Euro NCAP MPDB Compatibility Assessment

Introduction

This document describes the Occupant Load Criterion (OLC) calculation performed in the REPORTER templates:

- Euro NCAP MPDB Compatibility Assessment **2020**
- Euro NCAP MPDB Compatibility Assessment **2023**

The calculation follows the method specified in the Euro NCAP Technical Bulletin (TB 027) v1.1.1, which is intended to be used with the Adult Occupant Protection Assessment Protocol v9.1.1.

The OLC calculation itself is contained within the script:

%TEMPLATE_DIR%/scripts/MPDB/**this_MPDB_Impact_common.js**

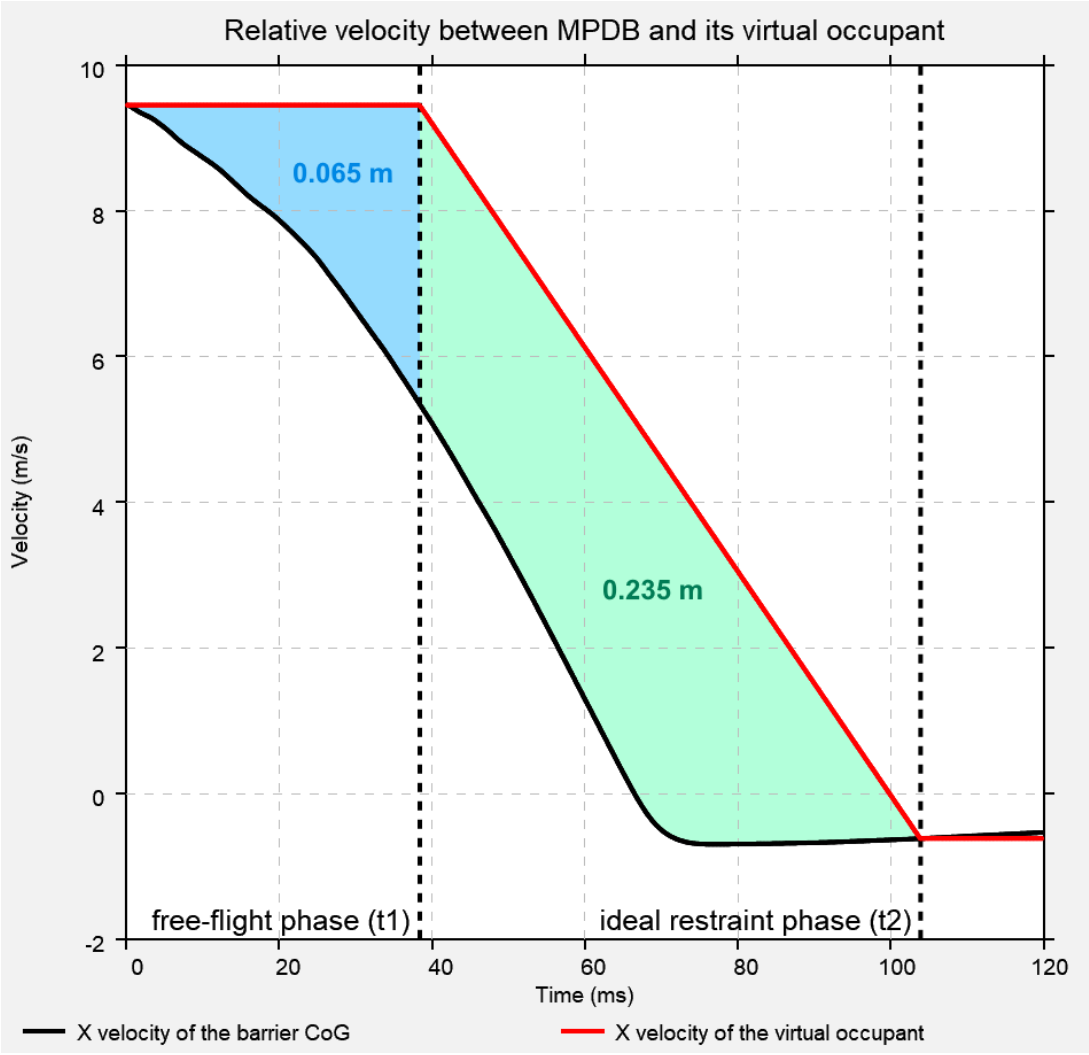
Occupant Load Criterion (OLC) calculation

According to TB 027, the virtual occupant velocity is piecewise linear: a **free-flight phase** in uniform motion (zero acceleration) is followed by an **ideal restraint phase** with constant deceleration (in *g* units) equal to the OLC:

[3.5.2]- *t_1 is end of the free-flight-phase of a virtual dummy on the barrier along a displacement of 0.065m, and*

- *t_2 is end of the restraining-phase of a virtual dummy on the barrier along a displacement of 0.235m after the free-flight-phase (i.e. in total 0.300m displacement for the virtual dummy).*

The **blue** and **green** shaded areas show the relative *displacement* between that barrier and its occupant during the two phases.



Calculating end of free-flight phase (t_1)

The T/HIS JavaScript[1] reads and filters the barrier's *x*-velocity and records the initial velocity V_0, and integrates to find the *x*-displacement $s_{MPDB}(t)$. The displacement $s_{FF}(t)$ of the virtual occupant in its free-flight phase is therefore:

$$s_{FF}(t) = V_0 t$$

The relative displacement Δs between the virtual occupant and the barrier is:

$$\Delta s = s_{FF}(t) - s_{MPDB}(t)$$

The script constructs a curve (called free_flight_time) of time t against Δs in order to determine t_1 (the time at which $\Delta s = 0.065\ m$).

[1]The OLC calculation is performed in the script: %TEMPLATE_DIR%/scripts/EuroNCAP/**this_EuroNCAP_MPDB_Impact_common.js**

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Calculating end of ideal restraint phase (t_2)

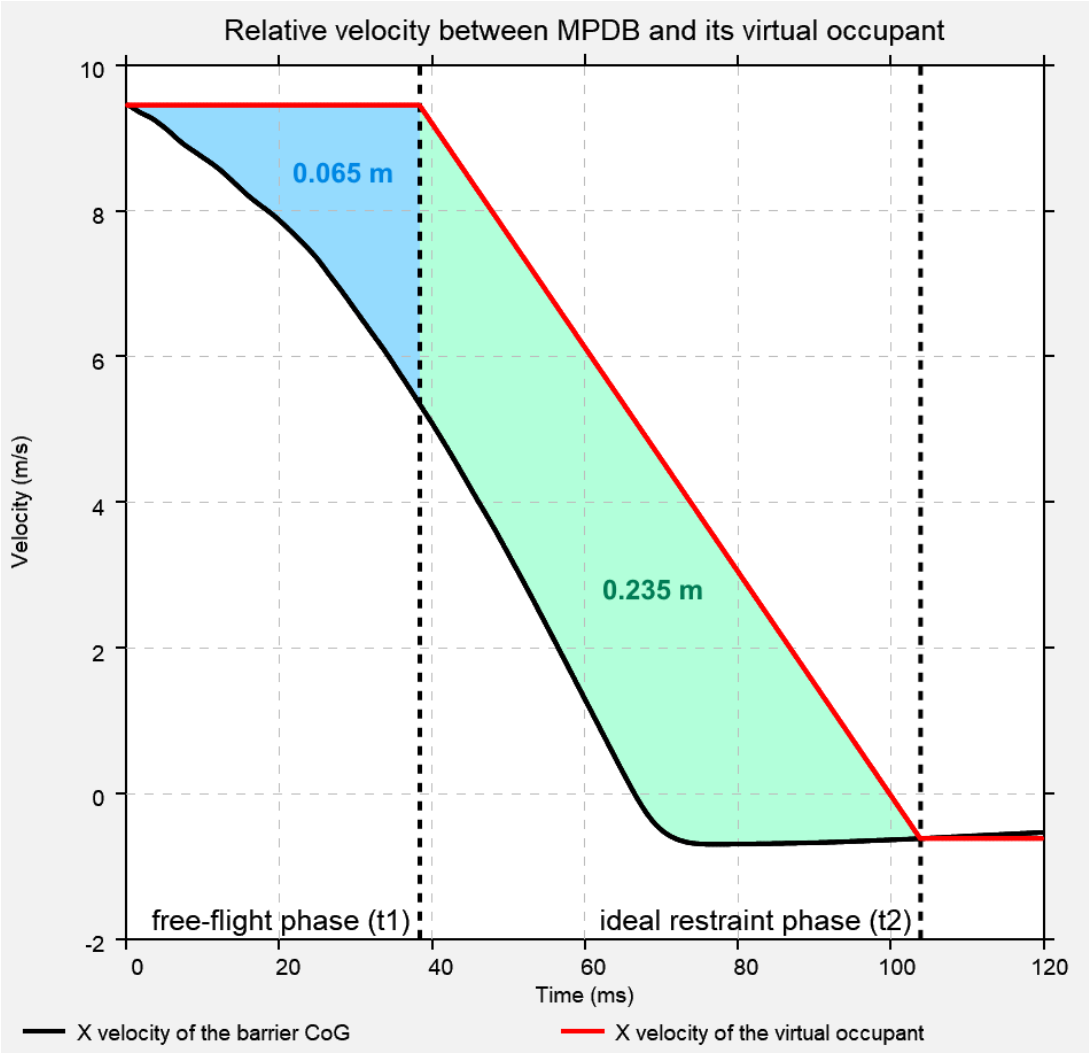
The end time t_2 of the ideal restraint phase is determined by iteration. For each iteration of t_2, the relative displacement $\Delta s = s_{IR} - s_{MPDB}$ between barrier and virtual occupant is checked by subtracting the area under the barrier velocity curve (**black**) from the area under the virtual occupant velocity curve (**red**) to give the area highlighted in **green**.

The area under the barrier velocity curve is its displacement between times t_1 and t_2:

$$s_{MPDB} = s_{MPDB,t2} - s_{MPDB,t1}$$

The area under virtual occupant curve (its displacement s_{IR} during the ideal restraint phase) is found by computing the area of the trapezium defined by t_1, t_2, the barrier's initial velocity $V_0 = V_1$ and the barrier velocity V_2 at t_2:

$$s_{IR} = \frac{(V_1 + V_2)(t_2 - t_1)}{2}$$



Converging on a solution for the OLC

In the script, the following steps are performed iteratively until a converged solution is reached:

1. Assume an initial t_2 (on the first iteration it is assumed that $OLC = 0$ i.e. a lower bound to t_2 is assumed)
2. Lookup the barrier velocity V_2 at time t_2
3. Compute the associated OLC:

$$OLC = \frac{1}{9.81}\left(\frac{V_2 - V_1}{t_2 - t_1}\right)$$

4. Compute the relative displacement $\Delta s = s_{IR} - s_{MPDB}$
5. Adjust t_2 based on the computed Δs. If $\Delta s > 0.235\ m$ then t_2 is decreased; otherwise it is increased:

$$t_{2,UPDATED} = t_2\left(1 + R\left(\frac{0.235}{\Delta s} - 1\right)\right)$$

   where $R = 0.1$ was selected from empirical testing

6. Check for the following three convergence criteria. If any of these is not satisfied, the iteration process is terminated:
   i. Assume that a solution for OLC has been reached if a convergence tolerance of 10^{-6} is reached:

$$|0.235 - \Delta s| \leq 10^{-6}$$

   ii. If the end t_2 of the ideal restraint phase is increased beyond the analysis termination time, then the process is terminated with no solution (a warning is printed in the template and $OLC = 0$ is returned)
   iii. If the total number of iterations exceeds 100 then the process is terminated with no solution (a warning is printed in the template and $OLC = 0$ is returned)

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