# Speed hump tester

**By Danish Road Directorate**
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Vejdirektoratet

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# Road standards

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**Contact information:**

If you have any questions regarding the Road Standards, please contact Esther Jung (email: vejregler@vd.dk)

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# Catalogue of speed humps

VEJREGEL
TYPEKATALOG

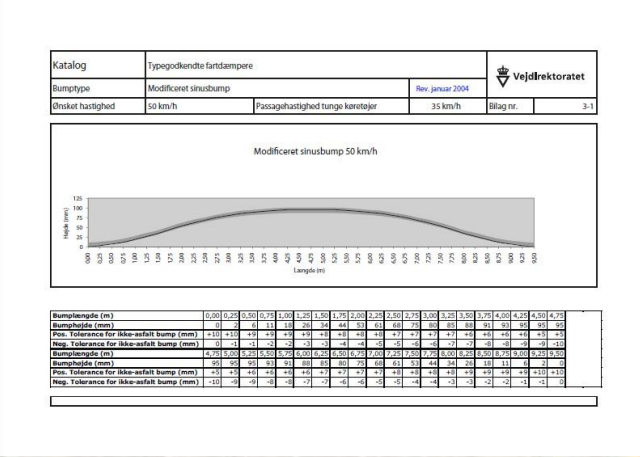
TRAFIKAREALER, BY

KATALOG OVER TYPEGOD-
KENDTE BUMP

Oktober 2019

Vejdirektoratet

# Types of speed humps



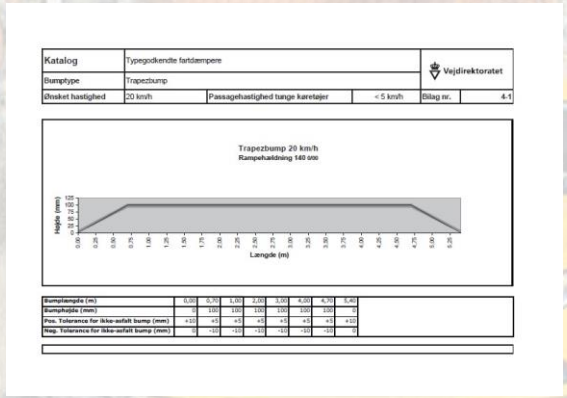
| Katalog | Typegodkendte fartdæmpere | | | Vejdirektoratet |
|---|---|---|---|---|
| Bumptype | Modificeret sinusbump | | Rev. januar 2004 | |
| Ønsket hastighed | 50 km/h | Passagehastighed tunge køretøjer | 35 km/h | Bilag nr. 3-1 |

Modificeret sinusbump 50 km/h

Højde (mm)

Længde (m)

| Bumplængde (m) | 0,00 | 0,25 | 0,50 | 0,75 | 1,00 | 1,25 | 1,50 | 1,75 | 2,00 | 2,25 | 2,50 | 2,75 | 3,00 | 3,25 | 3,50 | 3,75 | 4,00 | 4,25 | 4,50 | 4,75 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bumphøjde (mm) | 0 | 2 | 6 | 11 | 18 | 26 | 34 | 44 | 53 | 61 | 68 | 75 | 80 | 85 | 89 | 91 | 93 | 95 | 95 | 95 |
| Pos. Tolerance for ikke-asfalt bump (mm) | +10 | +10 | +9 | +9 | +9 | +9 | +8 | +8 | +8 | +8 | +7 | +7 | +7 | +7 | +6 | +6 | +6 | +6 | +5 | +5 |
| Neg. Tolerance for ikke-asfalt bump (mm) | 0 | -1 | -1 | -2 | -2 | -3 | -3 | -4 | -4 | -5 | -5 | -6 | -6 | -7 | -7 | -8 | -8 | -9 | -9 | -10 |
| Bumplængde (m) | 4,75 | 5,00 | 5,25 | 5,50 | 5,75 | 6,00 | 6,25 | 6,50 | 6,75 | 7,00 | 7,25 | 7,50 | 7,75 | 8,00 | 8,25 | 8,50 | 8,75 | 9,00 | 9,25 | 9,50 |
| Bumphøjde (mm) | 95 | 95 | 95 | 93 | 91 | 88 | 85 | 80 | 75 | 68 | 61 | 53 | 44 | 34 | 26 | 18 | 11 | 6 | 2 | 0 |
| Pos. Tolerance for ikke-asfalt bump (mm) | +5 | +5 | +6 | +6 | +6 | +6 | +7 | +7 | +7 | +7 | +8 | +8 | +8 | +8 | +9 | +9 | +9 | +9 | +10 | +10 |
| Neg. Tolerance for ikke-asfalt bump (mm) | -10 | -9 | -9 | -8 | -8 | -7 | -7 | -6 | -6 | -5 | -5 | -4 | -4 | -3 | -3 | -2 | -2 | -1 | -1 | 0 |

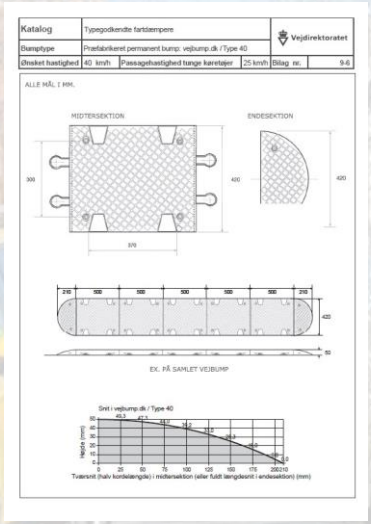
| Katalog | Typegodkendte fartdæmpere | | | Vejdirektoratet |
|---|---|---|---|---|
| Bumptype | Trapezbump | | | |
| Ønsket hastighed | 20 km/h | Passagehastighed tunge køretøjer | < 5 km/h | Bilag nr. 4-1 |

Trapezbump 20 km/h
Rampehældning 140 o/oo

Højde (mm)

Længde (m)

| Bumplængde (m) | 0,00 | 0,70 | 1,00 | 2,00 | 3,00 | 4,00 | 4,70 | 5,40 |
|---|---|---|---|---|---|---|---|---|
| Bumphøjde (mm) | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 0 |
| Pos. Tolerance for ikke-asfalt bump (mm) | +10 | +5 | +5 | +5 | +5 | +5 | +5 | +10 |
| Neg. Tolerance for ikke-asfalt bump (mm) | 0 | -10 | -10 | -10 | -10 | -10 | -10 | 0 |



| Katalog | Typegodkendte fartdæmpere | | | Vejdirektoratet |
|---|---|---|---|---|
| Bumptype | Prefabrikeret permanent bump: vejbump.dk /Type 40 | | | |
| Ønsket hastighed | 40 km/h | Passagehastighed tunge køretøjer | 25 km/h | Bilag nr. 9-6 |

ALLE MÅL I MM.

MIDTERSEKTION

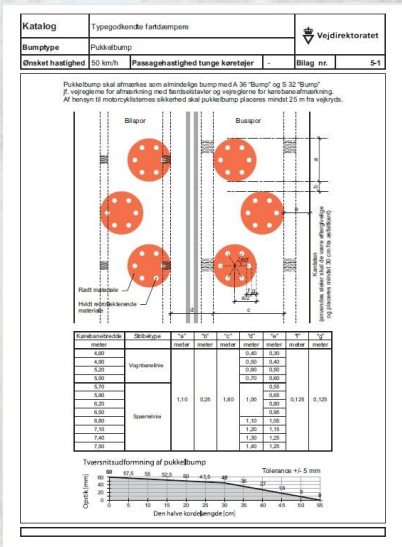
ENDESEKTION

EX. PÅ SAMLET VEJBUMP

Snit i vejbump.dk / Type 40

Højde (mm)

Tværsnit (halv kordelængde) i midtersektion (eller fuldt længdesnit i endesektion) (mm)



| Katalog | Typegodkendte fartdæmpere | | | Vejdirektoratet |
|---|---|---|---|---|
| Bumptype | Pukkelbump | | | |
| Ønsket hastighed | 50 km/h | Passagehastighed tunge køretøjer | - | Bilag nr. 5-1 |

Pukkelbump skal afmærkes som almindelige bump med A 36 "Bump" og S 32 "Bump" jf. vejreglerne for afmærkning med færdselstavler og vejreglerne for kørebaneafmærkning. Af hensyn til motorcyklisternes sikkerhed skal pukkelbump placeres mindst 25 m fra vejkryds.

Bilspor

Busspor

Radt materiale

Hvidt reflekterende materiale

| Kørebanebredde | Stribetype | "a" | "b" | "c" | "d" | "e" | "f" | "g" |
|---|---|---|---|---|---|---|---|---|
| meter | | meter | meter | meter | meter | meter | meter | meter |
| 4,60 | Vognbanelinie | 1,10 | 0,25 | 1,80 | 1,00 | 0,125 | 0,125 | |
| 4,90 | | | | | | | | |
| 5,20 | | | | | | | | |
| 5,50 | | | | | | | | |
| 5,70 | Spærrelinie | | | | | | | |
| 5,80 | | | | | | | | |
| 6,20 | | | | | | | | |
| 6,50 | | | | | | | | |
| 6,80 | | | | | | | | |
| 7,10 | | | | | | | | |
| 7,40 | | | | | | | | |
| 7,60 | | | | | | | | |

Tværsnitsudformning af pukkelbump

Tolerance +/- 5 mm

Dybde (mm)

Den halve kordelængde (cm)

# Impact on the driver

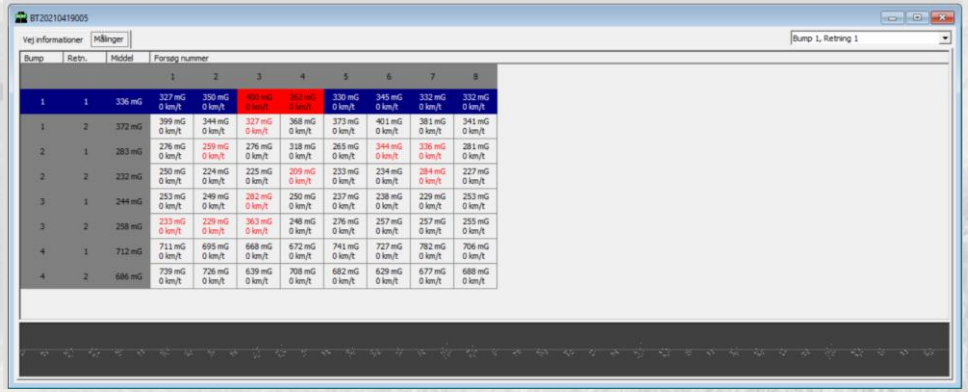
- The Road Standard for Speed Humps Chapter 2 Paragraph 5 states that
  Speed humps shall be designed in such a way that:

  (1) a driver of a passenger car when travelling at the desired speed and a driver of a heavy vehicle when passing at the desired speed minus 15 km/h are subjected to vertical acceleration of 0,65 to 0,75 times the acceleration of gravity G; and

  2) The vertical acceleration is increasing with increasing speed.

# Current equipment

- To control if a speed hump fulfills this requirement, the DRD is operating a measurement setup consisting of a reference vehicle (VW Passat stationwagon) and a measurement equipment.
- This measurement equipment is an accelerometer that is mounted on the chest of the test driver (me). It measures the vertical acceleration experienced by the driver while passing the speed hump.
- The data recording is activated by the operator by pressing a button right before and after each passage of the speed hump. The “repeatability” of the equipment requires that the tested speed hump is being measured 8 to 10 times before a valid value for the acceleration has been determined by the equipment.



# Development of new equipment

- Over the years, we have discovered that certain hump types exist, where the measurements show vertical accelerations well within the allowed range, but where the driver still gets a very unpleasant experience when passing the speed hump. So, a suspicion slowly built up, that the vertical acceleration may not be enough to describe the discomfort experienced by the driver of the passing car.
- Therefore, the Danish Road Directorate in collaboration with the Danish Technological Institute have developed a new measurement equipment for this purpose.

# Description of the new equipment

- The idea of the new equipment is that we can now apart from the vertical acceleration also measure the vertical jerk (the rate of change of acceleration). This jerk is a main component in the discomfort you feel when passing a speed hump (or a pothole or some other obstacle in the road).
- The new system consists of a tablet with dedicated software for hump measurement,
- an accelerometer,
- a GPS,
- and a button for activating data recording.
- The new system is mounted on the headrest of the driver's seat in our reference car.

# Description of the new equipment

Parameters:

- Vertical acceleration
- Vertical jerk
- Speed
- Position

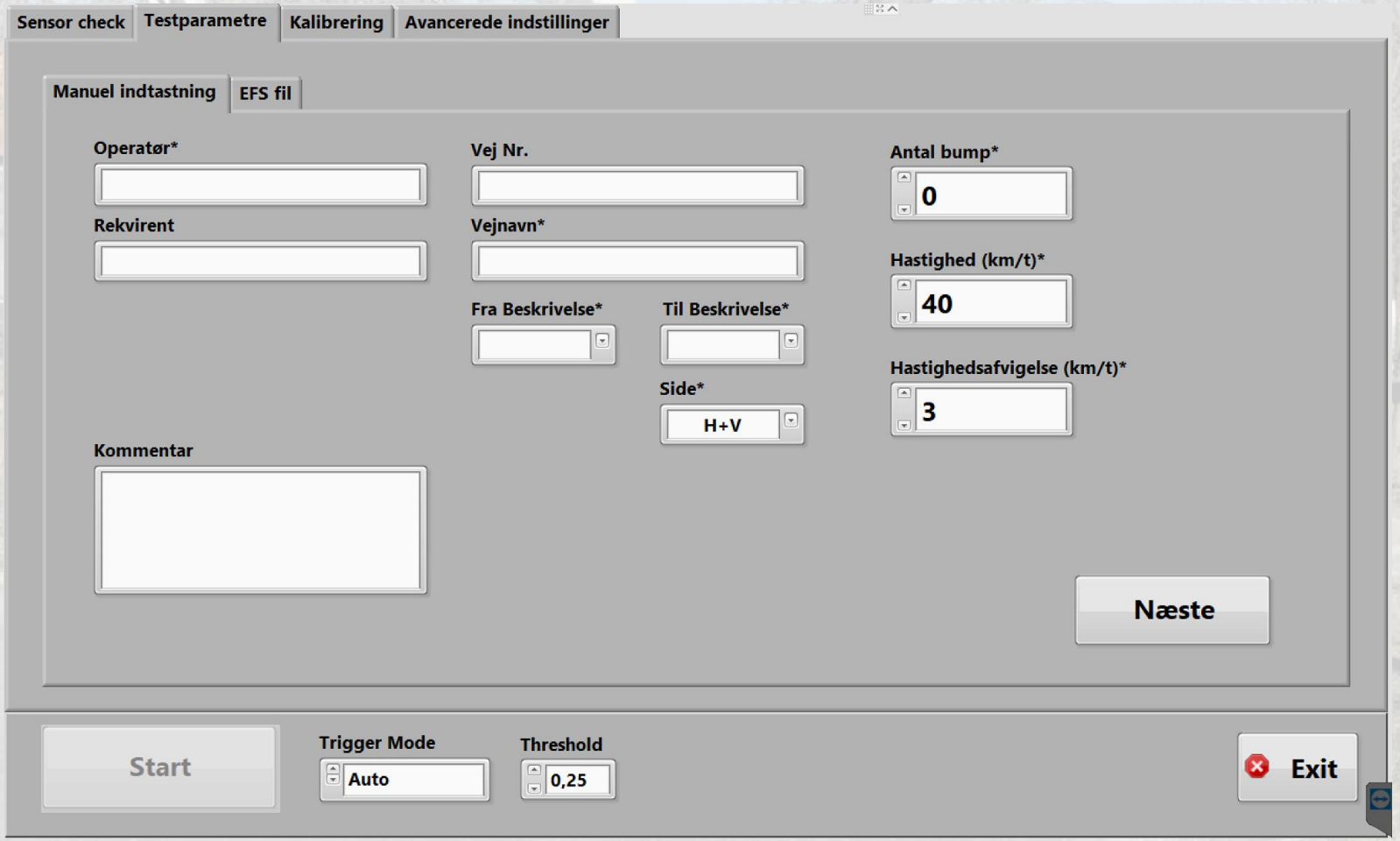
# System specifications

- Accelerometer triaxial MEMS sensor: Sequoia FastTracer.
- Analog sensor bandwidth of 0-2500Hz.
- Measuring range of 0-2G.
- Sample rate: 8192 Samples/sec.
- Digitally filtered to remove high-frequency noise generated by engine vibration.
- Downsampled to 100Hz.

# Measurement procedure

- For each crossing, the system finds the maximum vertical acceleration,
- Based on the same principle, the mean value of the maximum vertical jerk is calculated.
- If individual crossings differ significantly from the others, these are sorted out
- The repeatability of the new equipment is also better, so that we now typically will need only around 3-5 passings
- With the new system hump recording can now be activated in 3 ways:
  - Auto: Automatically detects levels above the limit value
  - Manual single: Press once when the bump is hit
  - Manual: Press before and after the bump

# Setup screen



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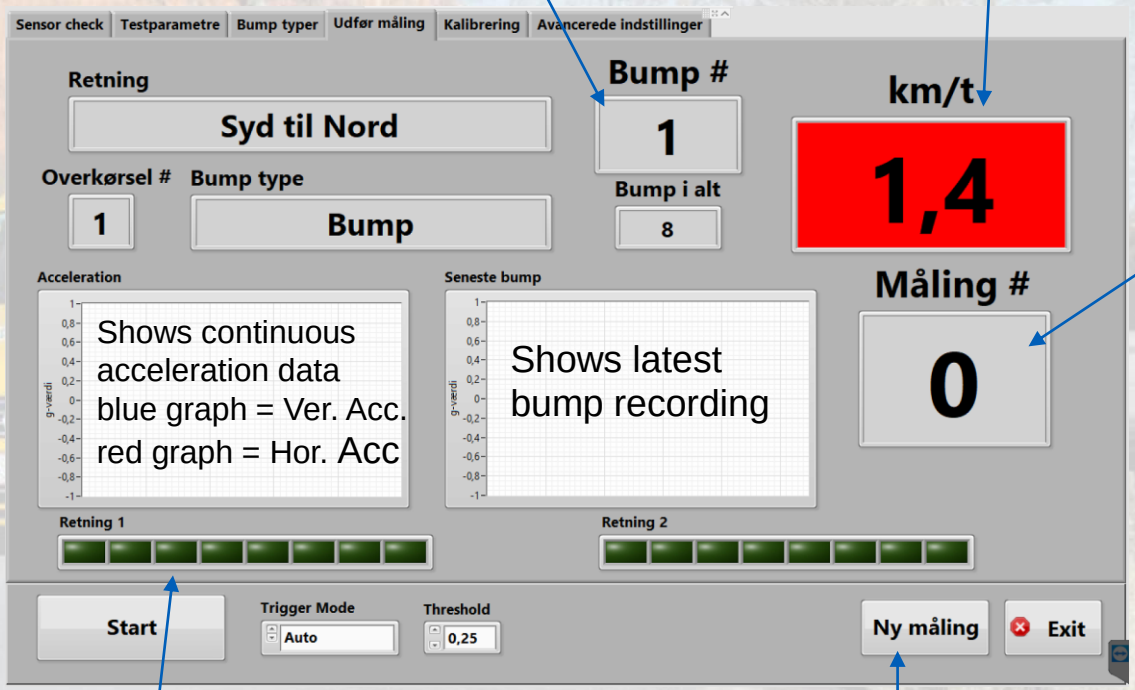
# Measurement screen

- Press "Start" to activate the accelerometer.
- Bump recording can be activated in 3 ways, which are selected using "Trigger Mode":
  - Auto: Automatically detects levels above the limit value
  - Manual single: Press once when the bump is hit
  - Manual: Press before and after the bump

The green button facilitates operation while driving. In Manual modes it is used for starting, starting/stopping bump recording, in auto mode it starts and stops the accelerometer, and can be used to pause the measurement during reversal and similar maneuvers.

The background color changes to green at proper speed

Indicates the bump you are heading for




Increases by 1 each time a measurement is performed

Lights up when there is sufficient data for that bump. Adapts to dynamic number of bumps.

Use this button to start all over again

# Test measurements

- The new equipment is now being tested on 5 different hump types, each type designed for 3 different speeds.
- In total fifteen humps driven 20 times in both directions.
- This adds up to 300 crossings.

# A new road standard?

- The results of the test measurements are being reviewed to make a recommendation for the requirements for vertical impact – taking both acceleration and jerk into account.

- This recommendation will then be submitted to the working group for road standards for final approval and implementation.


# Thank you for your attention!