TRAINING ON ANTAM STANDARD CODE
For TESTING OF KNAPSACK MISTERS CUM DUSTERS

Theory 13: Drawbar performance- Traction terminology

2nd Training of Trainers on ANTAM Codes
16 - 28 October2016, Nanjing China

Functional requirements

as applied to Power Tiller

The basic functions of the tractor can be reduced to the following (Reece 1971)

I. The provision of up to full power in the form of a large drawbar pull, at low speeds. The highly variable loading that occurs in agricultural work requires consideration of tractor performance at part load, particularly with respect to fuel consumption.

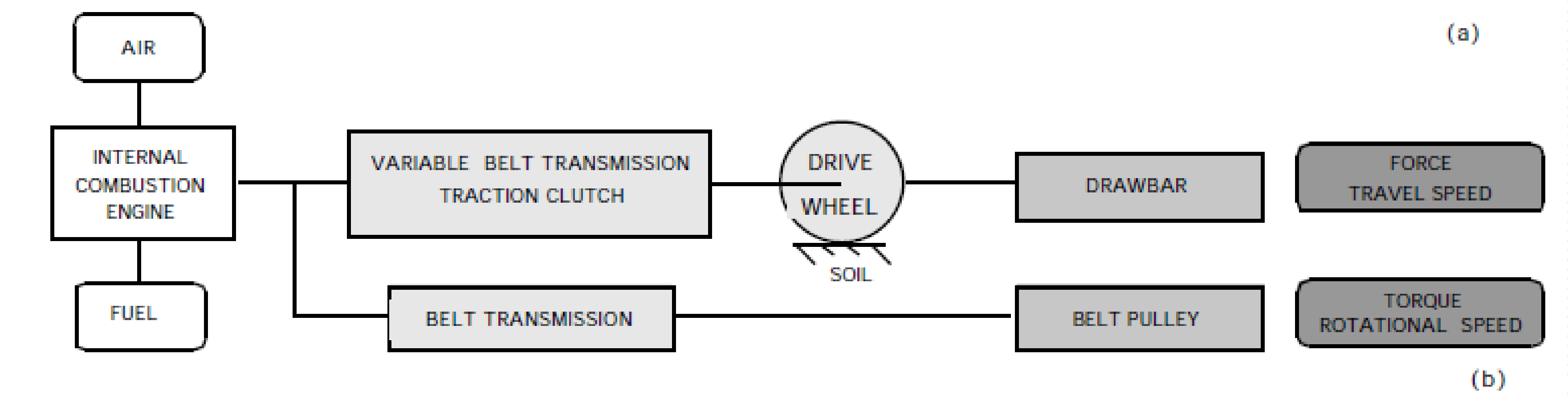
II. The provision of power for driving and control of a range of implements and machines performing various tasks and attached in a variety of ways.

III. The provision of power as the basis for a transport system in both on- and off-road conditions

Performance Limitations

- Since its main function is to pull (or push), the question arises as to how well and within what limits the tractor succeeds in performing those functions. How we might measure and represent that performance is also of interest.
- This output is expressed, as in engineering mechanics, in terms of force (engine torque and drawbar pull), speed (rotational and travel), power (engine and drawbar) and non-dimensional numbers (wheel slip, tractive efficiency).
- The input is performance is expressed in terms of fuel consumption (actual and per unit power output).

Power train of a Power Tiller



Mechanics of Power tiller - Traction

The Power tiller is a machine and the application of the general principles of mechanics to it provides a simple but fundamental understanding of its operation and ideal performance. The actual performance will be less than this, and may be much less, mainly because of the losses which occur at the wheel / ground contact surface.

The introduction to Mechanics of Power tiller will give an understanding of the tractive performance of the power tiller and the issues in testing the tractative performance.

Forward speed- Theoretical

Drive wheel diameter = D ,Engine speed = Ne

Overall transmission ratio q = Engine speed Ne/ Drive wheel speed Nw

Drive wheel rotational speed Nw = Ne / q

Assuming no losses in motion due to slip between the wheel and the surface:

Travel speed, Vo = Linear speed of wheels

$= \pi$ D Nw

$=\pi$ D N e/q

Power transmission system of Power tiller and transmission ratio

- The Power tiller usually has a two stage transmission .
- The first stage is by belt drive from Engine pullie to The pullie of a multi plate dry type clutch
- The common belt used Have a B type section

Calculating the speed ratio of drive

Pitch diameter= Outer diameter-2b

Where b, The difference between outer radius and pitch radius can be taken as

Type A = 3.3mm

Type B = 4.2 mm

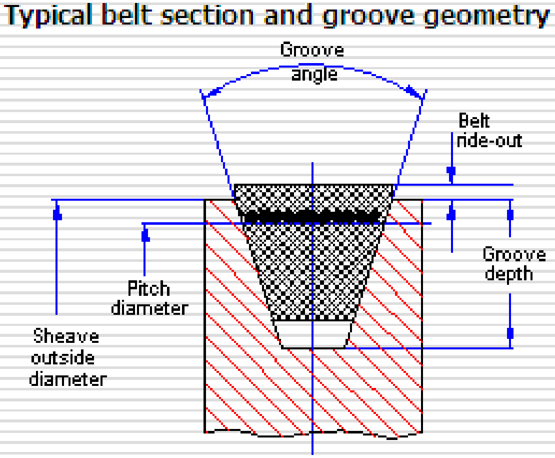
If the Engine speed = Ne

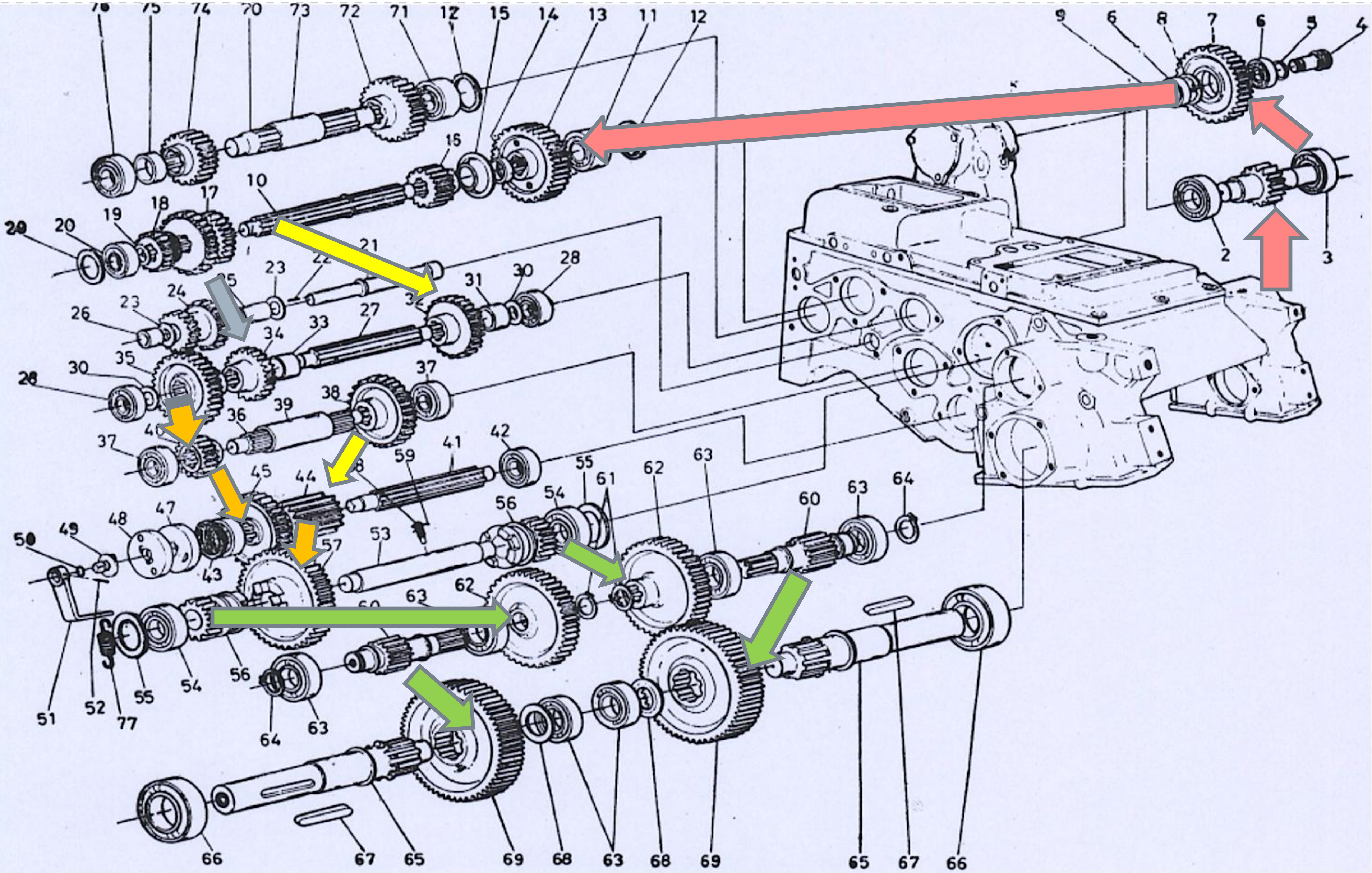
Clutch shaft speed = Nc

Pitch dia of engine pullie = De and

Pitch dia of clutch pullie = Dc

Then ratio of transmission :Ne/ Nc= Dc/De





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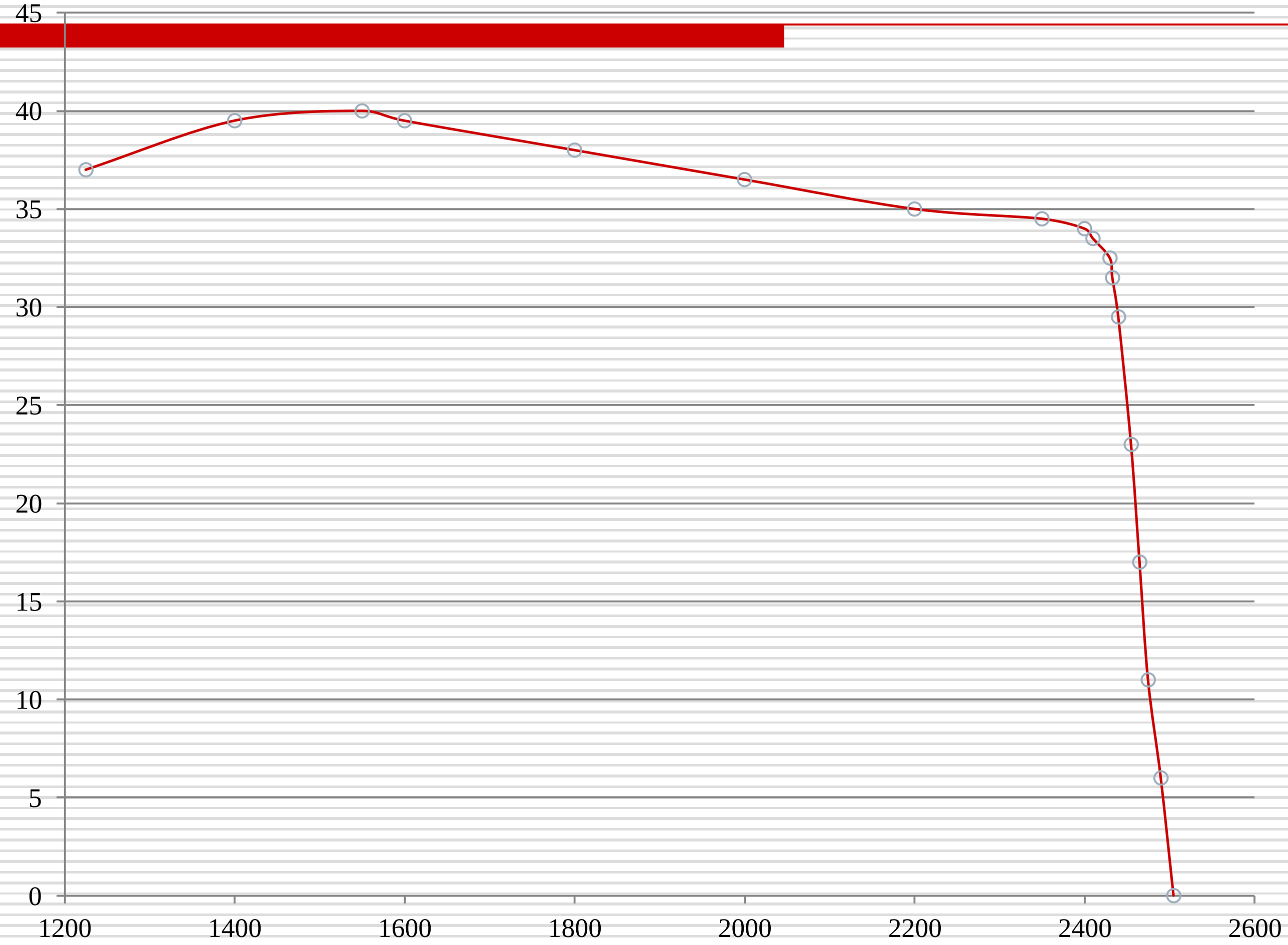
Calculating the Main gearbox transmission ratio Between clutch shaft and Axle shaft

Gear selected	Overall Reduction
Low- I	71.38
Low- II	65.47
Low-III	46.87
High-I	19.01
High-II	17.44
High-III	12.48
Rev-I	83.98
Rev-II	22.37

The overall ratio q can be found from product of the ratio of the belt drive and the multi speed Gear box

The Engine speed torque characteristists



Theoretical Draft

Engine torque = Te

Drive wheel torque, Tw = q Te

Equilibrium requires that this torque is equal and opposite to the moment of the soil reaction, H on the wheel:

$$H \times \frac{D}{2} = T_w = qT_e \qquad H = \frac{2qT_e}{D}$$

If we assume that there are no other horizontal external forces acting (such as rolling resistance), equilibrium also requires that:

Drawbar pull, P = Soil reaction, H

$$P = \frac{2qT_e}{D}$$

Theoretical Power

Engine power, Qe = 2π Te Ne

Drawbar power, Qd = Drawbar pull . travel speed

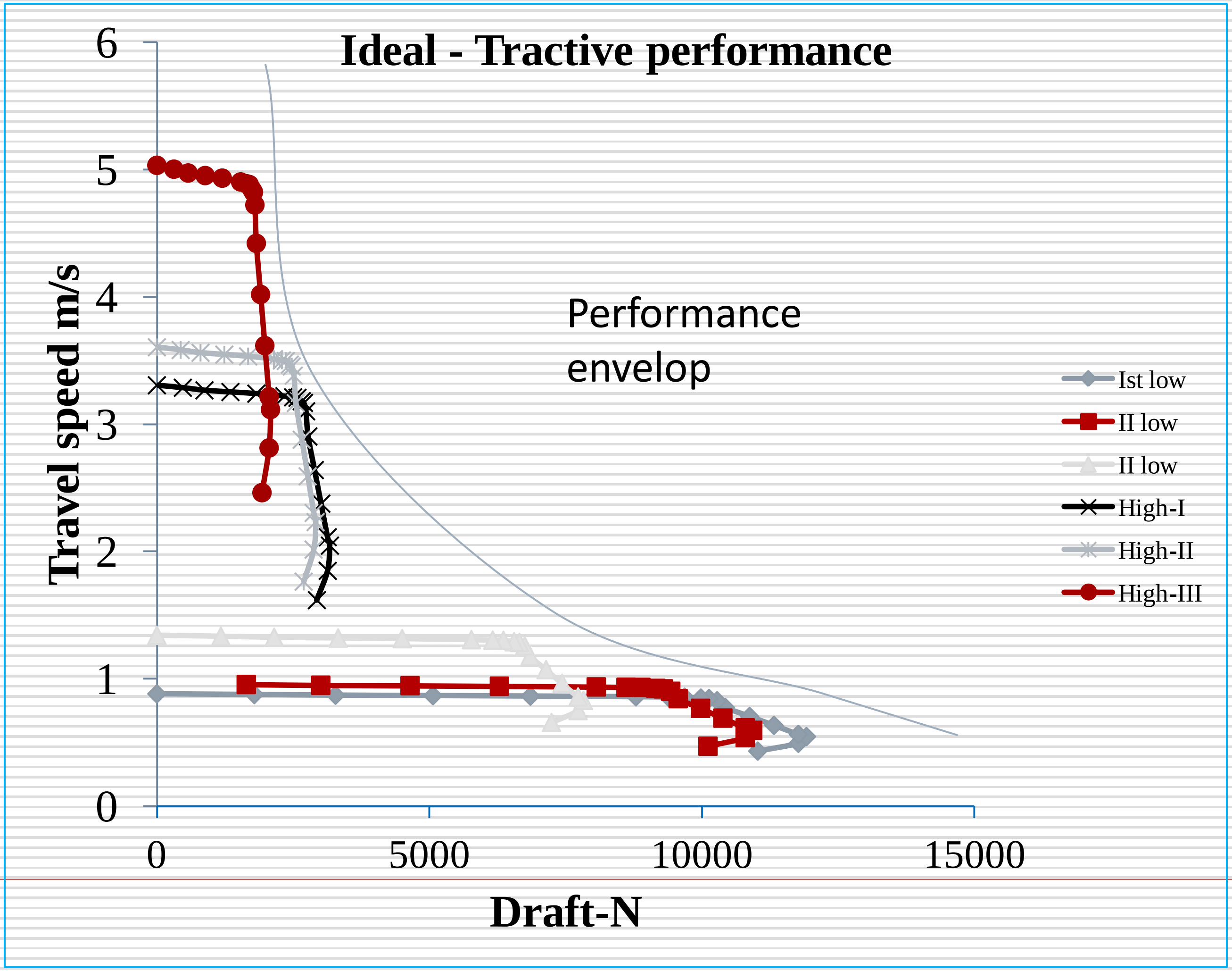
= P . Vo

$$= \frac{2\,q\,T_e}{D} \times \frac{\pi\,D\,N_s}{q}$$

$$= 2\pi T_e N_e$$

= Engine power

Ideal Performance



Inference from Ideal curves

- The Ideal Draft- speed curves give and idea of the maximum power envelop.
- The regions of operation possible are also clearly seen in the plot.
- Due to discrete steps in gear ratios, the Power tiller can only operate in some space within the boundaries
- In Practice, the speed values will be due to slip (Ground slip and slip of friction devices like clutch and belt drive)
- The Draft generated will be reduced due to the tractive efficiency.
- The limiting value of pull due to maximum coefficient of traction will also limit the maximum pull generated.

CONCLUSION

The simple analysis given above suggests that the actual performance of the tractor will reflect the performance of the engine:

(i) travel speed is determined by engine speed

(ii) drawbar pull determines engine torque

(iii) both travel speed and torque also depend on transmission ratio.