Report from simulation with Terranimo

Date: 27 October 2016

Terranimo version: Danmark

Selected machinery

170 HP tractor

Table 1. Loading characteristics for all wheels of the machine system.

Axle	Manufacturer	Tyre category	Tyre dimension	Wheel load [kg]	Pressure [bar]	Recommended pressure [bar]
Front axle	Michelin	Traction	480/70R24	1300	0.4	0.4
Rear axle	Michelin	Traction	580/70R38	1950	0.4	0.4

See a sketch of the machinery in Appendix 1.

Soil and soil water

You have simulated for a soil with 12.7 % clay content (topsoil, average 0-20 cm) and 485 hPa matric potential in the topsoil. Detailed data for soil texture and soil matric potential are found as tables in Appendix 2.

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The tyre-soil contact area

Table 2. Key figures for the stress distribution in the tyre-soil contact area.

Axle	Contact area [m²]	Mean ground pressure [kPa]	Maximum stress [kPa]
Front axle	0.263	49	101
Rear axle	0.413	46	86

A graph showing the contact area stress distribution for all tyres is displayed in Appendix 3.

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Soil profile stress

The vertical stress right below the center of each tyre is tabulated below. For most tyres and inflation pressures, these data will indicate the highest stresses affecting the soil profile,- at least for soil depths deeper than ~0.3 m.

Table 3. Vertical soil stress (kPa) in a line under the center of the tyre for all tyres on the machinery.

Axle	Soil depth [m]														
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
Front axle	87	65	46	33	24	18	14	11	9	7	6	5	4	4	4
Rear axle	81	67	53	40	31	24	19	15	13	11	9	8	7	6	5

Soil profile strength and stress

Soil compaction will take place if stress exceeds soil strength. A comparison can be made between the two. Severe compaction will occur in case stress exceeds the soil strength significantly.

Table 4. Soil compaction index (SCI) calculated as the log to the ratio of stress and strength (see section 14 in the Terranimo Introduction file).

Axle	Soil depth [m]														
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
Front axle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rear axle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SCI=0: No compaction risk. 0<SCI<0.2: Intermediate compaction risk. SCI>0.2: High compaction risk.

A graph showing the soil profile stress and strength for all tyres is displayed in Appendix 4.

Recommendation

If SCI>0.2 (especially if this is the case for layers deeper than 0.5 m), the intended traffic should not be undertaken. We suggest one or more of the following actions: Change tyre, reduce inflation pressure (primarily affecting stresses in upper soil layers), reduce wheel load (primarily affecting stresses in the deeper soil layers), wait with the intended traffic to soil water content has reduced (which will increase soil strength).

Comments

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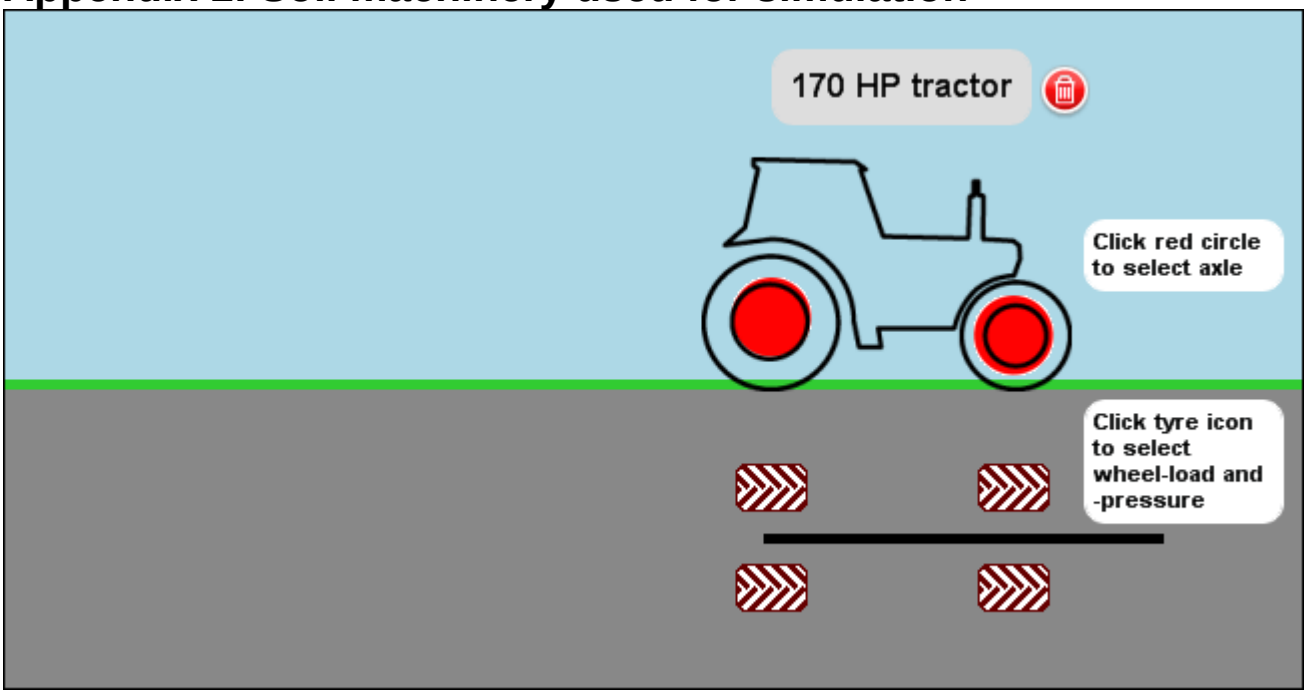
Appendix 1: Soil machinery used for simulation



Appendix 2: Detailed data on texture and water

Soil depth [m]	Clay [%]	Silt [%]	Sand [%]	Organic matter [%]	Bulk density [g/cm3]	Matric potential [hPa]	Soil strength [kPa]
0.1	12.7	25.6	61.7	2.6	1.5	485	122
0.2	12.7	25.6	61.7	2.6	1.5	485	122
0.3	12.7	21.9	65.5	0.5	1.6	485	138
0.4	12.7	21.9	65.5	0.5	1.6	485	138
0.5	12.7	21.9	65.5	0.5	1.6	485	138
0.6	12.7	21.9	65.5	0.5	1.6	485	138
0.7	12.7	21.9	65.5	0.5	1.6	485	138
0.8	12.7	21.9	65.5	0.5	1.6	485	138
0.9	13.3	23.9	62.8	0.2	1.7	485	154
1.0	13.3	23.9	62.8	0.2	1.7	485	154
1.1	13.3	23.9	62.8	0.2	1.7	485	154
1.2	13.3	23.9	62.8	0.2	1.7	485	154
1.3	13.3	23.9	62.8	0.2	1.7	485	154
1.4	13.3	23.9	62.8	0.2	1.7	485	154
1.5	13.3	23.9	62.8	0.2	1.7	485	154

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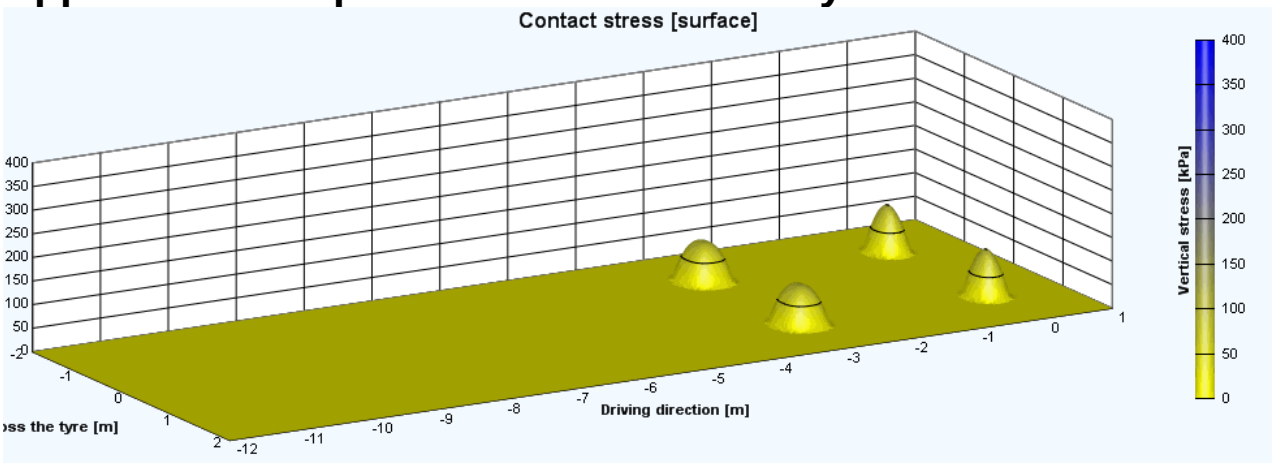
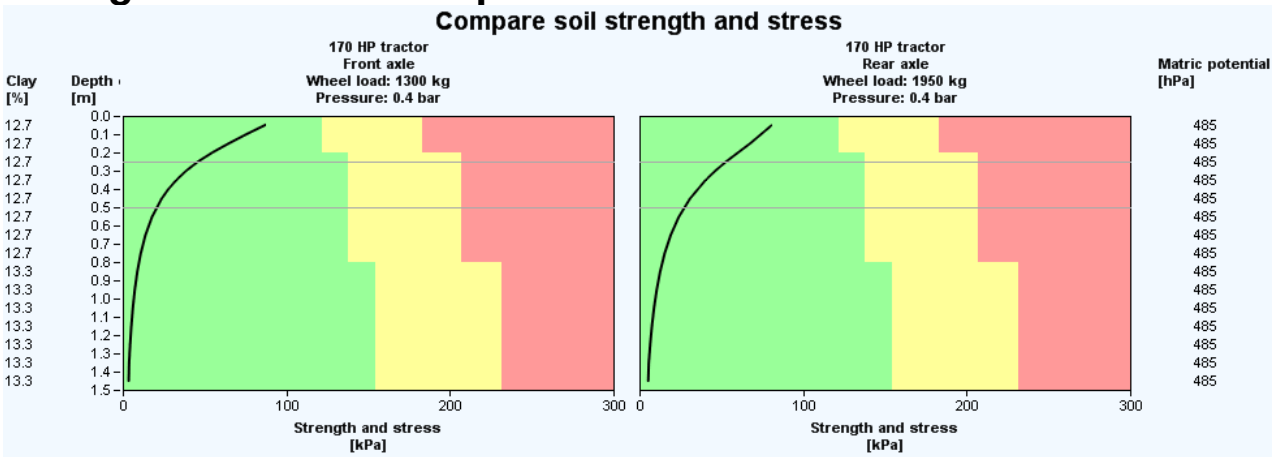
Appendix 3: Graph with stresses in the tyre-soil contact area



Appendix 4: Graph comparing stresses from the wheels with soil strength for all the soil profile



The limit between green and yellow indicates soil strength estimate, and the limit between yellow and red gives strength 50% higher than estimated. Black lines show vertical soil stress.

The intended traffic should not be undertaken if the black line runs within the red area (especially for layers deeper than 0.5 m). We suggest one or more of the following actions: 1) change tyre, reduce inflation pressure (primarily affecting stresses in upper soil layers), 2) reduce wheel load (primarily affecting stresses in the deeper soil layers), and/or 3) wait with the intended traffic to soil water content has reduced (which will increase soil strength).