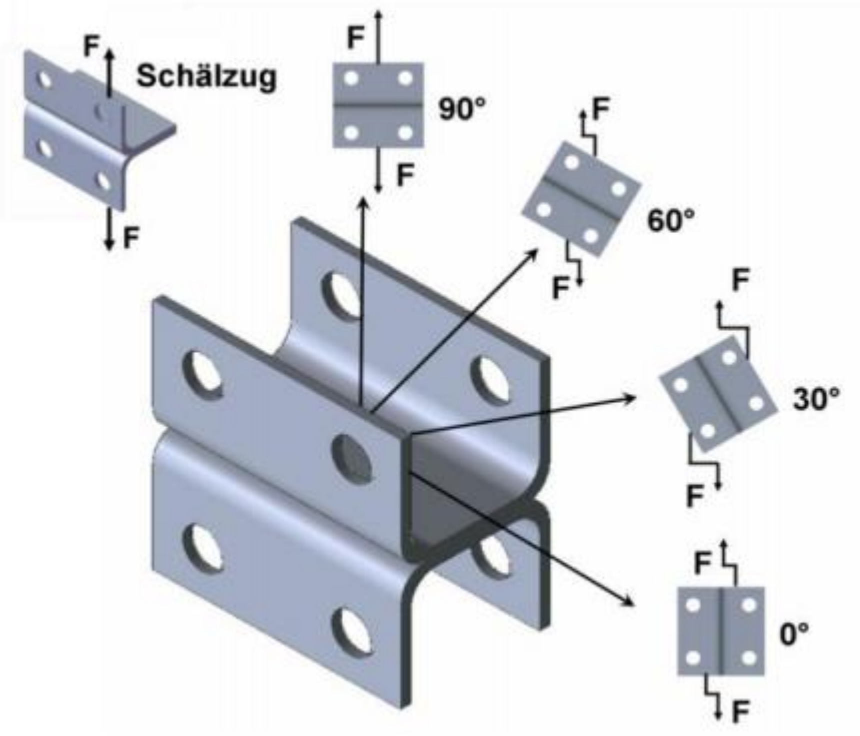
Solving

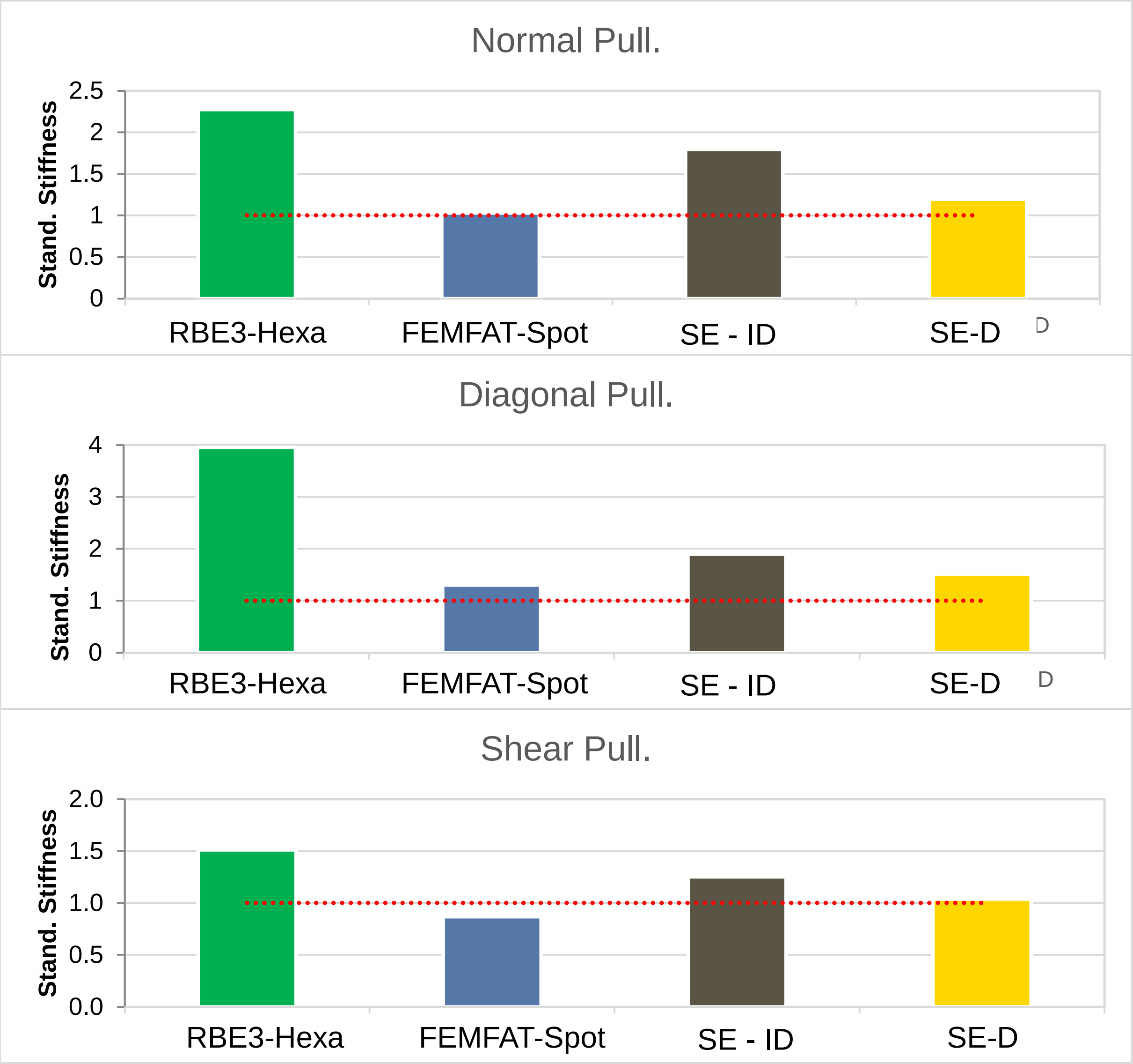


- Local Stresses are analyzed in FEMFAT Postprocessing & confronted with S-N-Curve.
- Most critical result mapped on dummy-hexaedron (optional).
- Via read .nas-file & command "read options seweldmap enable“ mapped results, e.g. vMises, can be extracted easily from hexaedron when using .

Fatigue Postprocessing

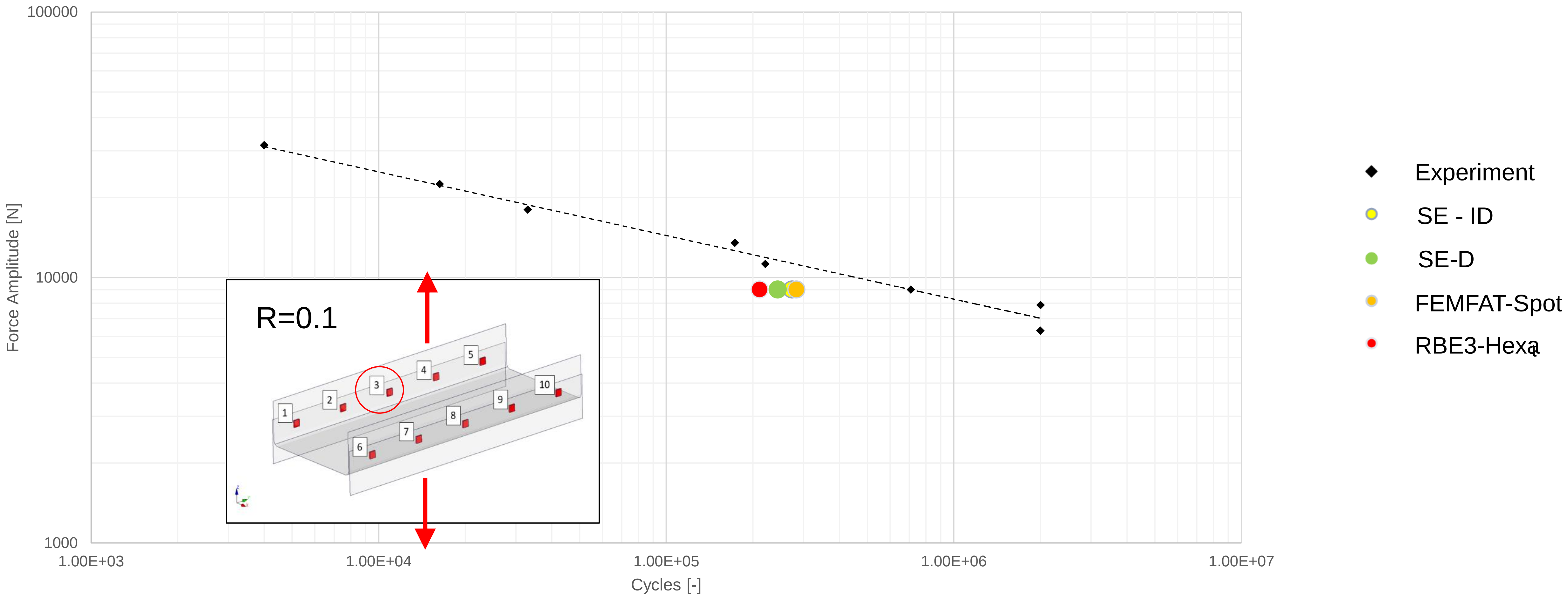
RESULTS.
STIFFNESS – KS2-SPECIMEN.





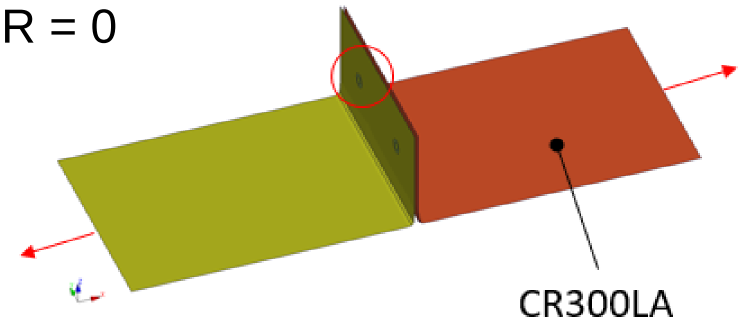
*Standardized on Detail FE-Modell

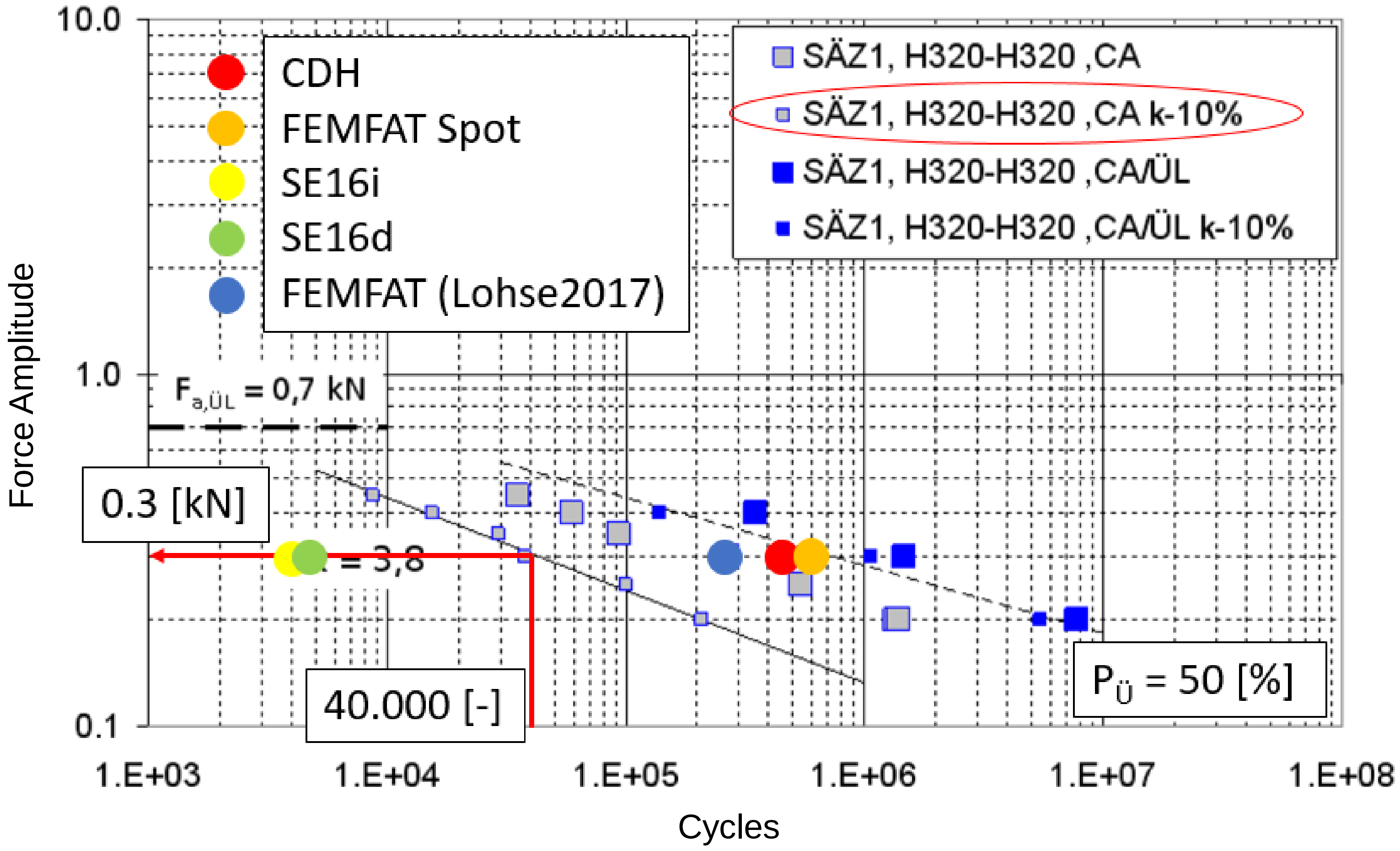
RESULTS.
DURABILITY – H-SHEAR PULL SPECIMEN (FAT179).



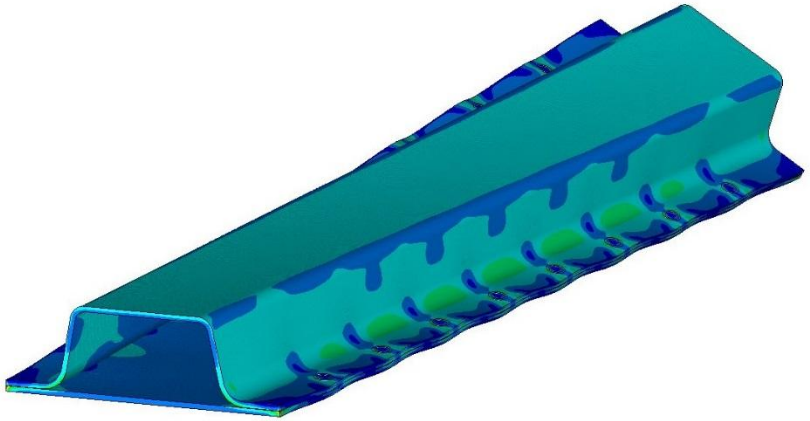
RESULTS.
DURABILITY – PEEL PULL SPECIMEN (FAT239).

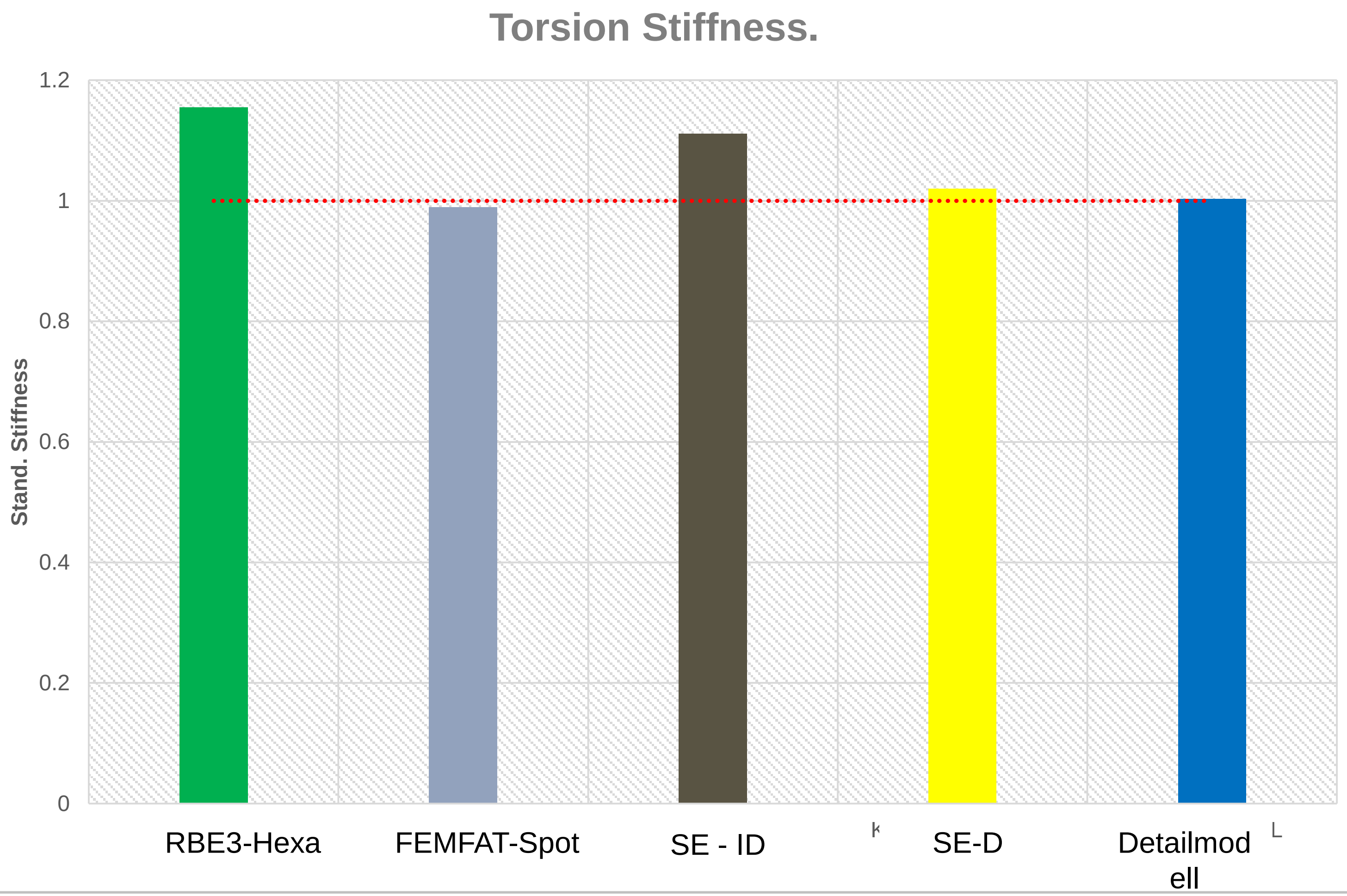
R = 0





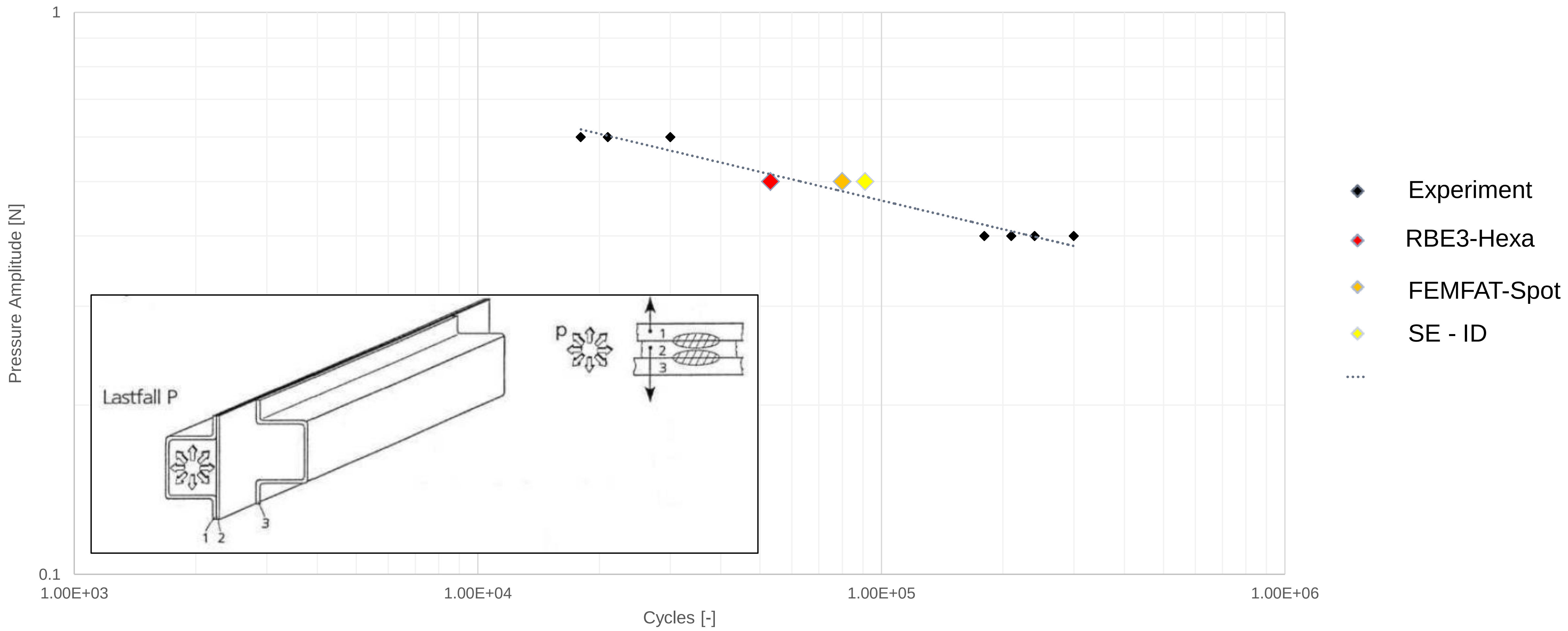
RESULTS.
STIFFNESS – HAT PROFILE, TORSION.



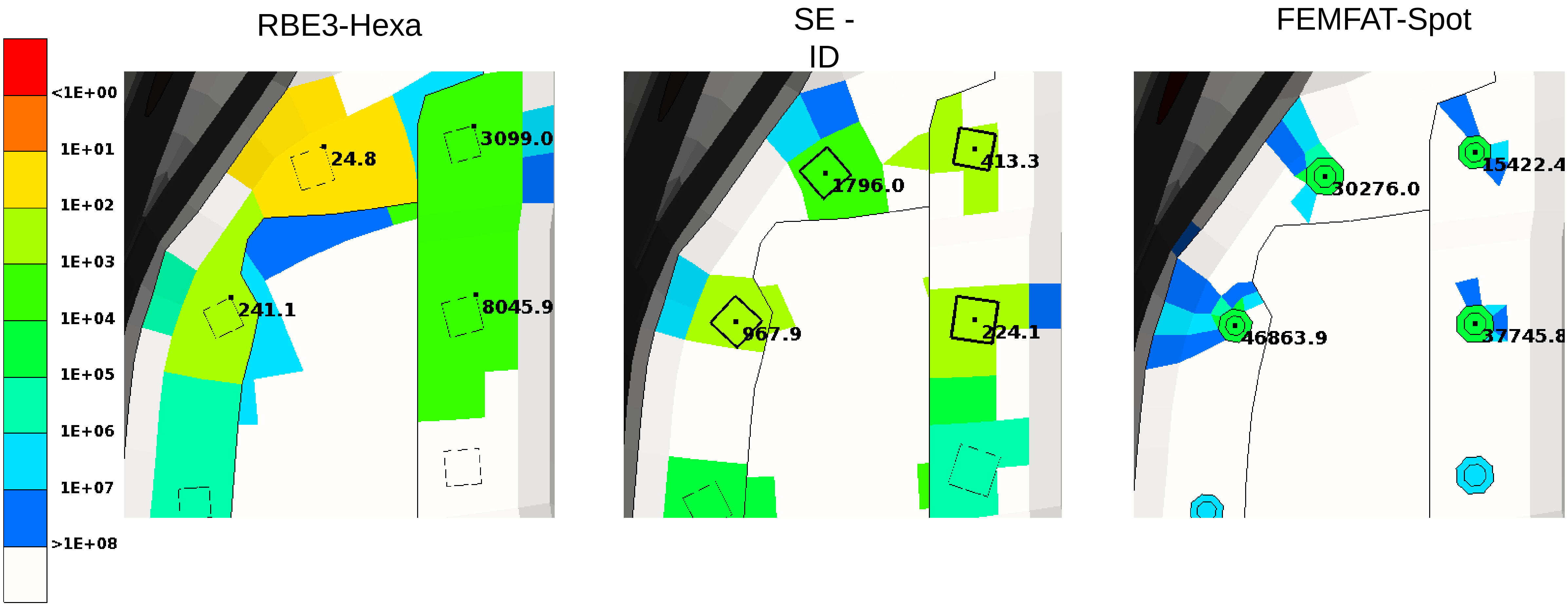


*Standardized on experiment.

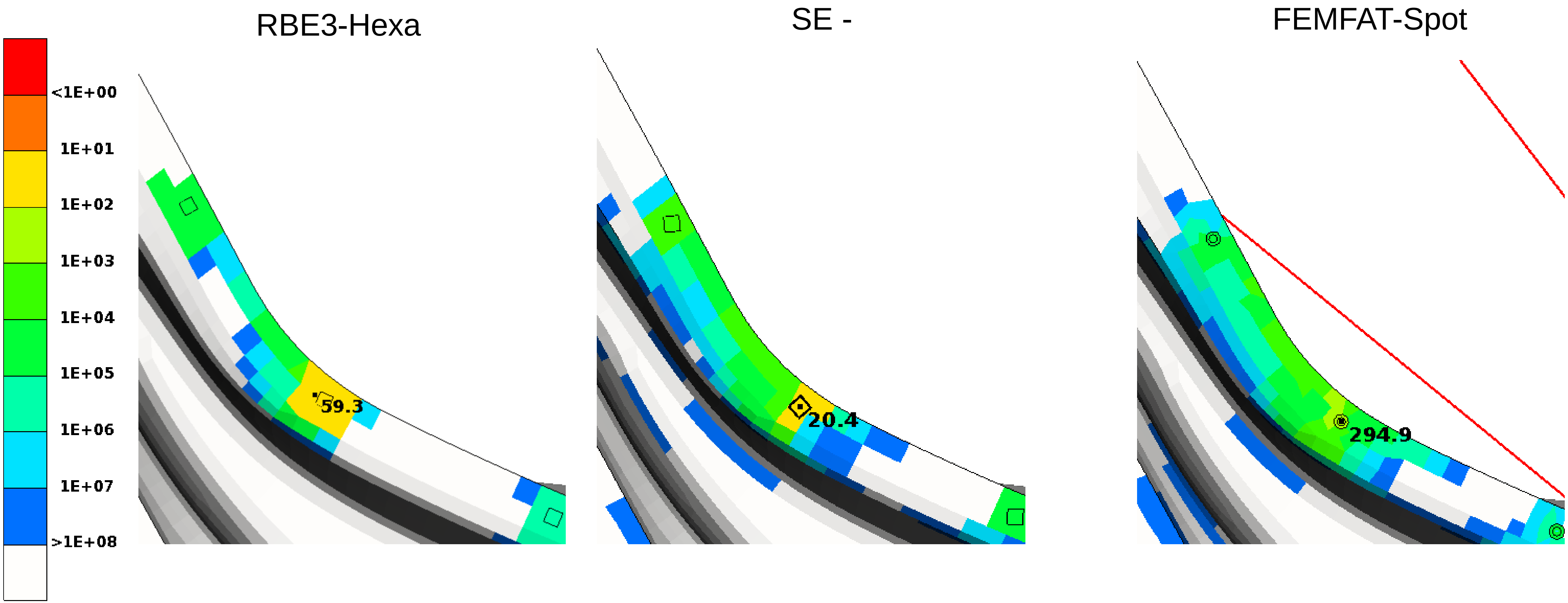
RESULTS.
DURABILITY – DOUBLE HAT PROFILE, PRESSURE (FAT164).



RESULTS.
DURABILITY – OPERATING LOADS.



RESULTS.
DURABILITY – OPERATING LOADS.



RESULTS.
NVH – EIGENMODES, BODY IN WHITE.

Spectral deviation of natural frequencies to NVH-Standard Hexa-RBE3 Modeling [%]

Mode	SE-ID	SE-D	FEMFAT Spot
7	-1	-3	-6
8	-1	-3	-6
9	-1	-3	-5
10	-1	-3	-6
11	0	-5	-8
12	-1	-4	-7
13	-1	-4	-7
14	-2	-5	-7

RESULTS.
NUMERICAL EFFICIENCY.

Deviation of computational time to NVH-Standard Hexa-RBE3 Modeling [%]			
Loadcase	SE-indirekt	SE-direkt	FEMFAT Spot
Operating loads	801	700	17
Statics BIW	129	96	24
Modal BIW	607	639	11
Operating loads fatigue (NASTRAN)	1200	n.a.	186
Operating loads fatigue (FEMFAT)	2300	n.a.	259

Comments:
- FEMFAT – Scratch time not taken into account.
- Scratch memory in NASTRAN ~5TB.

SUMMARY.

- Local stiffness & robustness.
  - Node coinicident models > models with RBE3-couplings.
  - Accuracy improves, when applying more RB3-nodes.
- Durability.
  - Notch stress concept = nominal stress concept > force based concept.
  - All techniques: Peeling / calculation in frequency domain
  - FEMFAT Spot: S-N-curve system.
- Numerical efficiency
  - Notch stress concept < nominal stress concept & force based concept.
- Modelling.
  - Node coinicident models << models with RBE3-couplings.
  - Notch stress concept with RBE3 couplings efficient FE-workflow (common Mesh).