(R) Crawler Mounted Hydraulic Excavator Travel Performance

1. Scope—This SAE Standard provides a uniform method for calculating and specifying travel performance characteristics of hydrostatically driven crawler mounted hydraulic excavators as defined in SAE J1057.

2. References

2.1 Applicable Documents—The following publications form a part of this specification to the extent specified herein.

2.1.1 SAE PUBLICATIONS—Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J745 APR87—Hydraulic Power Pump Test Procedures

SAE J746 MAR86—Hydraulic Motor Test Procedure

SAE J872 MAY86—Drawbar Test Procedure for Construction, Forestry, and Industrial Machines

SAE J897 OCT85—Machine Slope Operation Test Code

SAE J1057 JUN81—Identification Terminology of Earthmoving Machines

SAE J1193 NOV84—Nomenclature and Dimensions for Hydraulic Excavators

SAE J1349 JUN85—Engine Power Test Code—Spark Ignition and Diesel

3. Definitions

3.1 General Items

3.1.1 Track gage "V_1" and "V_2," width of crawler track assembly "Y," nominal distance between centerlines of drive sprockets and idlers "J_2," and nominal overall length of track assembly "J_4" as used in this document are defined in SAE J1193, and are specified in millimeters.

3.1.2 Rated engine speed "N_R" as used in this standard is defined in SAE J1349 and is specified in revolutions per minute.

3.1.3 ROLLING RESISTANCE "R_R"—The force, in Newtons, required to sustain track rotation over a given level surface. It includes losses caused by soil deformation, track chain motion and the drive sprocket. For the purpose of developing uniform ratings within this document, a value of 6% of operating weight should be used. This represents a relatively firm soil surface, flexing some under load. "R_R" shall be determined using the following formula:

$$R_R = \left(\frac{6}{100}\right)(W) \quad \text{(Newtons)} \quad \text{(Eq. 1)}$$

where: "W" is the operating weight as defined in 3.2.2.

3.1.4 PITCH RADIUS "R_p"—This dimension shall be the pitch radius of the driving sprockets. It shall be determined using the following formula:

$$R_p = \frac{(P)(n)}{2\pi} \quad \text{(millimeters)} \tag{Eq. 2}$$

where: "P" is the track chain pitch in millimeters and "n" is the number of track chain pitches advanced past any fixed point on the machine during one revolution of the sprocket. Pitch radius is specified in millimeters.

3.1.5 TRAVEL MOTOR TORQUE "T_M"—Maximum output torque, in Newton-meters, of each hydraulic drive motor, at working hydraulic pressure differential and with output shaft rotating as determined according to SAE J746.

3.1.6 HYDRAULIC PUMP DELIVERY "Q_P"—Combined output flow, in liters per minute, with engine at "rated engine speed," of all pumps supplying oil to hydraulic travel motors, as determined according to SAE J745, and at the hydraulic pressure differential required to sustain travel motion on a level surface having a "rolling resistance" equal to that specified in 3.1.3.

3.1.7 TRAVEL MOTOR SPEED "S_M"—Output shaft rotational velocity, in revolutions per minute, as determined according to SAE J746, at the hydraulic pressure differential required to sustain travel motion on a level surface having a "rolling resistance" equal to that specified in 3.1.3, and with "Q_P" divided appropriately among the travel motors.

3.1.8 GEAR EFFICIENCY "E_R"—Proportion of power, expressed as a percentage, transmitted through the total gear system. For the purpose of developing uniform ratings within this document, an efficiency of no greater than 98% should be used for each set of gears. "E_R" shall be the multiple of all individual gearset efficiencies.

3.1.9 GEAR REDUCTION RATIO "R_G"—The total gear reduction ratio between travel motor output shaft and sprocket drive shaft.

3.2 Operating Mass and Weight

3.2.1 Operating Mass "M" shall be the total mass, specified in kilograms, of a machine equipped as specified in 4.1 and ready to perform its intended function, including all working equipment and tools, a 75 kg allowance for an operator, full fuel tank, but not including any load in the bucket or other tool. Also included is the mass of all oils and greases necessary to fill oil reservoirs and lubrication compartments to the specified levels.

3.2.2 Operating weight (W) is specified in units of force, Newtons, where:

$$W = 9.807\,M \quad \text{(Newtons)} \tag{Eq. 3}$$

3.3 Rated Travel Speed

3.3.1 Travel Speed "S_N" at Rated Engine Speed "N_R" for hydrostatically driven excavators shall be determined using the following formula, and is specified in kilometers per hour:

$$S_N = \frac{(0.00012\pi)(S_M)(R_p)}{R_G} \quad \text{(kph)} \tag{Eq. 4}$$

3.4 Rated Drawbar Pull

3.4.1 Rated Drawbar Pull "DBP" for hydrostatically driven excavators having two travel motors shall be determined using the following formula, and is specified in Newtons:

$$DBP = \frac{(2000)(T_M)(R_G)(E_R/100)}{R_p} - R_R \quad \text{(Newtons)} \tag{Eq. 5}$$

Appropriate adjustments must be made to Equation 5 for machines having other than two travel motors.

3.5 Average Ground Pressure

3.5.1 Average Ground Pressure "P_G" shall be determined using the following formula, and is specified in kilopascals:

$$P_G = \frac{(500)W}{(Y)[J_2 + 0.35(J_4 - J_2)]} \quad \text{(kPa)} \qquad \text{(Eq. 6)}$$

This formula makes allowance for some penetration into the supporting soil surface, and the resulting increase in support area.

3.6 Turnability Index

3.6.1 Turnability Index "T" shall be determined using the following formula, and is specified as a dimensionless number:

$$T = \frac{(OTP) \; (V_1 \text{ or } V_2)}{W(J_2)} \qquad \text{(Eq. 7)}$$

where: OTP = One Track Pull (in Newtons) (Maximum Track Pull that can be produced by one track while turning excavator, generally one half of DBP for hydrostatically driven excavators).

3.6.2 On machines where track gage "V_1" and "V_2" can be retracted or extended, the position(s) used for calculation of "Turnability Index" shall be specified.

3.6.3 Published "Turnability Index" values must be accompanied by a statement which acknowledges that the actual ability to turn will vary depending on track shoe type and size and surface condition.

3.7 Drawbar Pull to Weight Ratio

3.7.1 Drawbar Pull to Weight Ratio "D_W" shall be determined using the following formula, and is specified as a dimensionless number:

$$D_W = \frac{DBP}{W} \qquad \text{(Eq. 8)}$$

3.8 Gradeability

3.8.1 Gradeability "G_A" is the calculated tangent of the slope expressed as a percent, independent of surface conditions, that the hydraulic excavator can negotiate based on Rated Drawbar Pull "DBP" and Operating Weight "W." It is determined using the following formula:

$$G_A = [\tan (\arcsin \frac{DBP}{W})] \; (100) \qquad \text{(Eq. 9)}$$

3.8.2 If "Gradeability" of the excavator is limited by factors other than surface conditions and Rated Drawbar Pull, such as engine lubrication, steering, braking ability, stability, etc., the manufacturer shall specify the lower "Gradeability" value and its cause. Determination of other limiting factors should be based on SAE J897.

4. Conditions

4.1 The equipment on the basic excavator shall be specified by the manufacturer and shall be the same as that used for "Rated Lift Capacities," "Rated Digging Forces," range diagrams, and other standard specifications.

4.2 **Permissible Variations**—Because of the large number of attachment options and machine variations available, the manufacturer shall specifically state which machine configuration(s) are included in the specifications. Variations causing changes of "Operating Mass," "Rated Travel Speed," "Rated Drawbar Pull," "Turnability Index," "Drawbar Pull to Weight Ratio," "Ground Pressure," or "Gradeability" in excess of 5% will require additional specifications.

4.3 For machines having more than one speed range (i.e., two-speed hydraulic motors, series-parallel method of combining pump flows, etc.), the manufacturer shall specify "Rated Travel Speed" and "Rated Drawbar Pull" for each speed range. Published "Turnability Index," "Drawbar Pull to Weight Ratio," and "Gradeability" values must be identified with their corresponding speed ranges.

4.4 The manufacturer must be able to verify the published "Operating Mass" within ±5% by actual measurement. The manufacturer must also be able to verify published "Rated Travel Speed" and "Rated Drawbar Pull" specifications by actual tests. Test values for any new machine must exceed 95% of published values. Tests are to be made in accordance with SAE J872 and rolling resistance shown in 3.1.3.

4.5 This document acknowledges that actual travel performance will vary depending on track shoe type and size and surface conditions, and that the defined characteristics are representative values for comparative purposes. Travel speed and drawbar pull are interdependent characteristics, with "Rated" values in this document being defined as the maximum of each, thus the two do not occur simultaneously.

4.6 The tolerances in this document are the sum of the actual deviations plus the measuring error.

5. Notes

5.1 Marginal Indicia—The (R) is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

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