T H E S I S

TESTS WITH RECORDING TRACTION DYNAMOMETER TO DETERMINE PULL OF DIFFERENT LOADS ON ROADS OF DIFFERENT GRADES AND SURFACES.

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The traction dynamometer which was designed by Messrs. Faris and Ramsey in 1906, underwent two tests; the first being made on the two large helical springs by the designers. They proceeded with their test by first testing each spring separately in the Riehle' Testing Machine, by increasing the load by 100 lbs. steps and measuring the corresponding deflections, until the load reached 2500 lbs. Their results showed that one spring was approximately ten percent stronger than the other. In order that the two springs might always have an equal deflection, they made the arm against which the stronger spring was to press, approximately one-tenth shorter than the other. They now completed the test by testing the springs together when they were assembled in their frame. The loads were increased by 250 lbs. steps up to 5000 lbs., but the mean deflections of the two springs were not constant for each 250 lbs. increase of load, although they were nearly all within ten percent of the average deflection. Their data of the test is given below:

Loads	Deflections of strong spring	Deflections of weak spring
250#	.122"	.128"
500#	.129"	.130"
750#	.118"	.123"
1000#	.105"	.102"
1250#	.107"	.109"
1500#	.114"	.114"
1750#	.149"	.144"
2000#	.100"	.095"
2250#	.112"	.110"
2500#	.125"	.113"
2750#	.114"	.112"
3000#	.110"	.104"
3250#	.104"	.104"
3500#	.116"	.116"
3750#	.109"	.105"
4000#	.109"	.105"
4250#	.106"	.107"
4500#	.107"	.106"
4750#	.112"	.110"
5000#	.114"	.113"
Total	2.282	2.250

The average deflection for each 250 lbs. was .113". From this result they designed the dynamometer so that for each 500 lbs. pull, the pencil would be displaced one inch.

The object of our test was to calibrate the machine after all parts were assembled. This was done by chaining the rear draw bar to a tree and fastening the front draw bar to another tree by a differential pulley block with a spring balance inserted between the draw bar and pulley block. The load was increased or decreased by 250 lbs. steps up to, or from, 2000 lbs. and the corresponding displacements of the pencil were recorded.

Our data of the test, which is given below shows that all the average deflections of the up and down readings of the pencil are not off more than four percent, except the first which is off 13.3%.

First Test.

Increasing load	Displacement of pencil	Decreasing load	Displacement of pencil
0#	0	2000#	3-52/64"
250#	25/64"	1750#	3-32/64"
500#	58/64"	1500#	3-oo/64"
750#	1-32/64"	1250#	2-30/64"
1000#	1-60/64"	1000#	2-oo/64"
1250#	2-28/64"	750#	1-34/64"
1500#	2-60/64"	500#	1-1/64"
1750#	3-24/64"	250#	32/64"
2000#	3-52/64"	0#	0

Second Test.

0#	0"	2000#	3-54/64"
250#	24/64"	1750#	3-28/64"
500#	1-oo/64"	1500#	3-oo/64"
750#	1-32/64"	1250#	2-30/64"
1000#	1-60/64"	1000#	2-oo/64"
1250#	2-28/64"	750#	1-32/64"
1500#	2-60/64"	500#	1-oo/64"
1750#	3-26/64"	250#	30/64"
2000#	3-54/64"	0#	0"

Tests made on roads with Recording

Traction Dynamometer.

The object in these tests was to determine the pull of certain loads on dry and muddy roads of different grades and surfaces. The following roads were selected on which the tests were to be made; the road that leads from shops to East college entrance oiled road (Manhattan Avenue) from East college entrance to Fremont street; Fremont street from South end of oiled road to 9th street; South on 9th street to Leavenworth street; East on Leavenworth street to 2nd street; South on 2nd street to Humbolt street; West on Humbolt street to 9th street; North on 9th street to Fremont street; East on Fremont street to 2nd street; North on 2nd street to Moro street, West on Moro street to oiled road (Manhattan Avenue); North on oiled road to North end; West from North end of oiled road to gate just North of college barns; from this gate up to shop to starting point. These were supposed to be fair samples of different kinds of road. A survey was then made of these roads and a profile of them plotted on standard profile paper to a convenient scale from which the grades of the road may be obtained.

The recording traction dynamometer used in connection with these tests was built in the Kansas State Agricultural College shops. A full description with detail and assembly drawings of the instrument is given in the designers' thesis.

A few minro changes were made in the construction of the dynamometer and some new parts were added. The main axle was shortened so that the wheels would track with a farm wagon. The spring that was to be placed in the supply drum was omitted and a brake shoe was substituted in its place. Instead of using one

edge of the paper as a zero line, a marker was attached to the machine to make a zero or base line and in which the movable pencil would lie when there was no pull. As metallic coated paper was used on the dynamometer, brass points were substituted in place of the common pencil points.

Method of making Test.

The dynamometer was first placed between the engine and the load. One man was stationed on the wagon to take notes of the conditions of the road, and take care of the brake while another man walked along to see that the dynamometer was working satisfactorily and to mark points for reference on the record paper corresponding to certain points on the road which were located on the profile. The number and location of these points were noted by the man taking notes.

Four tests were made. The first test was made May 17th on the oiled road, begining at the South end. The load, which was pulled by a traction engine, consisted of a heavy farm wagon loaded with pig iron. The load including weight of wagon was 6502 lbs. The width of tires on wheels was four inches.

The other three tests were made in a similar manner. The second was made May 20th on the following roads; begining at East college gate we went South on oiled road to Fremont street; went East on Fremont street to 9th street, South on 9th street to Leavenworth street; East on Leavenworth street to 2nd street; South on 2nd street to Humbolt street; West on Humbolt to 9th street; North on 9th street to Fremont street; East on Fremont street to 2nd street; North on 2nd street to Moro street; West on

Moro street to oiled road (Manhattan Avenue); North on oiled road to Vattier street; from East main entrance to college shops by the road which runs around South end of Main Building.

The third test was made June 1st on the following roads after.52" of rain fall. Begining at North-west corner of city park on Fremont street, we went East to 7th street; North on7th street; West on Moro street to oiled road (Manhattan Avenue); North on oiled road to East main entrance; and from East entrance to shops.

The last test was made June 2nd on the oiled road, starting at the South end.

Having the records that were made by the dynamometer of different roads, smooth curves were drawn through the maximum and minimum points on the record. A curve representing the mean pull was then drawn between these two curves. A profile was then plotted on the record sheet corresponding to the road from which it was made. The record of each sheet being divided up into as many equal parts as the record contained stations. All necessary notes giving location of different points, condition of roads, and exact reference points, are on the record sheet.

We drew curves which indicated the difference in pull on the same stretch of road under different conditions, and on plate five (5) we drew several traction curves, some corresponding to the same grade of different roads and others corresponding to different grades.

From our observations and the curves on the five plates, we conclude that the pull is less on a 5-1/2% grade oiled road in wet weather than in dry weather, due to the fact that just enough moisture was absorbed to settle the dust formed ~~on the~~

~~###~~ in dry weather which made the surface of the road more compact than it was before the rain. The pull is about 17% greater on a level stretch of oiled road in wet weather than in dry weather when the road before the rain is very dusty and the dust will pack under the wheels. The pull is about 73% greater on a level stretch of oiled road in wet weather than in dry weather when the road before the rain is smooth and looks like a hard street. The pull is about 99% greater on a level stretch of oiled road in wet weather than in dry weather when the road before the rain is very dusty and the dust will not pack. The pull is about 87% greater in wet weather than in dry weather on a black dirt road which is hard, a little dusty, and uneven before the rain. The pull is about 139% greater in wet weather than in dry weather on a road which is slightly spongy before the rain and of a "gumbo" nature.

Clay will hold the oil better than black soil and therefore shed water better. It was partly due to the construction of the oiled road, from the South end to the bottom of the hill, that caused it to fail when it became wet. Oiled roads will shed water well.

Oiled roads will not be cut up by heavy traffic in wet weather, provided they are well oiled, well rounded, and well packed. The pull does not increase in a direct proportion as does the grade, but more rapidly. The more the travel, the better the road becomes both in dry and wet weather. Because an oiled road is very hard in dry weather is no sign it will not become soft in wet weather. Oil will appear on the surface of a well built oiled road.

The pull on a level oiled road is about 22% greater than

the pull on a level macadamized road. The pull on a level dirt road is about 51% greater than the pull on a level macadamized road. The pull on a level dirt road is about 22% greater than the pull on a level oiled road.

PLATE-I-

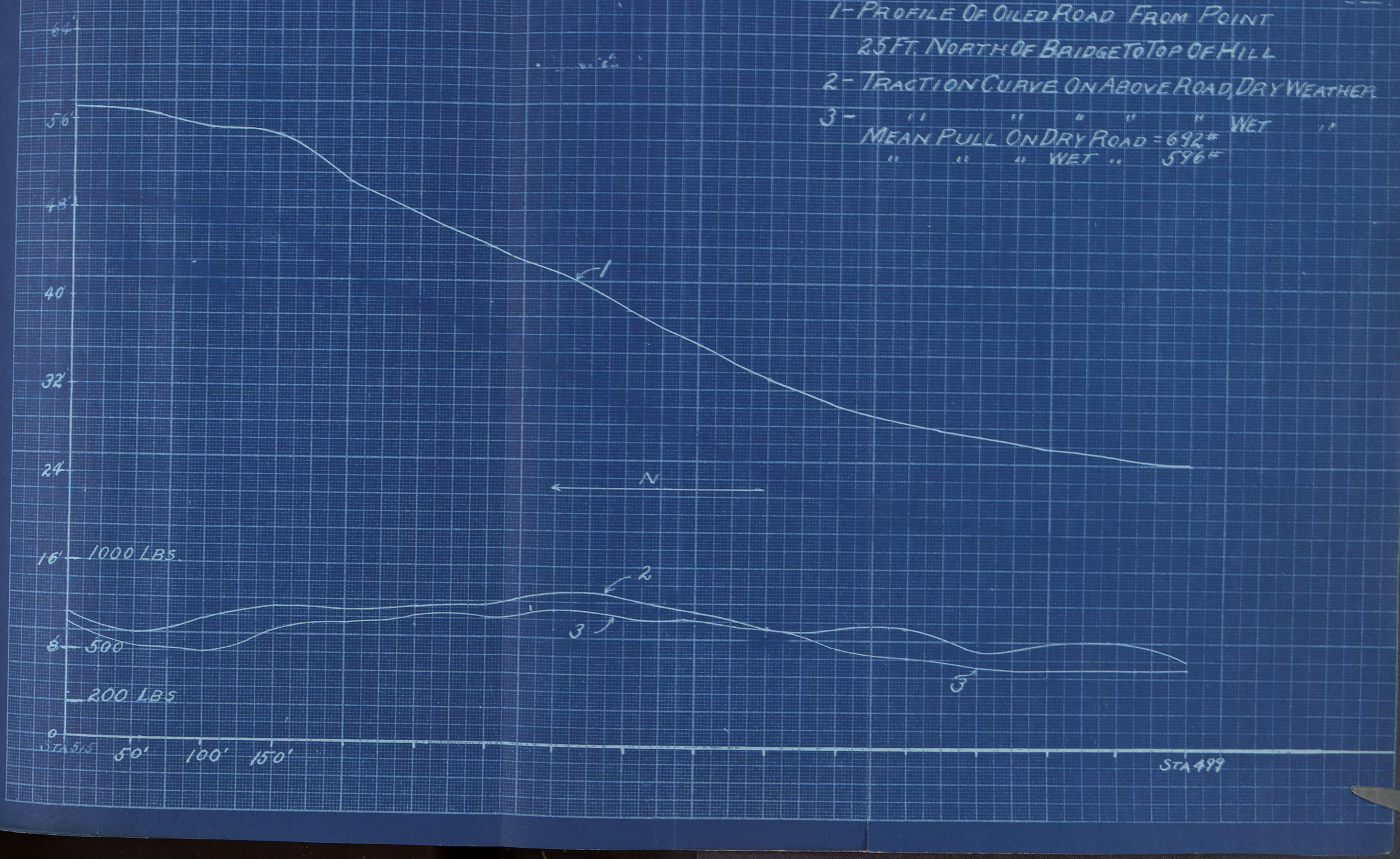
1- PROFILE OF OILED ROAD FROM POINT 25 FT. NORTH OF BRIDGE TO TOP OF HILL

2- TRACTION CURVE ON ABOVE ROAD, DRY WEATHER

3- " " " " " WET "

MEAN PULL ON DRY ROAD = 692#

" " " WET " 596#



4 – Profile Of Oiled Road From East Main Entrance To Point 150 Ft. South Of Bridge At Foot Of Hill.

5 – Traction Curve Of Above Road Dry Weather Mean Pull 311# Total Load Pulled 6401#
6 – " " " " " " Wet " " " 366# " " " 6585#

7 – Profile Of Oiled Road From Moro Str. To East Main Entrance

8 – Traction Curve On Above Road Dry Weather – Mean Pull 276# " " " 6401#
9 – " " " " " " Wet " " " 478# " " " 6585#

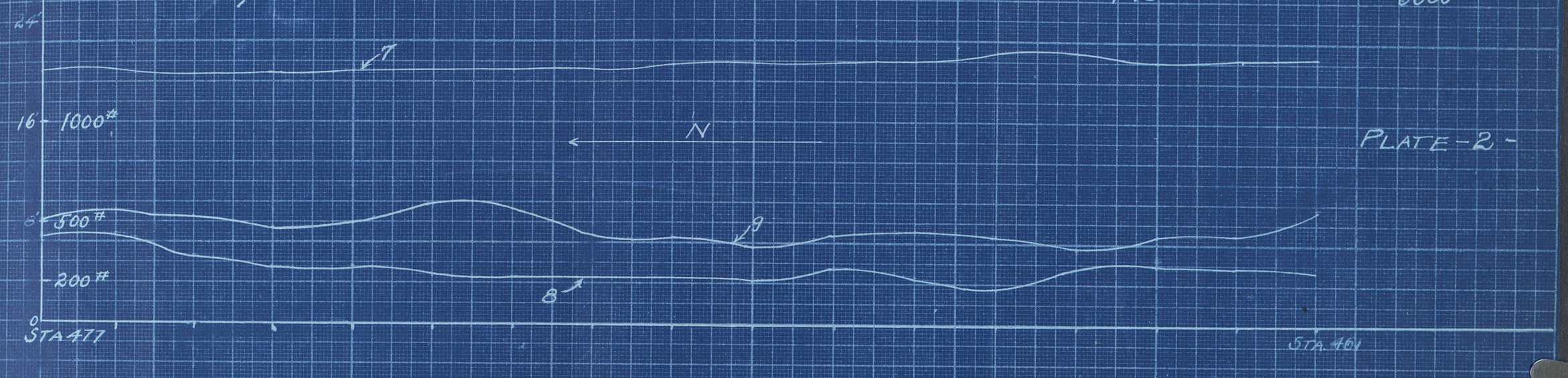


Plate – 2 –

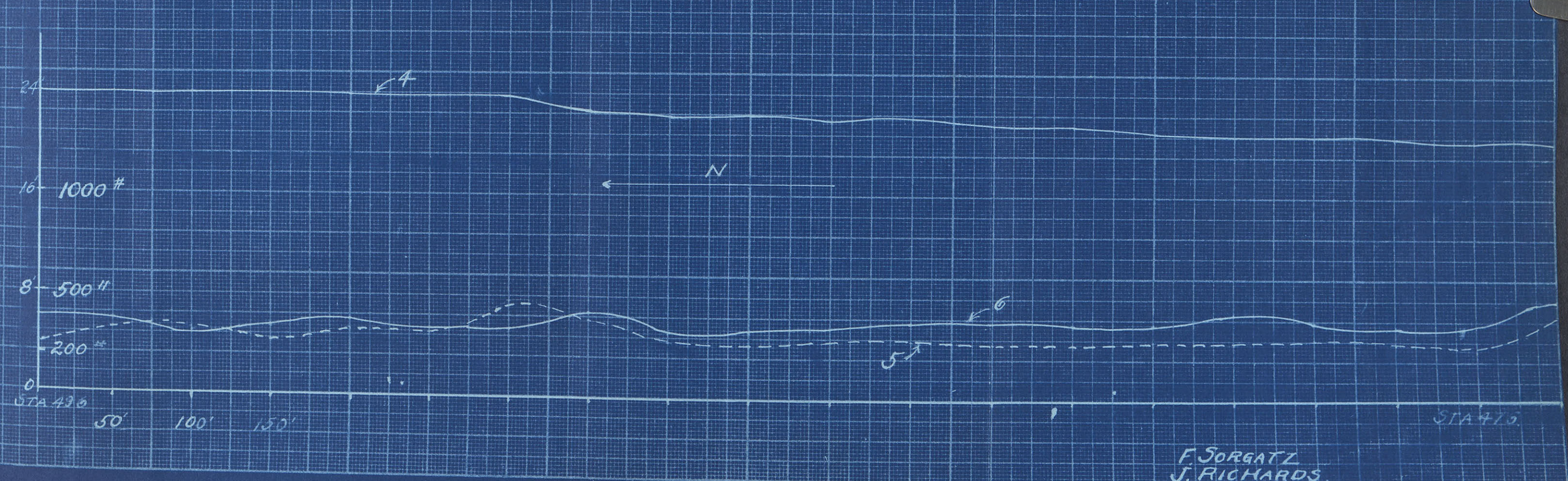


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PLATE - 3

10 - PROFILE OF DIRT ROAD ON FREMONT STR FROM OILED ROAD TO 9TH STR.

11 - TRACTION CURVE ON ABOVE ROAD, DRY WEATHER AVERAGE PULL 333 #
12 " " " " " " WET " " " 625 #

13 - PROFILE OF OILED ROAD FROM SOUTH END TO MORO STR.

14 - TRACTION CURVE ON ABOVE ROAD DRY WEATHER AVERAGE PULL 324 #
15 - " " " " " " WET " " " 636 #

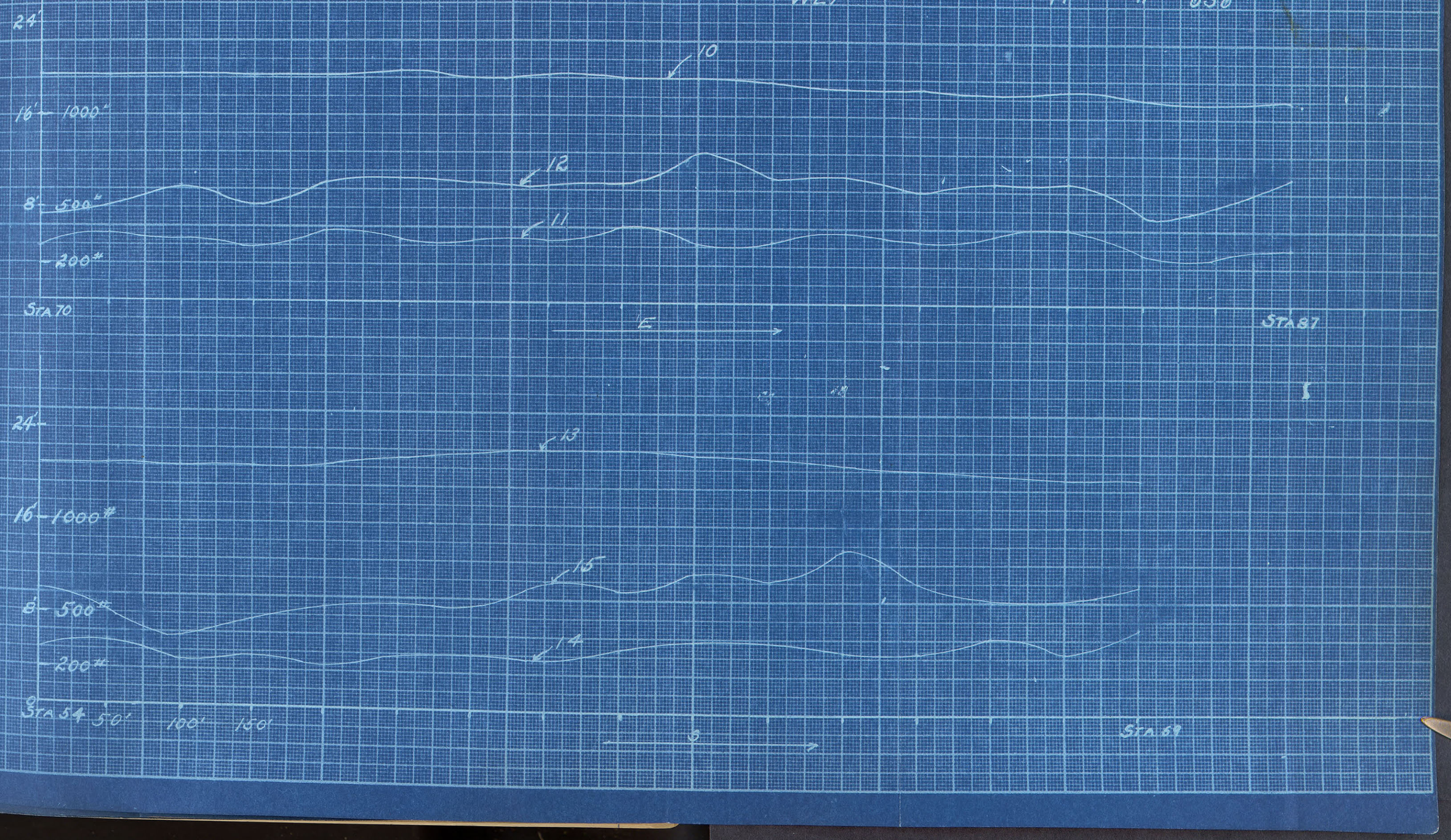

PLATE 4 -

22 - PROFILE OF MORO STREET FROM 7TH TO 9TH STREET

23 - TRACTION CURVE ON ABOVE ROAD. DRY WEATHER MEAN PULL 268 LBS.

24 - " " " " " " WET " " " " 642 "

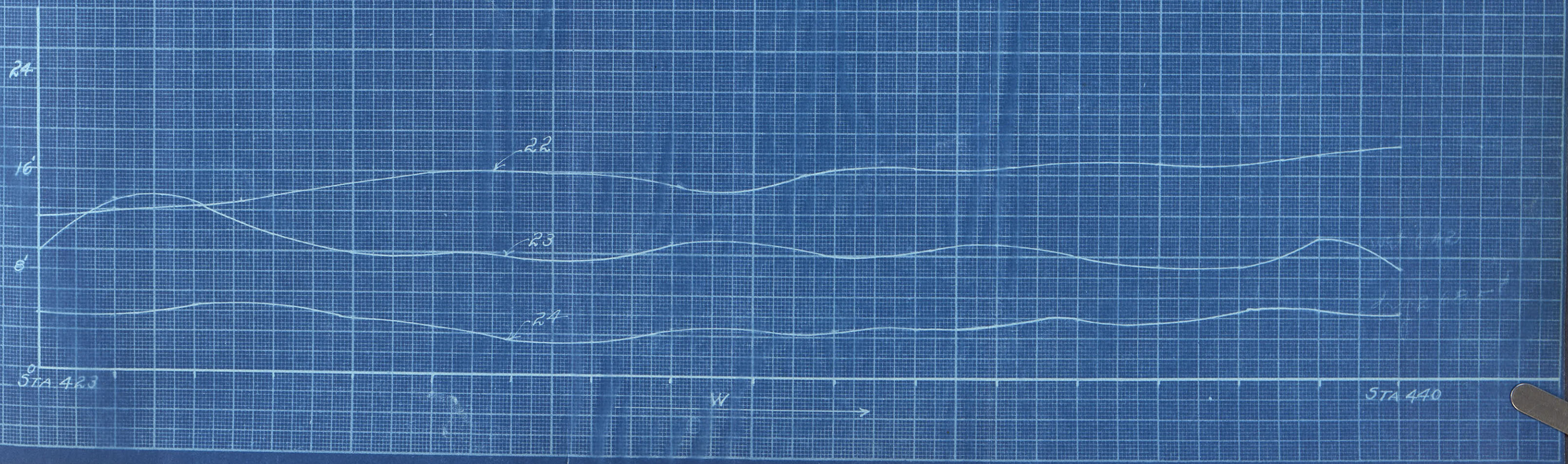

PLATE-5

16 – TRACTION CURVE MACADAMIZED ROAD 6 % GRADE
17 – " " ON DIRT ROAD WEST END HUMBOLT STR. 1½ % GRADE
18 – " " NORTH END OF OILED ROAD – 5.66 % GRADE
19 – " " ON OILED ROAD BETWEEN MODOC STR. AND EAST ENTRANCE – 0 % GRADE
20 – " " " DIRT ROAD (FREMONT STR) FROM 9TH TO POINT 250 FT WEST – 0 % GRADE
21 " " " MACADAMIZED ROAD AT FOOT OF HILL EAST OF MAIN ENTRANCE – 0 % "

1000#
500#
200#
0
50'
100'
150'
18
16
17
19
20
21
MEAN PULL 770#
MEAN PULL 543#
MEAN PULL 393#
MEAN PULL 334#
MEAN PULL 272#
MEAN PULL 222#