

Application of FEMFAT to Vehicle Development

Daihatsu Motor Co., Ltd.

Fuyuki Oshio



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- Forecasting technique for durable life span

4. Outcome of analysis

- Comparison between the results by actual test and CAE
- Detection accuracy with crack breaking-out portions

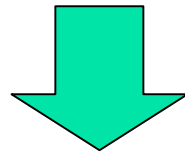
5. Summary

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1. Goal

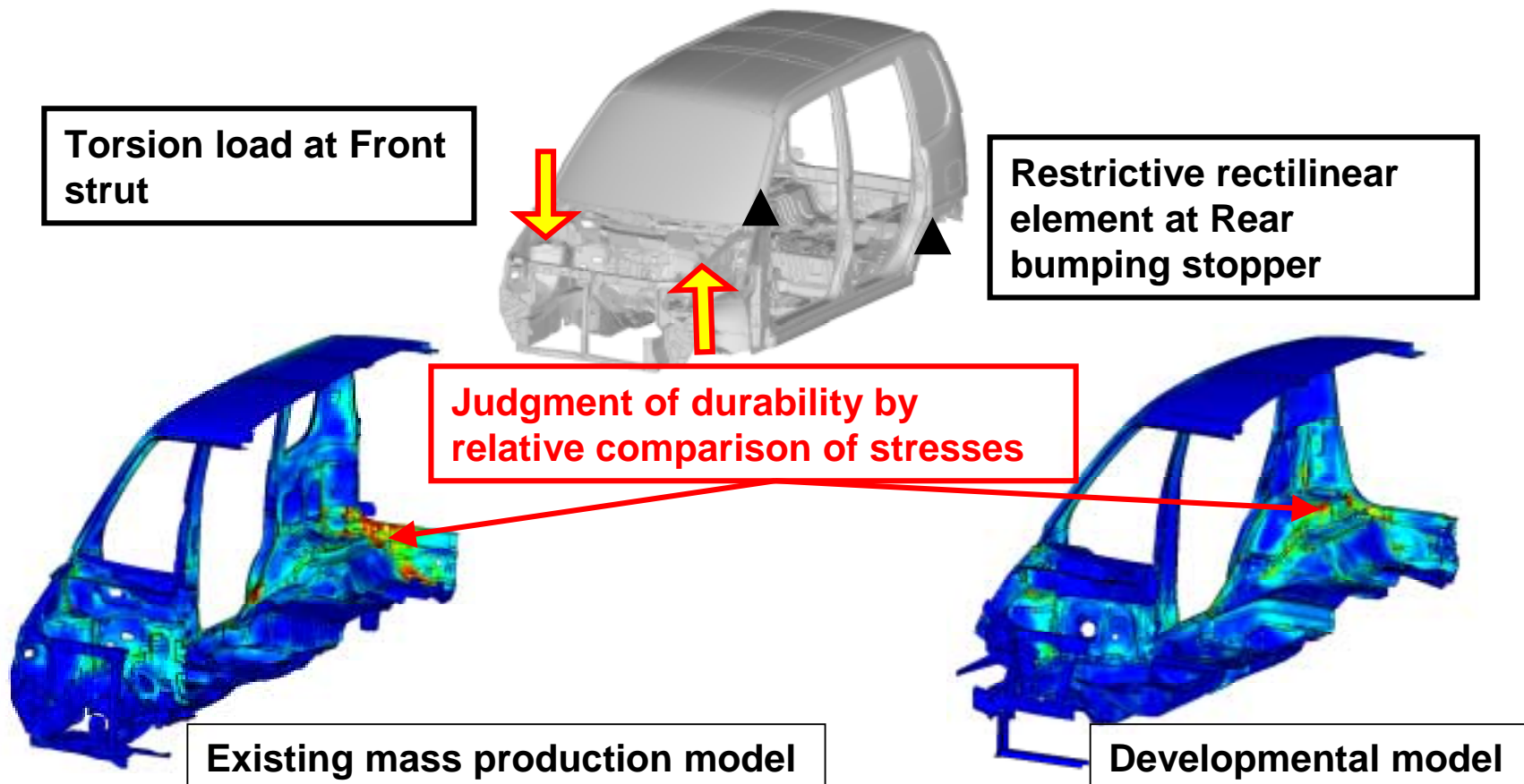
It is needless to say indispensable to establish more accurate method for forecasting life span of Body even in the designing stage that is naturally useful for compatibility of weight reduction with durability performance.



Establishment of forecasting technique for durable life span by CAE analysis

2. Review of present state

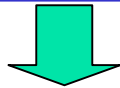
2-1. Usual evaluation of body durability by CAE



2. Review of present state

2-2. Problem of usual evaluation

Possible need to re-analyze due to NG result with actual vehicle



For earlier proposal required, hard to deliberate with the optimal measures but to take up safer proposal hindering, as a result, short-term development and weight reduction



Demand for much more accurate evaluation of durability

Excessive measures from unreasonable result of evaluation even in case of OK result with actual vehicle

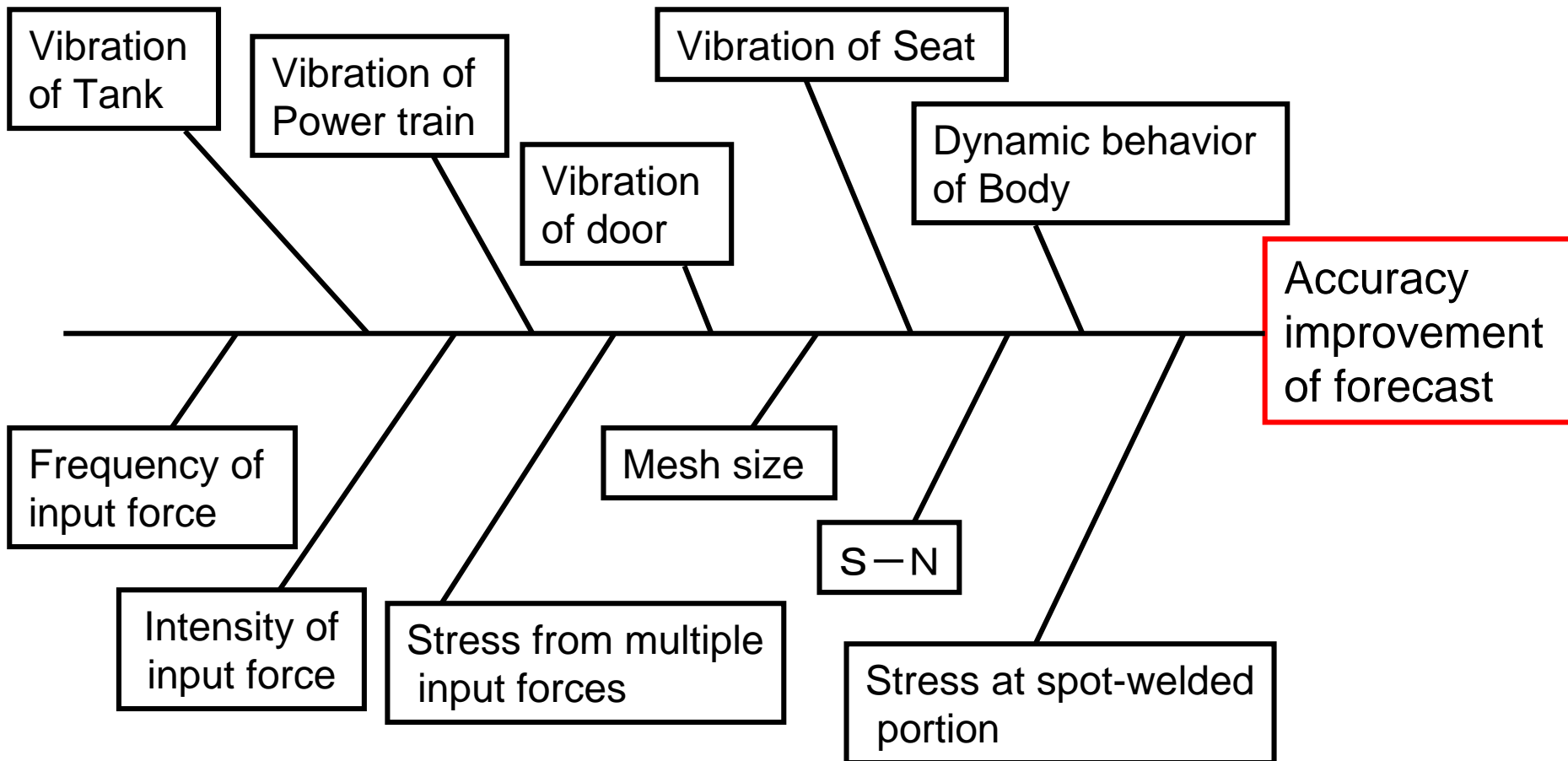


Disturbance of weight reduction



2. Review of present state

2-3. Factorial analysis

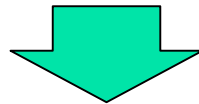




2. Review of present state

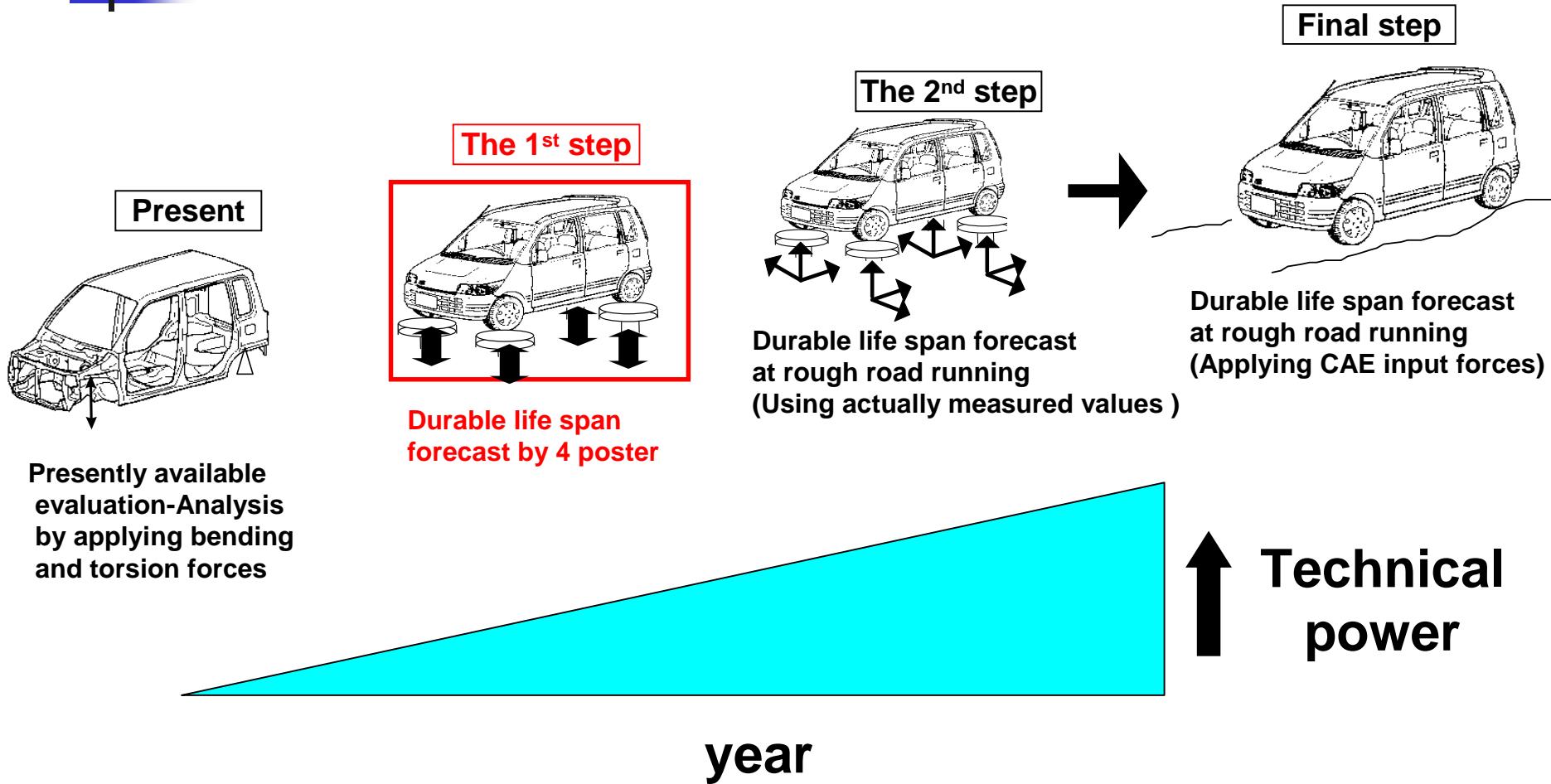
2-4. Awaiting solution with usual method

- Effect from vibration of components such as Engine, Seat, Tank, etc.
- Effect from dynamic behavior of Body
- Effect by input force-to-Body at rough road running
- Proper usage of S-N at spot welded portion



Establishment of forecasting technique for durable life span at rough road running by CAE

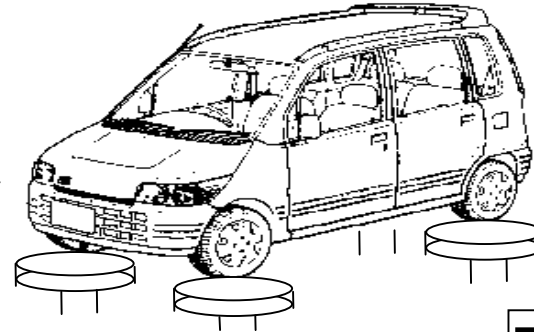
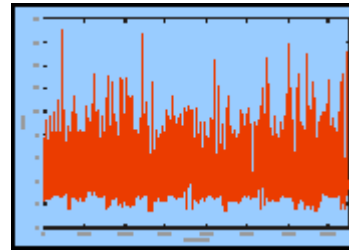
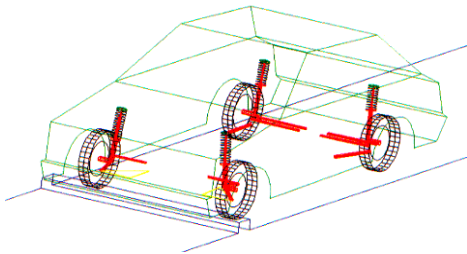
3. Analysis technique



3.1. Procedure of 4-poster forecasting method for durable life span by CAE

Durability simulation on 4-poster

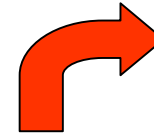
Practical running



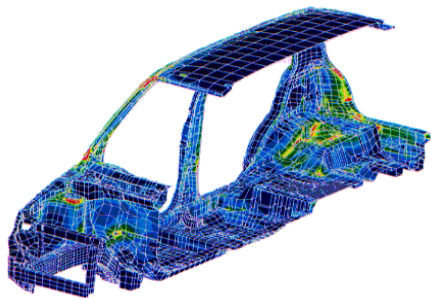
Input data at practical rough road running

Input data at durability test on 4-poster

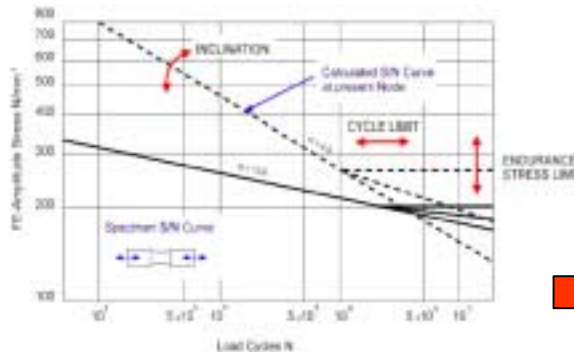
Forecast of durable life span



Software for analysis of life span forecast (FEMFAT)



Stress analysis by CAE



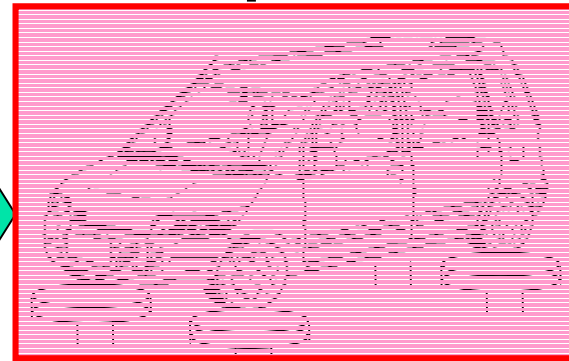
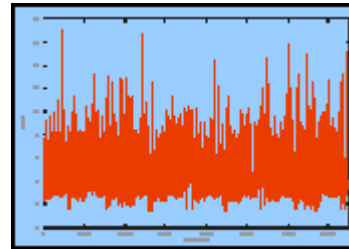
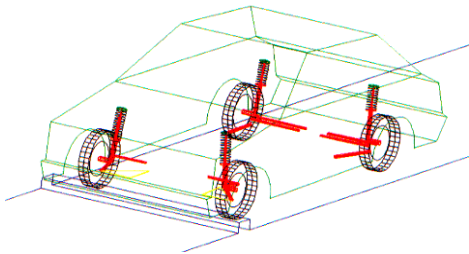
Material property data

3.2. Forecasting method for life span

1) Measurement of input force-to-Body at durability test on 4-poster

Durability simulation on 4-poster

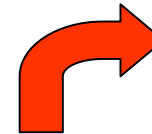
Practical running



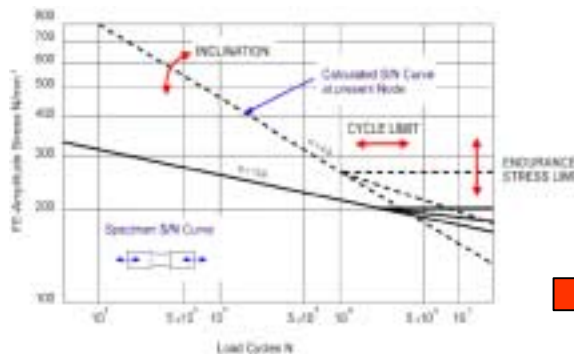
Input data at practical rough road running

Input data at durability test on 4-poster

Forecast of durable life span



Software for analysis of life span forecast (FEMFAT)



Stress analysis by CAE

Material property data

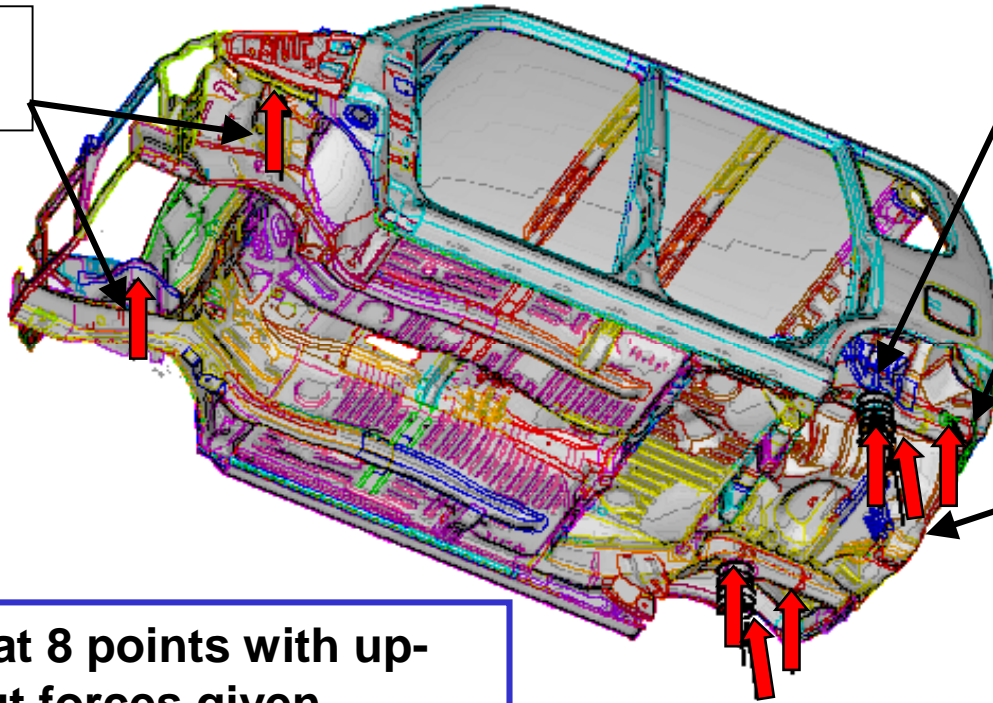
1) Measurement of input force-to-Body at durability test on 4-poster

Input force at Front strut

Input force at Rear spring

Input force at Rear shock absorber

Input force at Rear bumper stopper



Measurement at 8 points with up-and-down input forces given

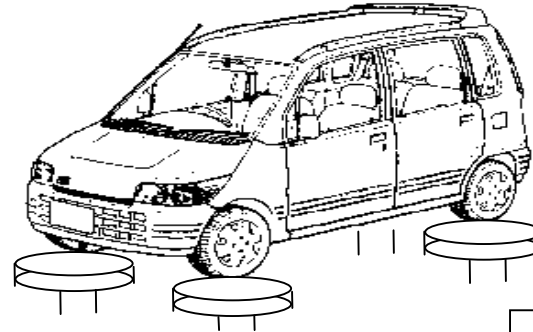
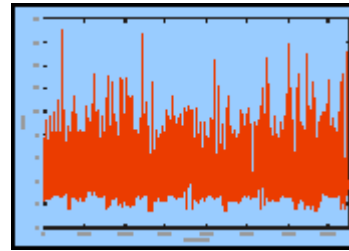
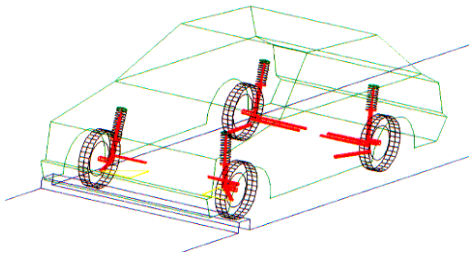


Measured values utilized for CAE analysis

2) Stress analysis by CAE

Durability simulation on 4-poster

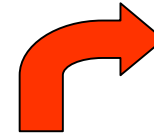
Practical running



Input data at practical rough road running

Input data at durability test on 4-poster

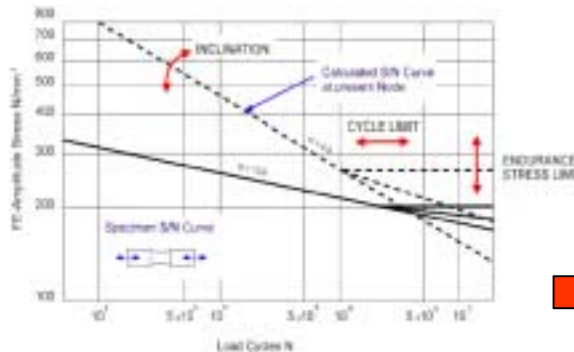
Forecast of durable life span



Software for analysis of life span forecast (FEMFAT)



Stress analysis by CAE

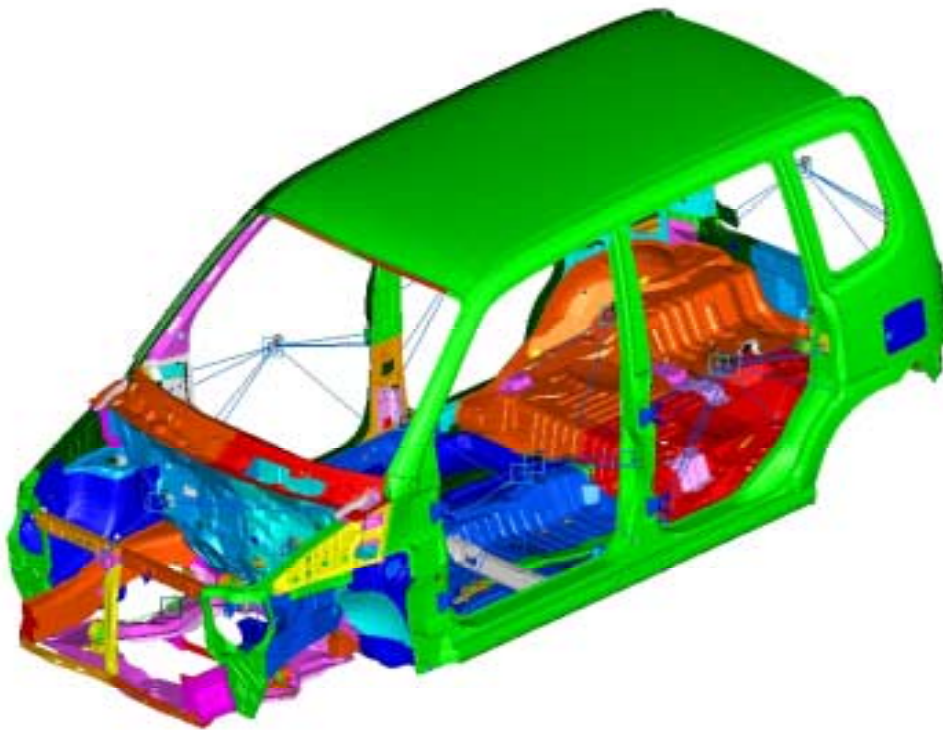


Material property data



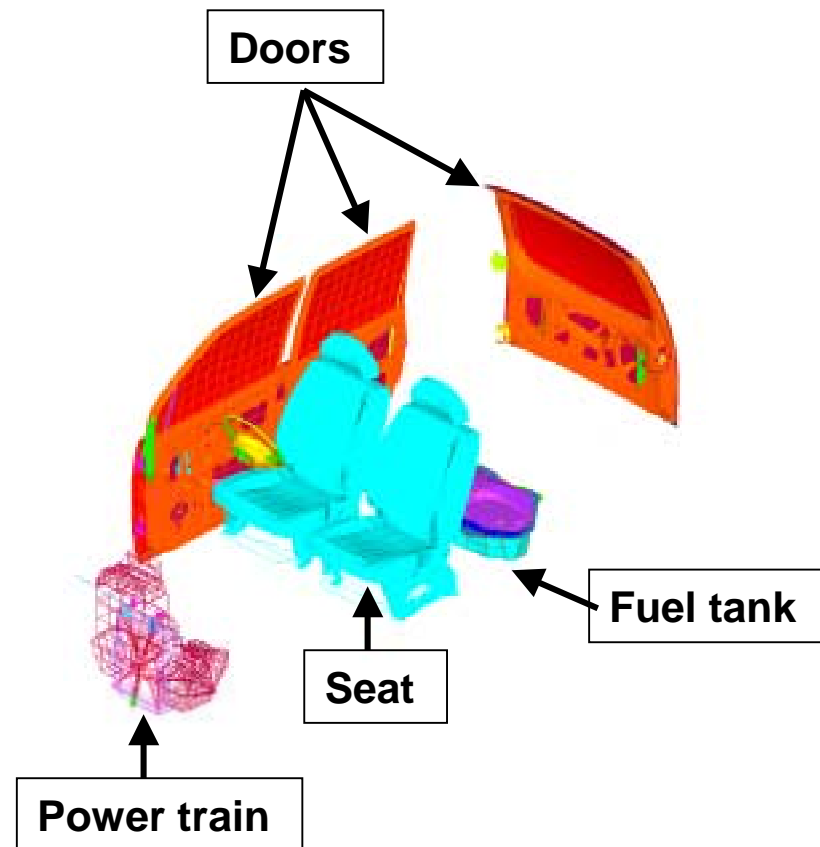
2)-1. FEA modeling technique

Modeling of Body



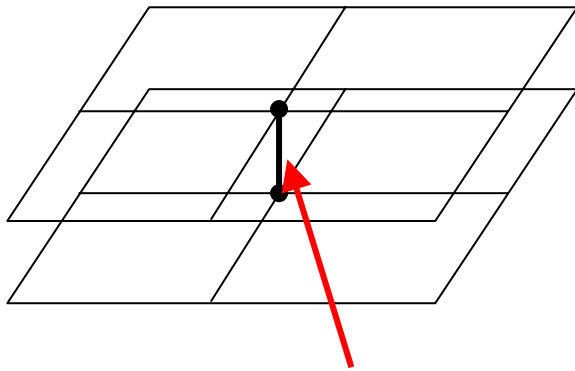
model

Main points for review



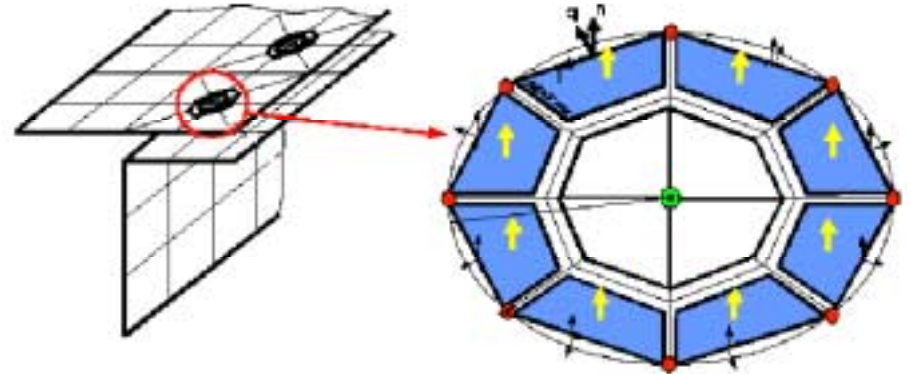
Modeling of spot welded portion

Usual technique



Modeling by using rigid elements

New technique



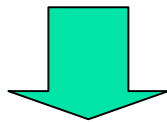
Minute model with nugget diameter taken into consideration

spot model

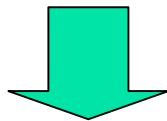
2)-2. Stress analysis technique

It is a need to have a clear grasp of stresses onto body during practical running and utilize them for life span forecast.

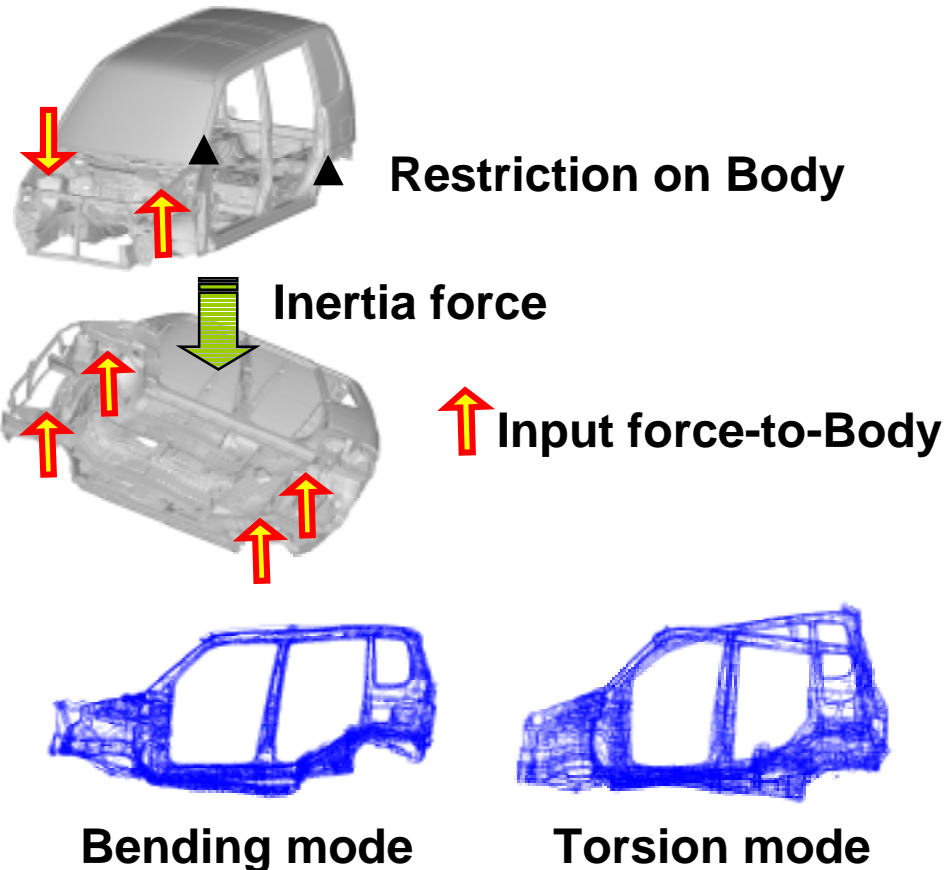
Usual technique



Inertia relief technique



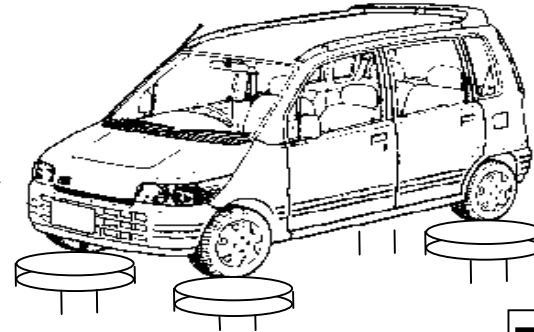
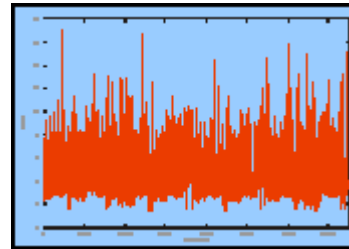
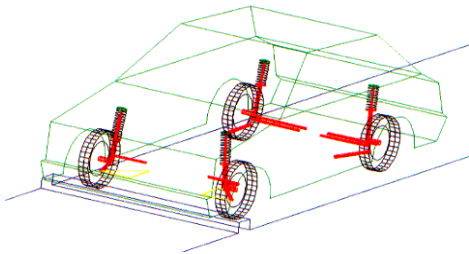
**Combined technique
with both inertia relief
and
resonance taken into
consideration**



3) Forecasting technique for durable life span

Durability simulation on 4-poster

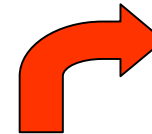
Practical running



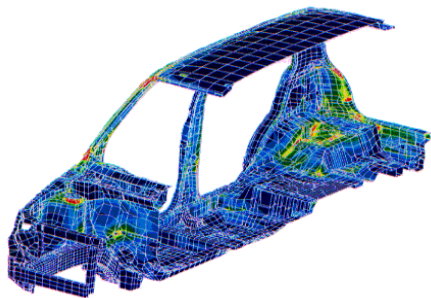
Input data at practical rough road running

Input data at durability test on 4-poster

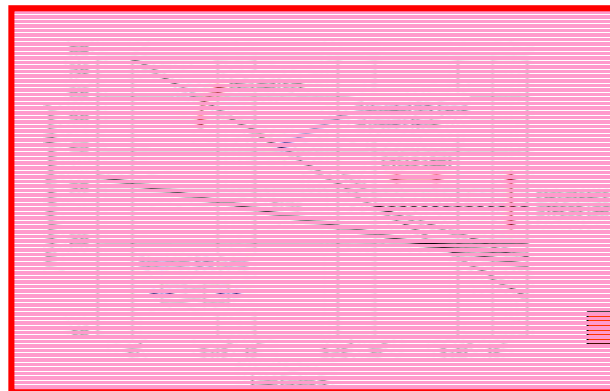
Forecast of durable life span



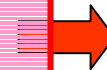
Software for analysis of life span forecast (FEMFAT)



Stress analysis by CAE



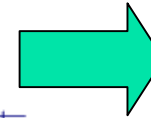
Material property data



3)-1. S-N diagram at spot welded portion

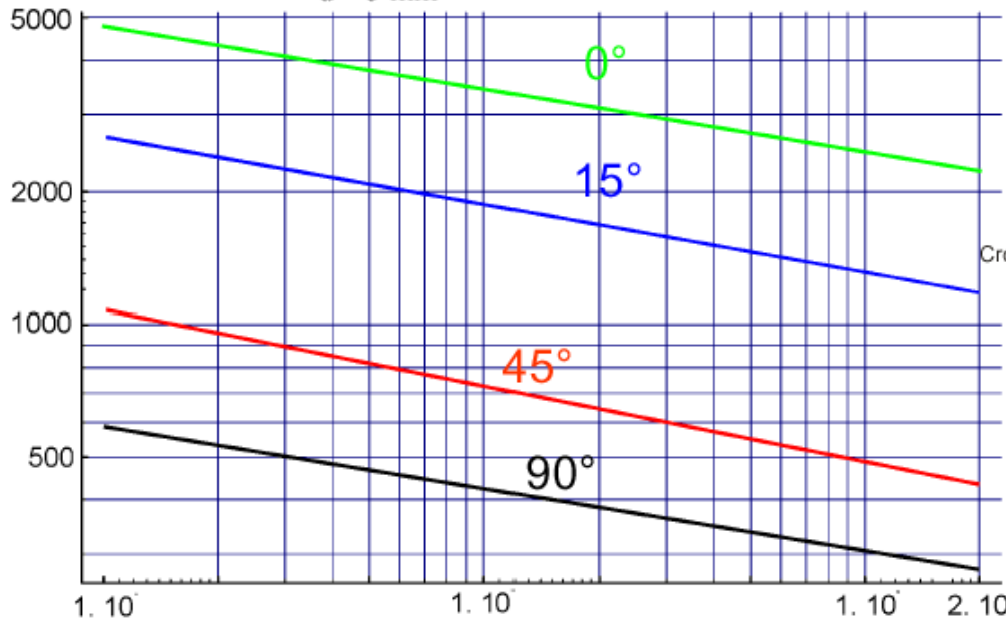
Material :St05
R = 0.1
d = 5 mm

s1 = 0.75 mm
s2 = 1.5 mm



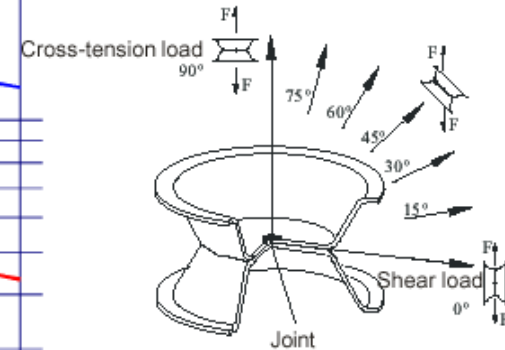
Realization of improved accuracy

Load amplitude (N)



Number of repetition for durability test

Test piece used for evaluation of spot welded portion

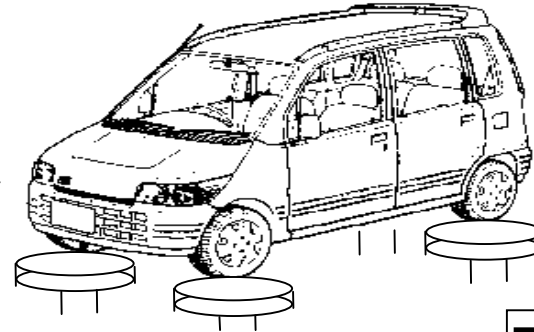
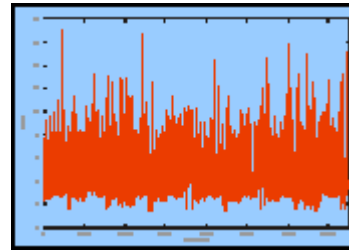
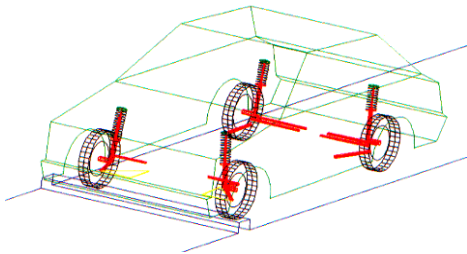


Select S-N in the direction of loading to spot welded portion

3)-2. Life span forecasting technique with input forces at rough road

Durability simulation on 4-poster

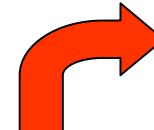
Practical running



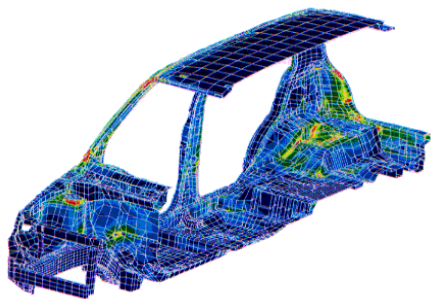
Input data at practical rough road running

Input data at durability test on 4-poster

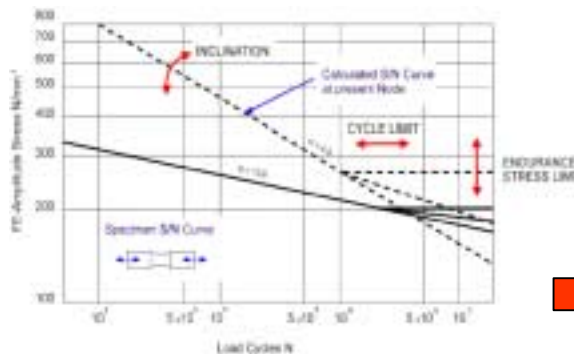
Forecast of durable life span



Software for analysis of life span forecast (FEMFAT)

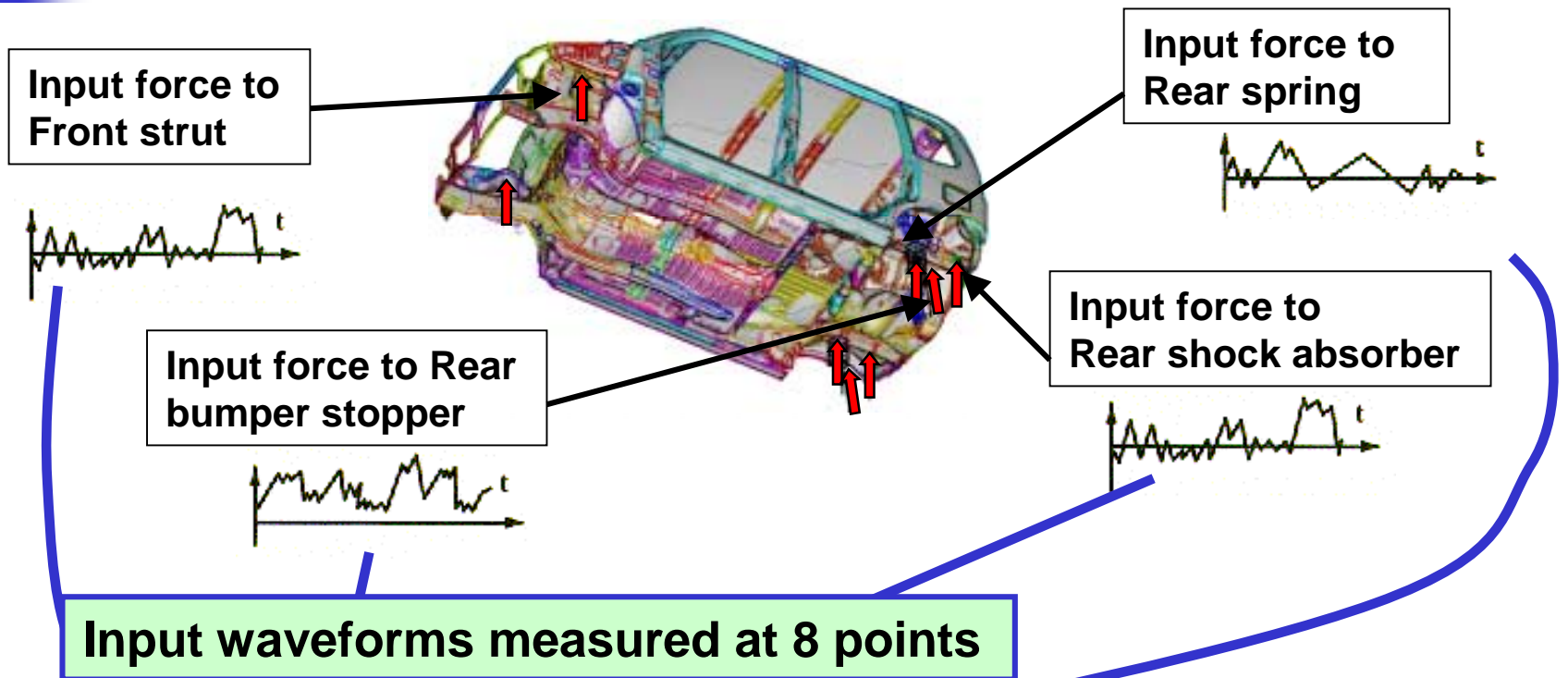


Stress analysis by CAE



Material property data

3)-2. Life span forecasting technique with input forces at rough road



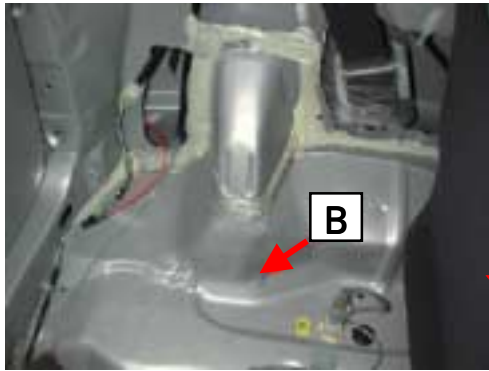
Outcome of stress analysis by CAE

Software for analysis of life span forecast

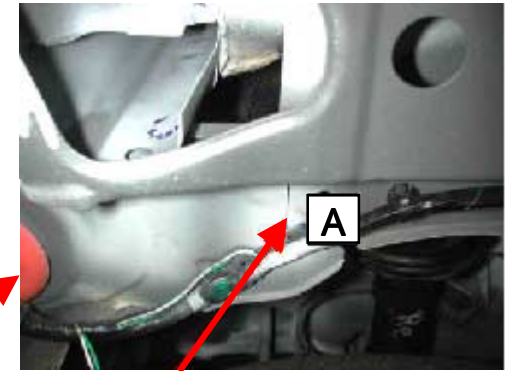
By inputting into Software-for-analysis of life span forecast, it becomes realized to forecast life span under the multiple input forces at 8 points

4. Outcome of analysis

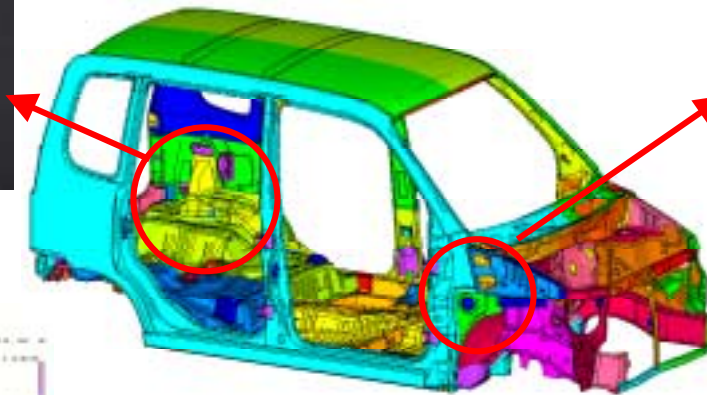
4.1. Comparison between the results by actual test and CAE



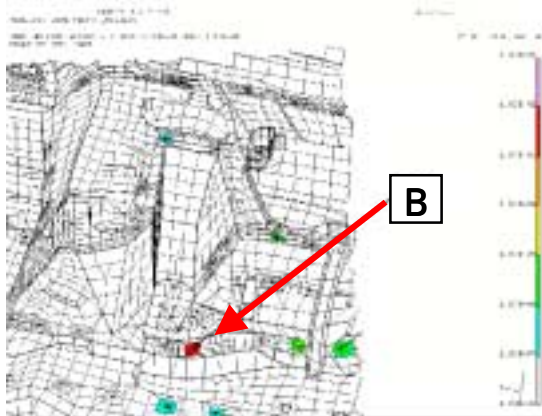
Result of durability test with Rear floor



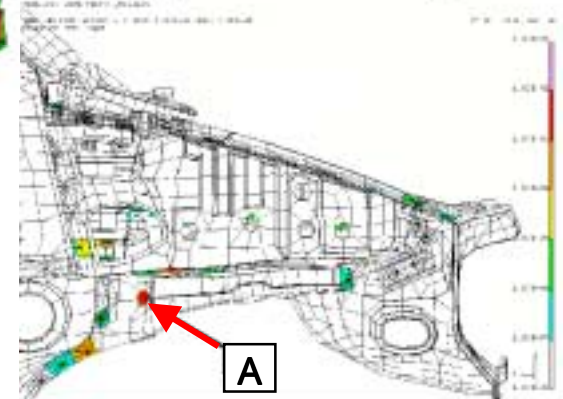
Result of durability test with Cowl side panel



Better corresponding state with actual vehicle

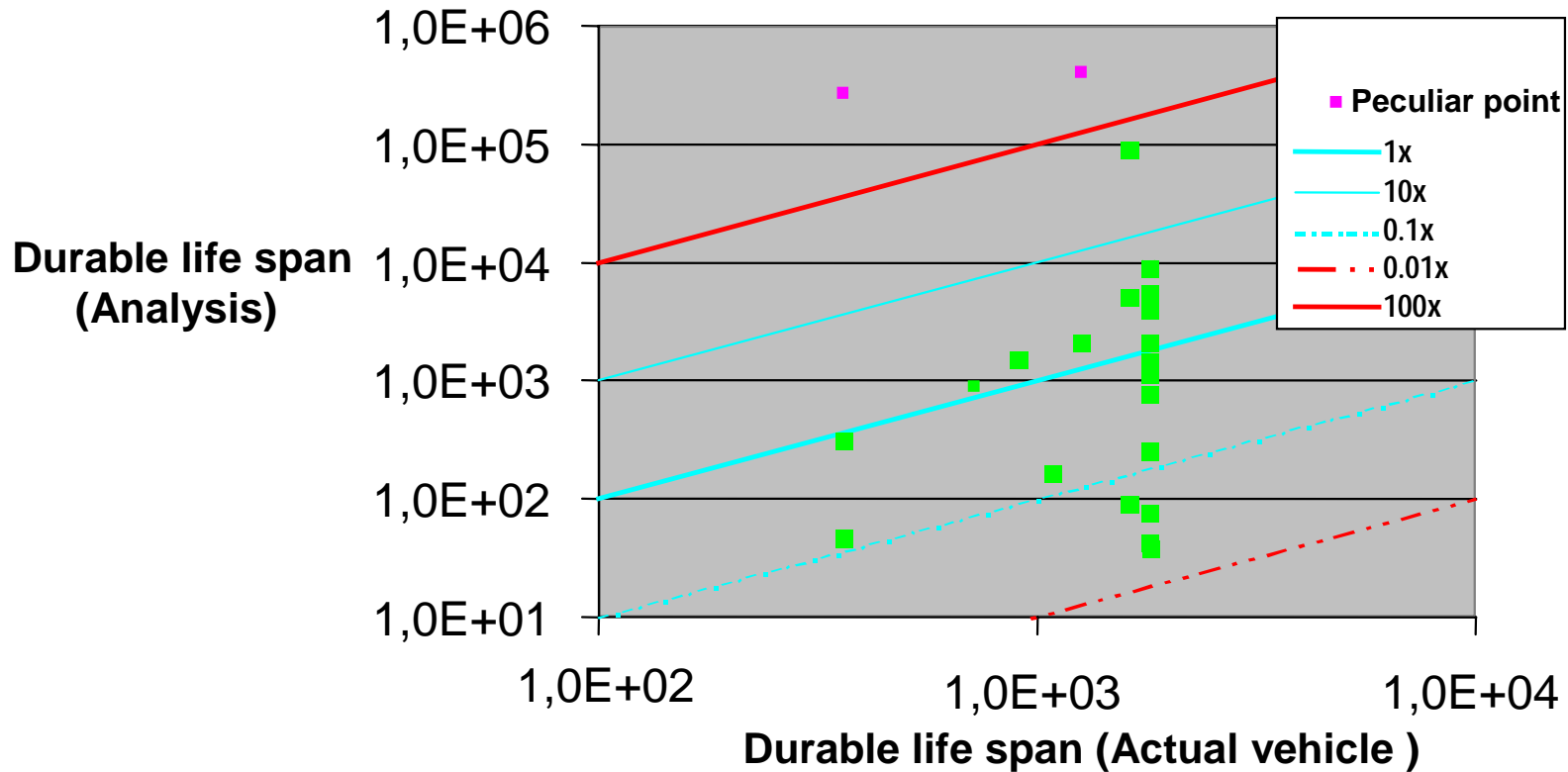


Result of analysis with Rear floor



Result of analysis with Cowl side panel

4.1. Comparison between the results by actual test and CAE



Comparison of two outcomes

4.2. Detection accuracy of crack outbreak

$$\text{Detection accuracy} = \frac{\text{Number of detection from analysis}}{\text{Number of crack occurrence}}$$

Detection accuracy

100
50
0

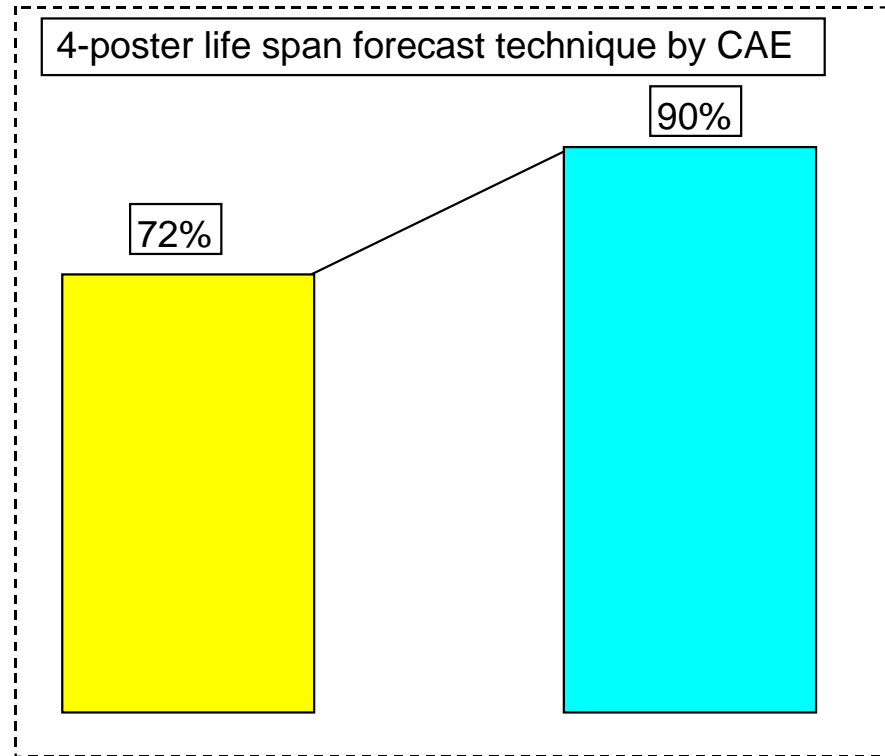
4-poster life span forecast technique by CAE

90%

72%

4-poster life span forecast technique by CAE (Inertia relief technique)

4-poster life span forecast technique by CAE (inertia relief and resonance taken into consideration)





5. Summary

Efficacy or outcome of establishment of Body durable life span forecast by CAE

- It has become realized to consider multiple input forces to make up a life span forecast, with another realization to identify portions where cracks may break out.**
- It has also become realized to point out possible dangerous portions where excessive body dynamic behavior may occur by taking into account resonance peculiarity.**



6. Further actions planned

In order to apply this new technique, it is planned to increase the number of trial for consistency confirmation and pursue much more improved accuracy.