An evaluation of the German TA31 transition rules. Performed by Bolennarth Svensson, VBG. Vänersborg 2013 September 06.

Below the D-value in the transition area according to the German TA31 is defined.
Tt is designating the towing vehicle weight.
Rr is designating the towed vehicle weight.
k is designating the quotient *Rr/Tt* between trailer weight and the weight of the towing vehicle
Thus the gross combination weight *GCW* equals *Tt*(1+k)*

given

D-value in the transition inteval, *k* = 1.6 to *k* = 4.

$$D(Tt,k,g) := g \cdot \frac{Tt^2\ k}{Tt \cdot (1+k)} (1.2 - 0.125 \cdot k)$$

Find extremum through the evaluation of the derevative:

$$DD(Tt,k,g) := \frac{d}{dk} D(Tt,k,g) \xrightarrow{simplify} \frac{1.325 \cdot g \cdot Tt}{(k+1.0)^2} - 0.125 \cdot g \cdot Tt$$

$$\left(\frac{10.6}{(k+1)^2} - 1\right) = 0 \qquad k := \sqrt{10.6} - 1 = 2.256$$

This *k* is in the interval 1.6 to 4.0

Some sample of evaluation of the maximum D-value in the interval

$$D\left(Tt, \sqrt{10.6} - 1, 9.81\right) \rightarrow 6.239738497613094017 \cdot Tt$$

Towing vehicle weight 18 tonnes

$$D\left(18, \sqrt{10.6} - 1, 9.81\right) = 112.315 \qquad \text{kN}$$

Towing vehicle weight 24 tonnes

$$D\left(24, \sqrt{10.6} - 1, 9.81\right) = 149.754 \qquad \text{kN}$$

Towing vehicle weight 32 tonnes

$$D\left(32, \sqrt{10.6} - 1, 9.81\right) = 199.672 \qquad \text{kN}$$

In the interval *k >4* the D-value formula according to TA31 shall be as the function Dx below.

$$Dx(Tt,k,g) := g \cdot 0.7 \cdot \frac{Tt^2\ k}{Tt \cdot (1+k)}$$

At what value for *k* will Dx be equal to the extremum value kalculated above?

$$Equality(Tt,k) := \frac{\left(Dx(Tt,k,9.81) - D\left(Tt,\sqrt{10.6}-1,9.81\right)\right)}{Tt} = 0$$

It can be seen that *Equality* is independent of *Tt.* Hence use any value for *Tt*

$$Equal(k) := Equality(1,k) \rightarrow \frac{6.867 \cdot k}{k+1} - 6.239738497613094017 = 0$$

$$k := \frac{6.239738497613094017}{6.867 - 6.239738497613094017} = 9.948$$

Define a function controlling the *D*-value as a funktion of *k* i.e.
*D(k)= Tt*g*Tranisition(k)*

$$Transition(k) := \begin{array}{l} \text{if } k<1.6 \\ \quad T \leftarrow \frac{k}{(1+k)} \\ \text{else if } k<4 \\ \quad T \leftarrow \frac{k}{(1+k)} (1.2 - 0.125 \cdot k) \\ \text{else} \\ \quad T \leftarrow \frac{k}{(1+k)} 0.7 \\ T \end{array}$$

In summary a proposal could be:

As long as D-value calculated is below:

D=*6.24*Tt* i.e. *k* < 1.748

The D-value formulae:

D=*9.81*Tt*Rr/(Tt+Rr)* {traditional *D*-value formulae}

where Rr, the weight of towed vehicle, shall be used.

Then as long as the quotient *k= Rr/Tt* is below 10 the D-value shall be set to

D=*6.24*Tt*

When in rare cases where the quotient *k* is above 10 the formulae:

D=*9.81*0.7*Tt*Rr/(Tt+Rr)*

shall be used.

This function is illustrated as *D=Tt*9.81*TransitionK(k)* below
The plot below is just to show that there is a maximum value in the inteval 1.6 to 4 for *k* in the function *Transision(k)* given in TA31. In the same plot you also find the proposed function *Transition(k)*.

$\frac{k}{1+k} < \frac{6.24}{9.81}$ i.e. $k < \frac{6.24}{9.81-6.24}$ =1.748

$$TransitionK(k) := \begin{array}{l} \text{if } k < 1.748 \\ \quad T \leftarrow \frac{k}{(1+k)} \\ \text{else if } k < 10 \\ \quad T \leftarrow \frac{6.24}{9.81} \\ \text{else} \\ \quad T \leftarrow \frac{k}{(1+k)}\ 0.7 \\ T \end{array}$$

$k := 1.,1.1..15$