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CROSSCOUNTRY MOBILITY OF THE M-60 TANK

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The Army's present mainstay of the Armor Force, the M-60 main battle tank, has the ability to ascend or descend a 60% slope. This is fine, but what does this mean to you? What in reality is a 60% slope? How was the ability of the M-60 tank to negotiate a 60% slope determined? Under what conditions was the ability of the M-60 tank determined?

The purpose of this article is to show you, the reader, how the gradeability of the M-60 tank was determined. However, before we discuss this, let us first define slope and also discuss a method for determining slope.

Webster says a slope is, "The degree of deviation from the horizontal or perpendicular." Field Manual 21-26 says that "The rate of rise or fall of a ground form is known as its slope." Slope can be expressed as steep or gentle but the question arises as to how steep or how gentle. Slope may be expressed in several ways; however, all of them are dependent upon a comparison of vertical distance to horizontal distance. Vertical distance is the difference in elevation between the highest and lowest elevation of the slope. Horizontal distance is the measured ground distance between the highest and lowest elevation of the slope. The percentage of slope may be derived at by dividing the vertical distance of the slope by the horizontal distance of the slope.¹

1 FM 21-26, Map Reading, p. 68

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Now let us discuss the purpose of testing the M-60 tank, who conducted the tests, how and under what conditions the tests were conducted, and where some of the tests were conducted.

Purpose of Tests

The gradeability of a track vehicle is a measure of its capabilities for operating on slopes. Ordnance specifications require that combat vehicles be able to negotiate a 60% grade of smooth, dry concrete in both forward and reverse gears. They must also be able to brake adequately on this same grade. In addition, it is desirable to learn the performance of the vehicle on both 60% and lesser grades to determine the speeds which can be attained on more realistic grades.

Agencies Conducting Tests

Two of the agencies conducting tests on the M-60 tank were, the United States Army Test and Evaluation Command, Aberdeen Proving Ground, Maryland, and, the United States Army Armor Board, Fort Knox, Kentucky.

How Tests Were Conducted

Vehicle Requirement: Prior to the tests, the M-60 tank was in condition for optimum performance, with particular attention given to the engine, transmission, brakes and running gear. The vehicle was loaded with its combat weight, complete with a full crew.

Test Conditions: Standards for gradeability and side slope performance of track vehicles are prescribed by the Ordnance Proof Manual 60-80, Aberdeen Proving Ground, Maryland.² Track vehicles must be

² Ordnance Proof Manual 60-80, 27 September, 1960, pp. 1-5

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capable of operating in any tactical situation without relying upon established roadways. The evaluation of the gradeability of a vehicle on calibrated grades provides a means for determining the tractive ability of the vehicle crosscountry.

The artificial slopes, ordinarily used in testing the M-60 tank, include a 30%, 40%, 50% and 60% concrete grade. The sustained speed of a pilot model vehicle is usually determined by bringing the vehicle to a maximum slope speed from a standing start at the foot of the grade. The necessary trials are made to assure use of the optimum gear or range for maximum performance on a given grade. Maximum reverse speeds are measured on the steeper grades when appropriate; but, in any case, maximum gradeability (up to 60%) in reverse is determined.

The braking system should be capable of stopping and holding the M-60 tank in both forward and reverse directions on the 60% slope. While the tank is being held on the 60% slope, engine checks are made as prescribed.

It is necessary to ascertain the minimum fuel supply required to ascend or descend a 60% slope. The test is conducted by placing the M-60 tank on the 60% slope with only sufficient fuel as has been previously determined as necessary for level road operation. If the engine does not start or perform satisfactorily, fuel is added, in five-gallon increments, until engine performance is normal.

The standard military requirements for side slope operation for the M-60 tank is to successfully negotiate 25% grades. Not only should the M-60 tank be easily kept under full control at the specified angle

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at reasonable speeds, but, the engine should perform at idling speeds as required.

A special test was made on the M-60 tank to determine its proficiency on different type terrain. The test was the limited mobility test conducted in the sand dunes of southern California.³ The objective of this test was to determine the maximum gradeability, average speed, fuel consumption, and any performance characteristics which might be peculiar to soft, rolling sand dunes. Maximum gradeability was determined by attempting to ascend various measured slopes (longer than one vehicle length) from a standing start. The M-60 tank easily climbed slopes of 35% and 36%, but because of track slip or transmission stall, slopes of 38% could not be ascended in a single attempt. Average speeds in the rolling sand dunes varied from 7.6 MPH to 11.5 MPH during runs from 6.7 to 13.7 miles in length. Fuel consumption varied from 0.309 to 0.363 MPG during the same runs.

An additional test to determine the crosscountry mobility characteristics of the M-60 tank was performed by the United States Army Armor Board, Fort Knox, Kentucky. During this test, which was test number three, crosscountry mobility,⁴ the M-60 tank was operated over various crosscountry courses, including both rough, hilly, wooded terrain and open, rolling country under various weather and course conditions. In addition, the M-60 tank was operated over various types of crosscountry terrain features to determine crosscountry

³ D&PS Manual, Aberdeen Proving Ground, Md., DFS/OTA-174, p. 9

⁴ Test 3, US Army Armor Board Test Manual, 22 April, 1963
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mobility characteristics which may not have become evident in testing on established crosscountry courses.

The M-60 tank was first operated over muddy and then over dry crosscountry courses containing various longitudinal and side slopes, hills, natural hogbacks, open and rolling terrain, ditches, embankments, log obstacles, stumps, trenches, clay, rocks, sand, through timber and brush, through close woods, and, on winding narrow trails.

The M-60 tank was then driven up and down, backed up and down, and, held stationary headed up and down various longitudinal slopes not exceeding 60%. After this test, the M-60 tank was driven forward and turned in various directions, first on dry and then on muddy dirt side slopes not exceeding 40%.

The mobility tests for the M-60 tank discussed in this article were basically conducted under conditions you will not have when you put your M-60 tank to test with your life at stake. The fact that the M-60 tank has the ability to ascend or descend an established concrete 60% slope means very little to you except that it sets a standard for track vehicles. However, the fact that the M-60 tank could maneuver the crosscountry mobility test conducted by the Armor Board gives us the assurance that our equipment is qualitatively superior to that of any potential enemy, thus enabling our Army to carry out its national security missions with maximum effectiveness, in any environment, and under all conditions of war.

BIBLIOGRAPHY

1. FM 21-26, Map Reading (Department of the Army, 1960).
2. Ordnance Proof Manual 60-80, Volume 11, Automotive Testing, Aberdeen Proving Ground, Maryland, 1960.
3. Development and Proof Services Manual, DFS/OTA-174, Aberdeen Proving Ground, Maryland.
4. United States Army Armor Board Test Manual, Test Three, 22 April, 1963, US Army Armor Board, Fort Knox, Kentucky.

BIOGRAPHY

Capt. Tom H. Gann, Sig C, was commissioned in the Army National Guard in 1955. He completed the Signal Officer Basic Course in 1957. After completion of the Associate Armor Officer Career Course, he will return to his present assignment as Assistant Training Officer for the 48th Armored Division Support Command, Georgia Army National Guard.

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AIBKAS-GS

Date 11 Jan 1964

SUBJECT: Submission of "Article for Publication"

TO: Director
General Subjects Department
US Army Armor School
Fort Knox, Kentucky

1. In accordance with para 1, Annex A to Supplemental Material, Orientation On Writing Projects (GDD.C30101), enclosed is my article for publication.

2. In the preparation of my article, I have followed the requirements as outlined in the afore-referenced Annex A. Further, I have included a biography of myself as well as a bibliography of all sources which I used in the preparation of my article.

3. My article is submitted to you as a complete article.

Tom H. Gann

(Signature)

Tom H. Gann

(Typed Full Name)

Captain

(Rank)

Sig C

(Branch)

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(Class)