Deq manual

Informal Group on Frontal Impact

GRSP

November 23th, 2012

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Content

- Simplified calculation
- Exact calculation (Use of Matlab routines)

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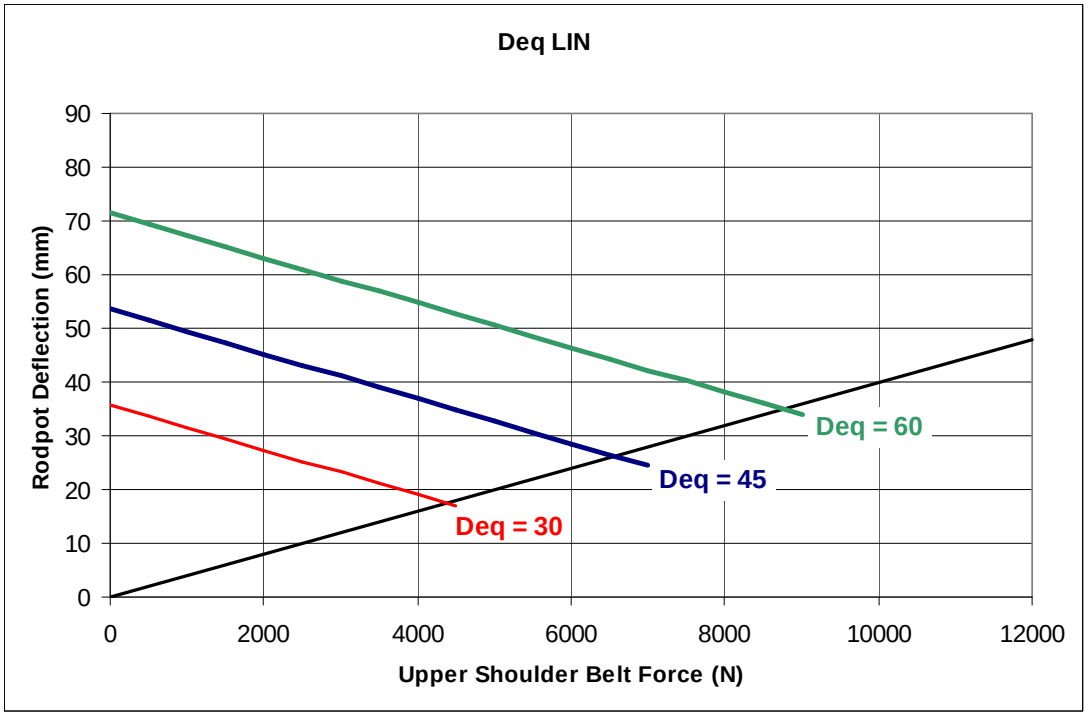
Simplified calculation

The following formula provides an approximate result and allows understanding the effect of the main components of Deq:

$$\text{Deq LIN} \Leftrightarrow 6.6*\text{USBF(kN)} + 0.84*\{\text{Rodpot(mm)} - 3.7*\text{USBF(kN)}\}$$
$$= 3.5*\text{USBF(kN)} + 0.84*\text{Rodpot(mm)}$$



Input

- Matlab script includes the following files :
  - DEQ_2012_iso.m (main program)
  - cfcfilt.m
  - Deter3db.m
  - thorax_lin_1c.m

- It requires ISO files of
  - Rodpot deflection
  - Upper Shoulder Belt Force

Input

- Iso files must have the following format:

File.iso

```
Name of the laboratory       :XXXXXX
Contact name of laboratory   :Data Adquisition
Contact phone of laboratory  :+11 111 111111
Contact fax of laboratory    :+11 111 111111
Name of customer             :EuroNCAP
Laboratory test ref. number  :000001XX
Customer test ref. number    :000001XX
Title                        :EuroNCAP ODB Frontal
Medium No./number of media   :1/1
Type of the test             :EuroNCAP ODB Frontal
Date of the test             :2012-01-01
Number of test objects       :1
Name of test object 1        :Vehicle1
Velocity test object 1       :17.01
Mass test object 1           :1000.0
Sign convent./Instr.Standard:SAEJ211
Number of channels           :94
Name of channel 001          :1000000000000TI00
Name of channel 002          :11HEAD0000H3ACXP
Name of channel 003          :11HEAD0000H3ACYP
Name of channel 004          :11HEAD0000H3ACZP
Name of channel 005          :11NECKUP00H3FOXP
Name of channel 006          :11NECKUP00H3FOYP
Name of channel 007          :11NECKUP00H3FOZP
Name of channel 008          :11NECKUP00H3MOXP
Name of channel 009          :11NECKUP00H3MOYP
Name of channel 010          :11NECKUP00H3MOZP
Name of channel 011          :11CHST0000H3ACXP
```

File.001

```
Test object number           :01
Errors occurred              :NO
Name of the channel          :Driver Seat Belt
Laboratory channel code      :NOVALUE
Customer channel code        :NOVALUE
Channel code                 :11SEBE0000B3FOXP
Unit                         :N
Reference system             :Global
Transducer type              :DK11-11-11
Pre-filter type              :6 poles Butterworth, 4kHz
Cut off frequency            :4000.0
Channel amplitude class      :16000.000
Reference channel            :novalue
Reference channel name       :NOVALUE
Data source                  :transducer
Data status                  :ok
Sampling interval            :0.000050
Bit resolution               :16
Time of first sample         :-0.499000E-01
Number of samples            :9999
Comments                     :next 6 items for proofing
First global maximum value   :+0.428300E+04
Time of maximum value        :+0.739500E-01
First global minimum value   :-0.350126E+02
Time of minimum value        :+0.225650E+00
Start offset interval        :-0.499000E-01
End offset interval          :+0.000000E+00
+0.124137E+01
+0.124137E+01
+0.124137E+01
-0.633634E+00
-0.125863E+01
```

Input

- Rodpot deflection should be named:
  - 11CHST0000H3Dxxx (for Driver)
  - 13CHST0000H3Dxxx (for Passenger)
    - The unit may be “m” or “mm”
- Upper shoulder belt force should be named:
  - 11SEBExxxxxxxxxx (for Driver)
  - 13SEBExxxxxxxxxx (for Passenger)
    - The unit may be “N” or “kN”
- In case a driver and a passenger are present, the Deq will be calculated for both of them.

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Calculations

- For the belt deflection calculation
  - the stiffness and damping are calculated as follow:
    - k1 = 135.78 - 0.0018*Max_Upper_Shoulder_Belt_Force
    - c1 = 0.0185*k1 - 0.2357
  - The belt deflection (Dbelt) is calculated by solving the differential equation
    - USBF = k1*Dbelt + c1*Dbelt'

- For the airbag deflection calculation
  - the initial stiffness and damping are calculated as follow:
    - ki = 238.14 - 0.0023* Max_Upper_Shoulder_Belt_Force
    - ci = 0.0185*k1-0.2357
  - The belt deflection is calculated by solving the differential equation
    - USBF = ki*Dbelt + ci*Dbelt'
  - The airbag deflection (Defl_airbag) is calculated by substracting the belt deflection from the rodpot deflection
  - Then the stiffness is increased until the difference between the localized calculated deflection and the measured sternal deflection is less than 5mm at any time.

- DEQ is calculated as follows:
  - DEQ LIN = Belt_deflection + (Fn*Defl_airbag)
  - With Fn =0.84

- The risks for M50 and F05 are calculated with the following formulas:
  - Risk DEQ M50 = (1-exp(-exp((log(DEQ_max)-intercept-fage*age)/scale)))*100
  - Risk DEQ F05 = (1-exp(-exp((log(DEQ_max/F05)-intercept-fage*age)/scale)))*100
  - With scale=0.246
  - intercept=4.9908
  - fage=-0.0174
  - F05=0.817

Injury Risk Curves

- HIII 50th Male

$$Injury\ risk(50th) = 1 - \exp\left(-\exp\left(\frac{\ln(deq) - 4.99 + 0.0174 * age}{0.246}\right)\right)$$

- HIII 5th Female

$$Injury\ risk(50th) = 1 - \exp\left(-\exp\left(\frac{\ln(deq / 0.83) - 4.99 + 0.0174 * age}{0.246}\right)\right)$$

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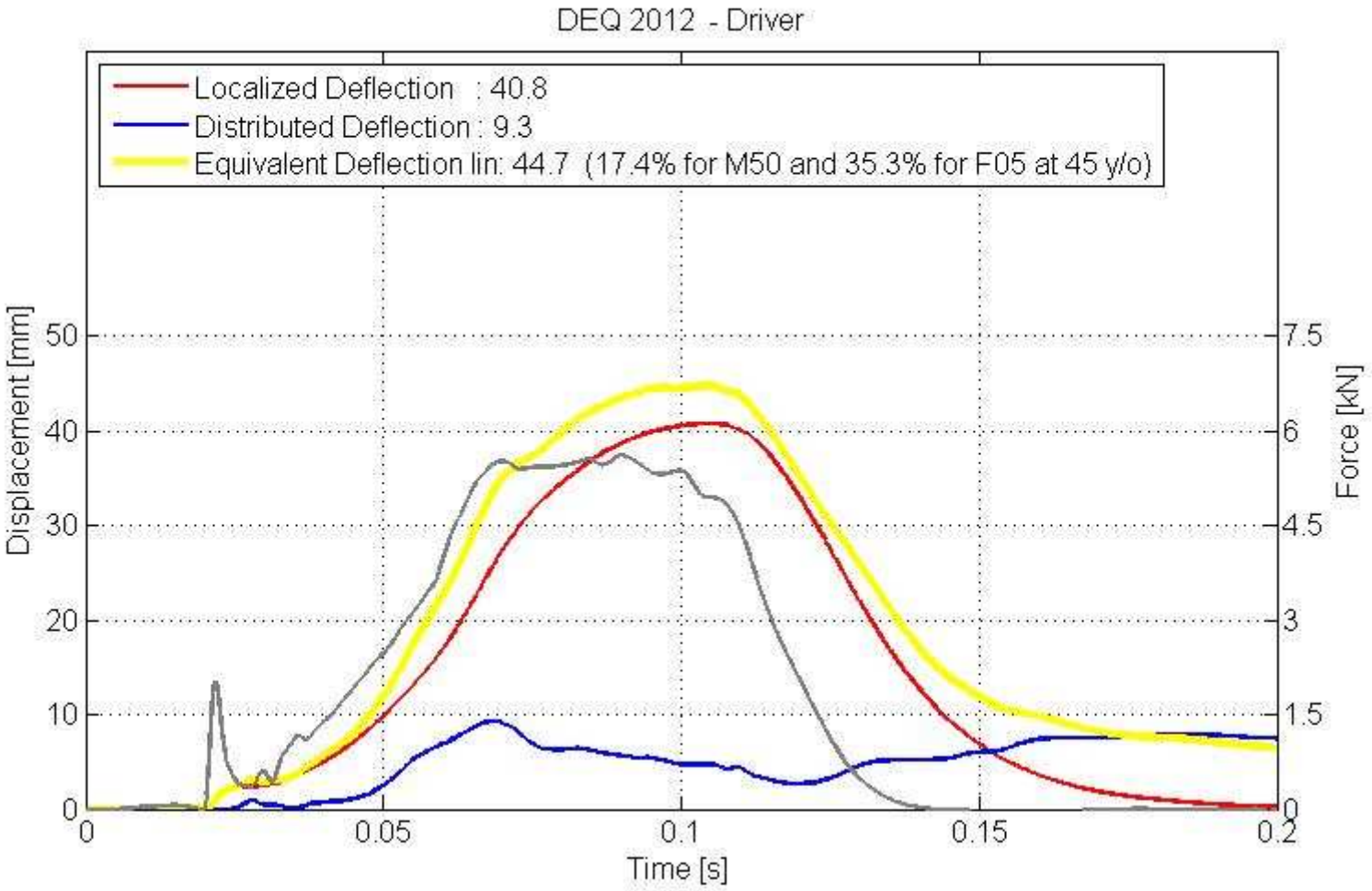
Output



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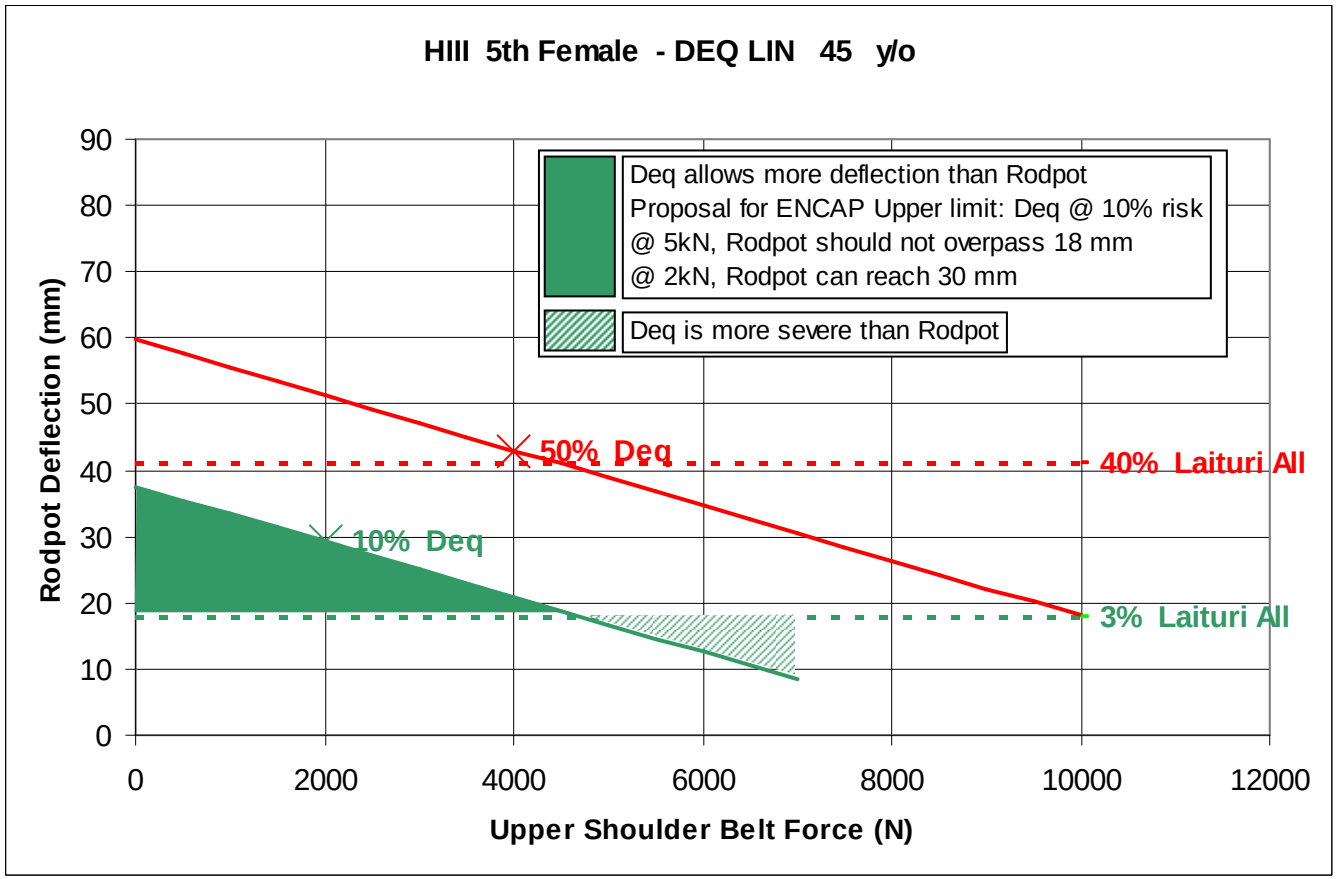
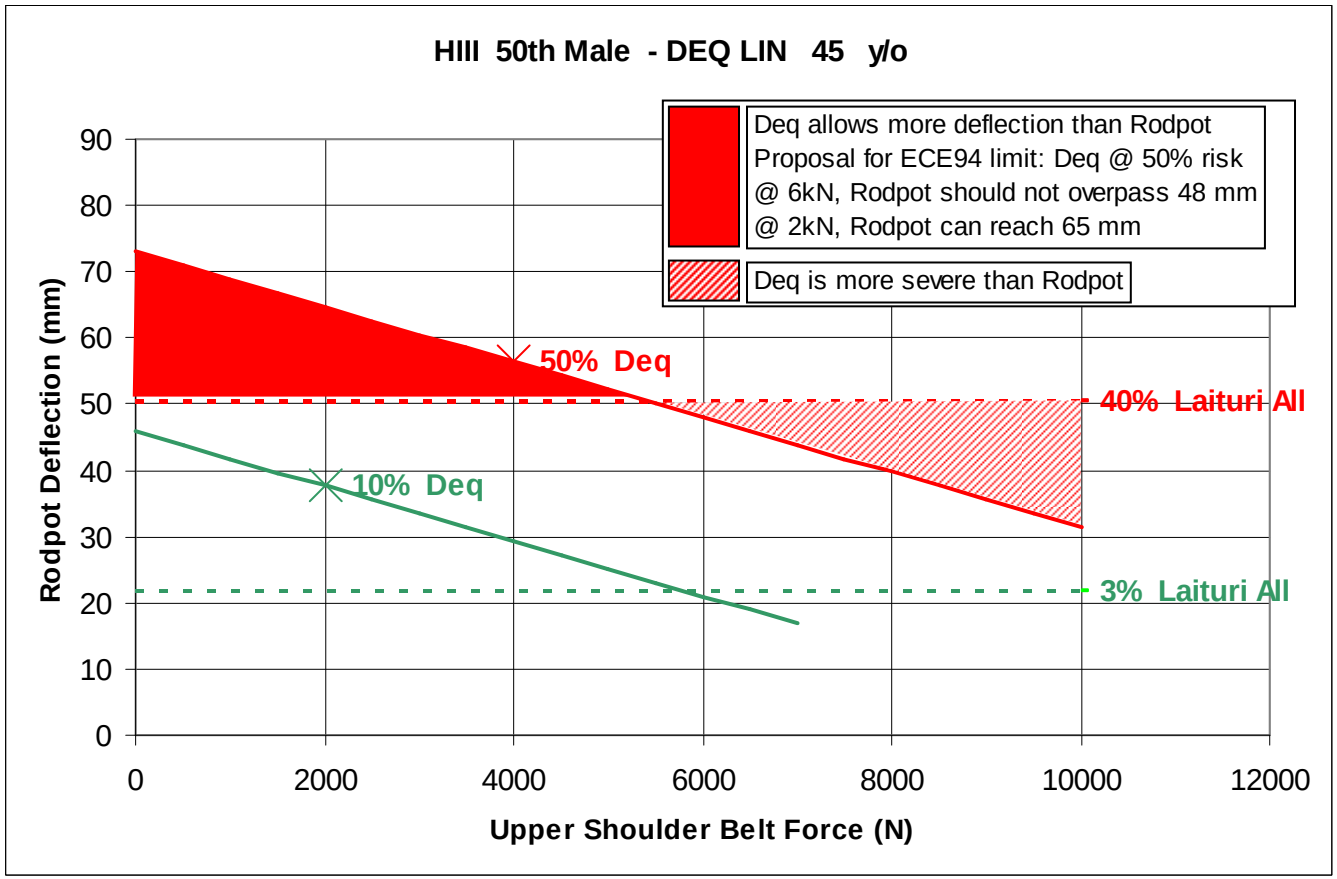
Thresholds



HIII 5th - 45 y/o for **ENCAP** UPPER limit

Thresholds



HIII 50th - 45 y/o for **ECE94** limit
and **ENCAP** LOWER limit