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Materiel Test Procedure 2-2-706*
Aberdeen Proving Ground

U. S. ARMY TEST AND EVALUATION COMMAND
COMMON ENGINEERING TEST PROCEDURE

TRACTION DEVICES

1. OBJECTIVE

The objective of this procedure is to determine the increased mobility given to vehicles over adverse terrain by traction devices and the durability of the traction device.

2. BACKGROUND

Traction devices are essentially accessory equipment for wheeled vehicles, designed to permit crossings of otherwise impassable terrain. Tire chains are the simplest and best known of such accessories. These appliances give added mobility and traction to vehicles operating over adverse terrain.

Most traction devices consist of a series of grousers fastened around the wheels by a system of connectors. Connector designs may vary from simple cables or chains to special arrangements. Grousers are usually constructed of welded metal sections, occasionally equipped with rubber pads, that may be secured around individual tires or may encircle a pair of wheels on tandem axles. The performance of traction devices is measured by drawbar pull tests.

3. REQUIRED EQUIPMENT

a. Control and Test Vehicles
b. Tools Required for Installation/Removal of Test Item
c. Tow Cables
d. Applicable Payloads
e. Cameras with Film (still and motion)
f. Weighing Scales
g. Tachometers
h. Dynamometers
i. Fifth Wheel
j. Test Roads
    1) Paved highway
    2) Improved roads
        a) Gravel
        b) Hard surface
    3) Level, moderately rough cross-country
k. Slipmeter or Sprocket or Wheel Counter

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4) Rough hilly terrain including:

a) Sharp turns
b) Slopes up to 30 percent

5) Marsh
6) Freshly tilled soils
7) Heavy turf

4. REFERENCES

A. MTP 2-2-604, Towing Resistance
B. MTP 2-2-619, Off-Road Vehicle Mobility Test

5. SCOPE

5.1 SUMMARY

The following procedures, using identical vehicles, which evaluate the ease of handling, effectiveness and durability of the test item, and compare it with a standard, similar traction device, are described in this MTP:

a. Installation - A study to determine ease with which, and the personnel required, the test item can be installed on an appropriate vehicle.

b. Preliminary Operations - A study to determine if the test item causes interference with, or damage to, the test vehicle.

c. Mobility - A study to determine the effectiveness of the test item in affording traction to the test vehicle when traversing adverse terrain by comparing the performance of a vehicle without traction devices to the performance of a vehicle with the test item installed.

d. Durability and General Mobility - A study to evaluate the ability of the test item to operate for a minimum number of miles over specific types of terrain, and a determination of its merits as compared with a standard traction device of similar style.

5.2 LIMITATIONS

None

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Inspection

Visually inspect the test item and record the following:

a. Type of traction device
b. Manufacturer
c. Surface imperfections

6.1.2 Physical Characteristics

Determine and record the following test item characteristics, as applicable:

a. Constructional features
b. Weight

1) Complete set of test items required for applicable vehicle
2) Unit weight of one test item (grousers and connector)
3) Gross weight of one test item and accessories, such as spreaders

c. Volume required to store complete set of test items and accessories
d. Shape and size of grousers
e. Guide system used
f. Special devices used for lateral stability

6.1.3 Assembly

Assemble the test item and record the following:

a. Methods of assembly
b. Adjustments made
c. Number of personnel required
d. Time required
e. Other details deemed appropriate
f. Adequacy of instructions

6.1.4 Vehicle (Test and Control)

6.1.4.1 Vehicle Preparation

a. Engine and transmission shall be prepared for maximum performance (properly tuned per individual vehicle specification).
b. All pertinent adjustments, such as brakes, throttle linkage, tire inflations, ignition timing, etc. shall be made to comply with specifications.

6.1.4.2 Instrumentation

Instrumentation used shall cover the following: drawbar, speed-measuring fifth wheel, engine tachometer, sprocket or wheel counters, slipmeter, thermocouples, manifold pressure gage, and temperature and pressure indicators.

6.1.4.3 Restrictions

a. Test shall be suspended when vehicle performance, both test and control, is subnormal unless caused by meteorological conditions.

NOTE: Atmospheric pressure, for instance, has a direct bearing on engine performance but is regarded as a test variable for which corrections can be made.

b. No test data shall be recorded until the test and control vehicles have been operated until component temperatures have been stabilized as required for normal operation.

6.2 TEST CONDUCT

6.2.1 Installation

NOTE: Installation operations shall be repeated five times for each test item.

Perform the following:

a. Mount the traction device on a test vehicle and determine the following:

1) Ease of operation
2) Time required
3) Number of personnel required
4) Overall dimensions of an individual assembly as installed
5) Special tools required
6) Adequacy of instructions

NOTE: Start from the stowed position and finish with the final adjustments. Vehicle shall be resting on a hard surface. Same crew will repeat each operation.

b. Photograph vehicle showing traction device installed.
c. Dismount the traction device and determine the following:

1) Ease of operation
2) Time required
3) Number of personnel required
4) Special tools required
5) Adequacy of instructions

NOTE: Stowage of traction device will complete dismounting operation.

6.2.2 Preliminary Operations

Mount the test item on an appropriate test vehicle and record the following:

a. Type and model of test vehicle
b. Tire size

6.2.2.1 Unloaded Condition Operation

a. Operate the vehicle a minimum of five miles over a smooth hard surfaced paved road and record the following:

1) Minor interferences between the test item and vehicle
2) Corrective action taken to eliminate interferences

NOTE: Major interferences are sufficient cause for suspension of the test pending guidance from the directing agency.

b. Operate the vehicle a minimum of five miles over rough terrain (see paragraph 6.2.4.f.2) and record the following:

1) Minor interferences between the test item and vehicle
2) Corrective action taken to eliminate interferences
3) Effects of the test item on vehicle suspension system

6.2.2.2 Loaded Condition Operation

a. Repeat steps 6.2.2.1.a and 6.2.2.1.b with the test vehicle loaded to its rated cross-country payload.
b. Record the payload.

6.2.3 Mobility Tests

Determine the effects of the test item on vehicle traction and soil trafficability as follows:

a. Ready a test vehicle and control vehicle for mobility tests by preparing the vehicles as described in paragraph 6.1.4.1 and instrumenting them as described in paragraph 6.1.4.2.

NOTE: The test and control vehicles shall be identical in type and model.

b. Install the test traction device on the test vehicle.
c. Load the vehicles with their normal payload or combat weight.

6.2.3.1 Traction

a. Perform drawbar pull tests, using the criteria of MTP 2-2-604, on the various types of terrain listed in MTP 2-2-619, and including prepared soil (mud), dry dune sand, snow, marsh, and prepared soil slopes, with the vehicle's engine operating at constant speed in its lowest gear.

NOTE: The test and control vehicles will not be operated over or across each others tracks.

b. Record the following for each vehicle and type of terrain:

1) Terrain data as described in MTP 2-2-619
2) Drawbar pull
3) Slip

NOTE: Slip can be determined directly by using a slipmeter on vehicles using standard gearbox transmission; however, in the case of hydraulic transmissions, speed counters are necessary.

4) Engine speed
5) Wheel revolutions
6) Distance travelled
7) Depth of penetration
8) Vehicle weight

6.2.3.2 Trafficability

a. Operate the test and control vehicle over the following types of terrain for a minimum of 1/4 mile:

1) Freshly tilled soil (to a depth of 6 inches)
2) Heavy turf
3) Marsh area having thick vegetation such as vines and grass

NOTE: The test and control vehicles will not be operated over or across each others tracks.

b. Have each vehicle retrace the path for a minimum of 5 round trips.
c. Record and photograph the trafficability of the terrain at the completion of the test.

6.2.4 Durability and General Mobility Tests

Determine the ability of the test item to operate, for 500 miles over various cross-country courses and hard surfaced roads, as well as or better than a standard traction device similar to the test item, as follows:

a. Prepare test and control vehicles as described in paragraph 6.1.4.1. A minimum of three test vehicles and three control vehicles is desirable.

NOTE: 1. The test and control vehicles shall be identical in type and model.

2. Tire inflation pressures may be reduced if it has been found that reduced pressure improves mobility.

b. Instrument the test vehicles and control vehicles to determine vehicle speed and engine RPM using the appropriate instrumentation of paragraph 6.1.4.2.
c. Install the test items on each test vehicle.

d. Install a new standard traction device, similar to the test item, on each control vehicle, and record the type.

e. Load the vehicles with their normal payload or combat weight.

f. Operate the test and control vehicles over the following durability phase courses:

NOTE: Half the mileage for each durability phase shall be operated with the test/control vehicles rated cross-country towed load.

1) Phase I - A course consisting of 50 miles of operation in severe mud conditions typical of swamp and marshes. The types of mud involved should vary to include tough cohesive mud, mud with free water, and soft terrain with a heavy mat of vegetation. The severity of this terrain should limit maximum vehicle speed to 5 to 10 miles per hour.
2) Phase II - A course consisting of 150 miles of operation over rough hilly terrain having sharp turns and slopes up to 30 percent. Surfaces should contain various mixtures of muddy clay and loam with moderate amounts of stone; the course should be sufficiently severe to limit speeds to 15 miles per hour.
3) Phase III - A course consisting of 200 miles of operation on level, moderately rough, cross-country terrain having little or no stone. This course should be muddy and sufficiently difficult to limit maximum speed to 15 to 20 miles per hour.
4) Phase IV - A course consisting of 100 miles of operation on improved roads, evenly divided between gravel and hard surface. Alternation shall be made at least every two miles. Operating speeds must be high enough to exceed the critical vehicle vibration point but are ordinarily limited by the ability of the traction device to follow tire rotation during acceleration and deceleration.

g. Perform the following during step f:

1) Visually inspect the traction devices (test and standard) at the completion of the first five miles of operation in each durability phase. Record and photograph any deficiencies noted.
2) Inspect the vehicles and traction devices after each 25 miles of operation. Record and photograph all signs of excessive wear and/or damage.
3) Measure and record the vehicles (test and control) speed and RPM during all phases of the durability test.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Inspection

Record the following for each test item set:

a. Type of traction device (chains, etc.)
b. Manufacturer
c. Surface imperfections

6.3.1.2 Physical Characteristics

Record the following:

a. Constructional features (steel with cleats, rubber covered without cleats, etc.)
b. Weight, in pounds of:

1) Complete set of test item
2) Unit weight of one test item (grousers and connectors)
3) Gross weight of one test item and accessories

c. Volume in cubic inches required to store:

1) Complete set of test item
2) Accessories

d. Shape and size of grousers
e. Guide system used
f. Special devices used for lateral stability

6.3.1.3 Assembly

Record the following:

a. Methods of assembly
b. Adjustments made
c. Personnel required
d. Time required, in minutes
e. Other details pertaining to assembly
f. Adequacy of instructions

6.3.2 Test Conduct

6.3.2.1 Installation

Record the following for each test conducted:

a. Test number

b. For mounting operations:

1) Ease of operation
2) Time required, in minutes
3) Personnel required
4) Overall dimensions of an individual assembly, in feet and inches
5) Special tools required, if applicable
6) Adequacy of instructions

c. For dismounting operations:

1) Ease of operation
2) Time required, in minutes
3) Personnel required
4) Special tools required, if applicable
5) Adequacy of instructions

d. Retain photographs of installed traction device.

6.3.2.2 Preliminary Operations

Record the following:

a. Road condition (hard surface, rough cross-country)
b. Vehicle condition (loaded, unloaded)
c. Interferences noted
d. Corrective action taken
e. Test item effect on vehicle suspension system

6.3.2.3 Mobility Tests

Record the following for each vehicle:

a. Use (test or control)
b. Type and model
c. Manufacturer
d. Serial number
e. Payload/combat weight, in pounds

6.3.2.3.1 Traction -

Record the following for each vehicle:

a. Use (test or control)
b. Type of terrain (mud, snow, etc.)
c. Terrain data as recorded and collected as described in MTP 2-2-619
d. Drawbar pull, in pounds
e. Slip in percent
f. Engine speed, in rpm
g. Wheel revolutions

h. Distance travelled, in feet
i. Depth of penetration, in inches

6.3.2.3.? Trafficability

a. Record the following for each vehicle:

1) Use (test or control)
2) Type of terrain (tilled soil, turf, etc.)
3) Number of round trips
4) Terrain trafficability (ruts, holes, matted, etc.)

b. Retain photographs of terrain.

6.3.2.4 Durability and General Mobility

a. Record the following for the standard traction device:

1) Type (chain, etc.)
2) Manufacturer
3) Constructural features (with cleats, rubber covered cleats, etc.)

b. Record the following for each vehicle:

1) Use (test or control)
2) Vehicle test number (1, 2. or 3)
3) Type and model
4) Manufacturer
5) Serial number
6) Payload/combat weight, in pounds

c. Record the following during the test for each vehicle test phase and traction device:

1) Vehicle use (test or control)
2) Vehicle test number (1, 2, or 3)
3) Test phase (I, II, III or IV)
4) Traction device deficiencies at the completion of five miles of each test phase
5) For each 25 miles of travel:

a) Miles travelled
b) Deficiencies, if any, for:

(1) Traction device
(2) Vehicle

d. Retain vehicle speed versus engine rpm records.
e. Retain all photographs taken.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Mobility Tests

Mobility test data shall be presented in the form of curves as follows:

a. Drawbar pull, in pounds, vs. percent slip
b. Drawbar pull, in percent of vehicle weight, vs percent slip

for the test and control vehicle on each type of test terrain.

6.4.2 Durability and General Mobility Tests

a. Data shall be presented in chart form indicating deficiencies and/or damages incurred by the vehicles and traction devices (both test and standard), the type of terrain causing the most extensive damage, and the miles travelled when damage occurred.

b. Engine rpm vs. vehicle speed for the individual vehicles and traction devices shall be presented in graphic form for each type of test devision.