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## Highway construction and maintenance equipment with machine and automotive repair shops for the reconstruction of the highways of the IV division, Ankara, Turkey

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HIGHWAY CONSTRUCTION AND MAINTENANCE EQUIPMENT  
WITH MACHINE AND AUTOMOTIVE REPAIR SHOPS FOR  
THE RECONSTRUCTION OF THE HIGHWAYS OF THE IV  
DIVISION, ANKARA, TURKEY

BY

STEVE THEODORIDES

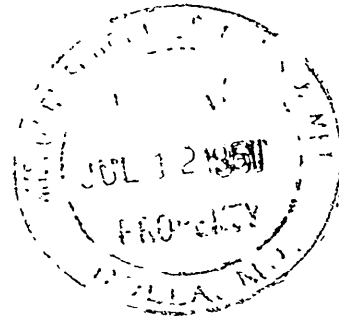
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A

THESIS

submitted to the faculty of the  
SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI  
in partial fulfillment of the work required for the  
Degree of  
MASTER OF SCIENCE, MECHANICAL ENGINEERING

Rolla, Missouri

1951  
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Approved by -

*Carson Miller*  
\_\_\_\_\_  
Professor of Mechanical Engineering

79677

## ACKNOWLEDGEMENT

The author wishes to express his appreciation to Dr. A. J. Miles, Dean of Mechanical Engineering, and Professor E. W. Carlton, Professor of Civil Engineering, Missouri School of Mines and Metallurgy, for their help in conducting this study.

"There is no better method of adding to the wealth of a country than by building all-weather roads which will guarantee 365-day highway transportation facilities to all the people of a nation."

Thomas H. Mac Donald

Commissioner of Public Roads

Washington, D. C.

## PREFACE

With the rapid advancements being made in travel and communication facilities today, the world is steadily growing smaller and people in the far places of the world are no longer strangers.

There is no doubting the importance of tractors, dozers, scrapers, power shovels, graders, bituminous construction equipment, aggregate handling, etc., in the present-day world, in aiding the progress of civilization and bringing to all people the good things of life.

It must be remembered that money expended for highways is not wasted, and can be classified as an asset.

In substance, this is a general project for the reconstruction and improvement of the highways of the IVth Division, Ankara, Turkey, on a four year program, which will cover approximately 1,400 miles of modern roads.

The project will consist mainly of :

- I. a) The type and size of roads that will be constructed.
  - b) An approximate estimation of the amount of earth to be moved per average mile in order to bring the highways to grade.
  - c) An approximate estimation of the quantity of materials necessary for the basing and surfacing of the roads.
  - d) Selection of type, size, and quantity of road construction and maintenance equipment.
  - e) Detail technical specifications of the forgone equipment.
- II. General outfits of machine and automotive repair

shops for the maintenance and repairs of the above equipment, giving locations, general plans, tools and machinery.

III. a) Initial cost of the road equipment.

b) Initial cost of the shops (Hangars), tools and machinery

CONTENTS

<u>ARTICLE</u>	<u>PAGE</u>
Acknowledgement	ii
Preface	iv
List of illustrations	vii
List of tables	viii
Introduction about Turkey	2
Highway building program in Turkey	4
American aid to Turkey in highway improvement	6
The IV Division, Ankara	9
General road specifications	11
Approximate period set for the various steps of the project	20
Final list of Equipment	34
Technical specifications of the equipment	36
Machine and automotive repair shops	65
Bibliography	95
Vita	97

LIST OF ILLUSTRATIONS

<u>CONTENT</u>	<u>PAGE</u>
I. General proposed plan of the Central Shop	67
II. General proposed plan of the District Shop	83



LIST OF MAPS

<u>CONTENT</u>	<u>PAGE</u>
I. General map of Turkey	1
II. Map of the IVth Division	8

K A R A

D E N İ Z

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LOANIST

MARMARA DENİZİ

IV. DIVİSİYON

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ANTALYA BÖLGE BAŞKANTONU

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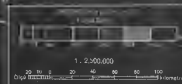
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YOLLARIN GİCİSLERİNİ VE MUHTELİF MEVSİMLERDE GEÇTİRİLEN KISIMLARINI GÖSTEREN HARITA  
MAP SHOWING TYPES OF AND PARTS PASSABLE DURING DIFFERENT SEASONS

<p>YOLUN GİCİSLERİNİN VE MUHTELİF MEVSİMLERDE GEÇTİRİLEN KISIMLARINI GÖSTEREN HARITA</p>	<p>YOLUN GİCİSLERİNİN VE MUHTELİF MEVSİMLERDE GEÇTİRİLEN KISIMLARINI GÖSTEREN HARITA</p> <p>ASFALT, BİTON MARMARA NUM VE ÇALIŞTIRILAN TESVİYE VE TÜZEM YOLLAR TESVİYE VE FURKAT YOLLAR PAZIRLAR TİPİTÖLÜ VE İNŞA İKİNGİS MÜHÜRMEYİŞİ K. MİRREZLER K. ÖR. MİRREZLERİ BUĞAK, MİRREZLERİ KÖYLER ÖZELLER TABAK GÜZELMEK TARİH ESERLERİ VE ANİTİLER DENİZ ALIM YERLERİ DENİZ ET. İKİNGİ Kışın geçilemez yollar ve kışın geçilemeyen yerler</p>	<p>DOĞRULAR HANGİ KIRPAZ YOLLAR GRANT, AND MACEDON YOLLAR GRATED EARTH ROADS GRADED EARTH ROADS TRAILS RAILROADS AND STATIONS RAILROADS UNDER CONSTRUCTION NATIONAL BOUNDARIES PROVINCIAL CAPITALS COUNTY CAPITALS TOWNSHIP CAPITALS VILLAGES HOTTEN TIFPIC PLACES</p>	<p>HANGİ KIRPAZ YOLLAR GRANT, AND MACEDON YOLLAR GRATED EARTH ROADS GRADED EARTH ROADS TRAILS RAILROADS AND STATIONS RAILROADS UNDER CONSTRUCTION NATIONAL BOUNDARIES PROVINCIAL CAPITALS COUNTY CAPITALS TOWNSHIP CAPITALS VILLAGES HOTTEN TIFPIC PLACES MONUMENTS AND HISTORIC BUILDINGS RAILROAD STATIONS STATE BOUNDARIES Railway numbers given between towns and junctions</p>
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\*Marmara Sea (Samsun - Trabzon)

\*\*Not recommended for use by motor vehicles

## Introduction about Turkey

The Turkish Republic lies between the meridians  $26^{\circ}$  and  $44^{\circ}$   $48$  minutes of Greenwich and between the parallels of latitude  $36^{\circ}$ - $42^{\circ}$ N. Its area is 296,503 square miles. Ankara, with a population of 300,000, is the capital of the republic. Other principal cities are Istanbul, Izmir, Adana, Bursa, Eskesehir, Gaziantep, Konya, Sivas, Erzurum, Kars, Diyarhaker, Trabzon, and Samsun.

The population of the country according to the census of 1950 is 20,900,000, of which about 2,000,000 live on the European side and the rest in Anatolia. Of the total population, about 94 per cent is Turkish speaking and the proportion of Mahammedans is 98 per cent.

The Strait of Bospharus is 18 miles long with a varying breadth of about half a mile to  $2 \frac{3}{4}$  miles. The dardanilles are 47 miles in length and have a varying bredth of 3 to 4 miles. The Montreux Convention guarantees free passage through the straits at all times for merchant vessels of all nations in peace or war.

With an area of 296,503 square miles, there are 4,454 miles of coasts, and 1,633 miles of frontiers.

At present, there are 4,652 miles of railroad and 26,536 miles of highways of mostly macadam. Turkey is still in the process of developing her system of transportation. The enormous dependence of agriculture, industry, and commerce on efficient railroads and highways has concentrated all possible efforts on this program.

Turkey is predominantly agricultural. Wheat ranks first among Turkish crops. Barley, oats, rye, corn, rice are other important grain products. Cotton, citrus fruits, and bananas are grown in the south. Tobacco is the principal export crop. An average of

\$30,000,000 worth of Turkish tobacco is purchased annually by American cigarette manufacturers, alone. In the last two decades, the government has encouraged and supported the establishment of industries related to the agricultural production.

Livestock raising is one of the outstanding Turkish occupations. Horses, cattle, water-buffaloes, sheep, and goats are the main animals raised.

Turkey has very rich mineral resources. The most abundant item is coal, the quality of which is comparable to any in the world. Second to coal is copper, mined on a very large scale. Next in importance are iron, chromium, manganese, emery, mercury, and sulphur. Besides these, there are nickel, tin, cobalt, phosphate, platinum, aluminum, antimony, soda, and zinc. The oil fields, which were discovered recently in the southeast, promise remarkable capacity.

The industries, except those locally connected with certain agricultural products or mines, are located around the larger cities where adequate transportation facilities are available. Therefore, only scattered plants are to be found in the mountainous eastern part of the country despite the fact that the mineral resources warrant more extensive manufacturing activity.

The lack of modern road building equipment has been the most deterrent factor in the much needed development of highways and roads. It is hoped that the alleviation of this shortage will help fulfill the transportation program. A nine year construction program has already been started with American technical help.

## THE HIGHWAY BUILDING PROGRAM IN TURKEY

This program was started in 1948 and is still undergoing preparations for future fast construction.

The program calls for 69 major projects in three year stages of 4425, 4325, and 5225 miles of roadbuilding, divided into categories of militarily and economically important roads. Work is already in progress on 1443 miles of roads of primary importance.

Major highways now being constructed or planned are as follows:

- 1) Edirne - Istanbul - Ankara - Kayseri - Ulukisla - Adana - Iskenderun.
- 2) Iskenderun - Erzurum.
- 3) Elmadag - Kirikkale - Sivas.
- 4) Ankara - Konya
- 5) Ankara - Kochisar.
- 6) Bor - Iskenderun.
- 7) Istanbul - Izmit.

Proper repair and maintenance of roads are also being stressed. Reinforced with additional equipment, road repair crews are continuously active on 7,735 miles of the more important highways.

In drawing up plans for roads which are primarily of economic importance, special attention is being paid to the needs of Turkey's eastern provinces where modern highways will play an important part in regional economic recovery.

In order to facilitate this program, the country has been divided into 10 divisions of approximately equal area. The Headquarters are at the Ministry of Public Works, and each division is represented by a division engineer. Because of the military and economic importance, the work cannot be concentrated on a smaller area, but must

be distributed among the 10 Divisions.

The author's thesis is a general project of selection of road construction equipment for the reconstruction and improvement of the highways only of the IV Division; and of the machine and automotive repair shops which will repair and serve all the equipment necessary for this project. After the project has terminated, the shops will still be used for repairing equipment used for the continuous maintenance of the highways, and for future highway building programs of the IV Division, and also, repair, when available, contractor's equipment.

## AMERICAN AID TO TURKEY IN HIGHWAY IMPROVEMENT

Legislation, enacted on May 22, 1947, authorized aid to Turkey of several kinds, including aid in the improvement of its highways. Shortly thereafter, the government of Turkey requested assistance, in accordance with the terms of this law. Among other things, it expressed its desire to take advantage of the experience and methods developed in the United States in highway construction maintenance and administration. The reasons for this were to establish a plan for a long-range highway improvement program, to devise a highway administrative pattern to fit the needs of the country, and to adopt standards for highway design, construction, and maintenance suited to the materials available, the traffic, and the economic and financial status of the country.

By agreement with the State Department on July 12, 1947, the Public Roads Administration undertook to supervise the highway program in Turkey.

A sum of \$5,000,000 was allocated as a grant to be used principally for purchase of highway equipment, materials, supplies, and spare parts from the United States of America and Europe.

The Turkish government agreed to provide adequate funds in the budget of the Turkish Ministry of Public Works for carrying out road program. These funds are to be used principally for the purchase of Turkish materials, supplies, and contractual services, and for the payment of salaries, wages, and expenses of engineers, laborers and others employed on this program in Turkey, but with minor amounts available for foreign purchase.

The U. S. A. Public Roads Administration assigned a staff of

engineers and specialists to Turkey in December, 1947, to work in close cooperation with the Turkish Ministry of Public Works.

By June, 1948, there had been received in Turkey, 3,517 tons of equipment, materials, and supplies which represented 78 per cent of those to be shipped. The equipment is being serviced at the port of Iskerderun and dispatched for operation as soon as trained operators and maintenance mechanics are available. Early impetus was given to training operators and mechanics, with the result that 120 graduate trainees were available after 6 months of operation.

Improvement of the 40 miles Iskenderun to Erzurum road was completely graded by summer, 1949.

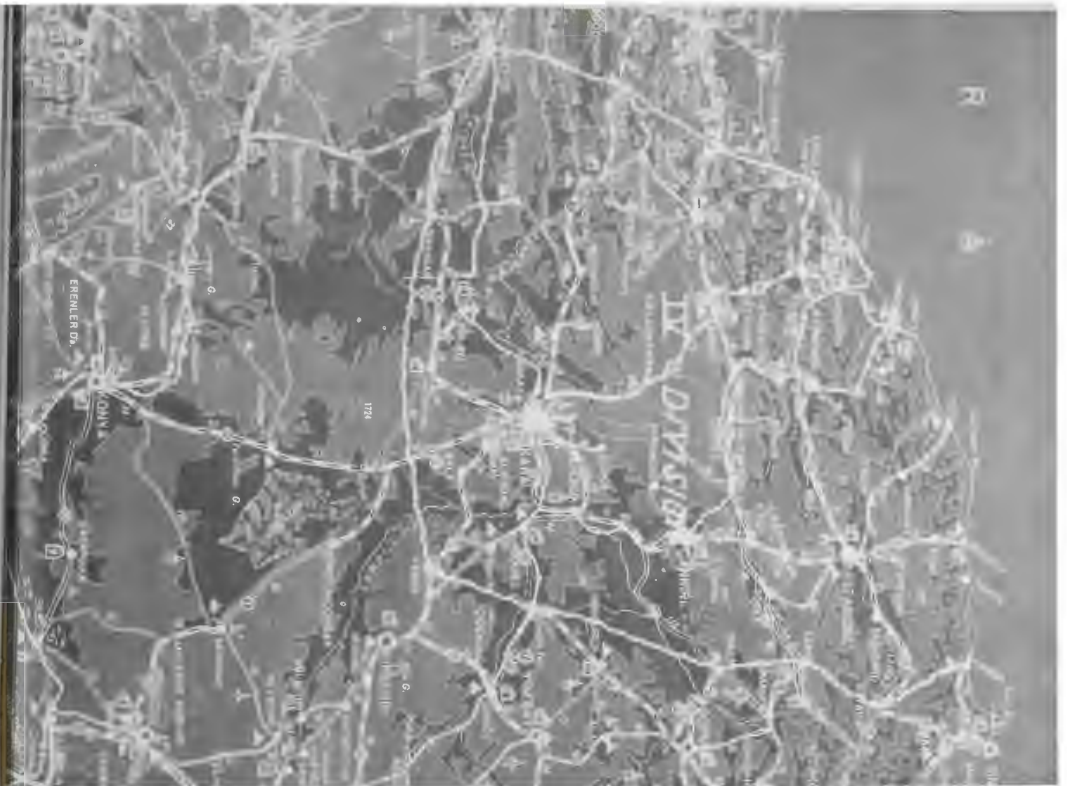
The Adana to Karatas project for widening the existing road, improving grades, placing base course and asphalt surface on 16 miles was, also, completed in the meantime.

A belt route at Iskenderun has been improved, and 70 miles of the road between Tarsus and Toprakkale has been given an asphalt surface.

A maintenance organization is being created and supplied with shops and modern equipment for the maintenance and repair of the road machinery.

Real progress has been made toward each of the objectives of the highway-aid program and Turkey is moving swiftly toward realization of its desire to establish a well-conceived, economical plan for a long-range highway improvement program; and is devising an effective highway administrative pattern that will fit the needs of the country.





## THE IV DIVISION, ANKARA

The IVth division extends along the Black sea coast from Ayancek to Akcakoca, to the east as far as Sungurlu, to the west to Eskisehir, and to the south to Kutlu near the north of the Tuzgolulake, and covers a total area of approximately 33,500 square miles.

There are no asphalt surfaced highways in this division, with the exception of the roads of the Ankara city which extend a couple of miles to the outskirts.

This division contains approximately 1,400 odd miles of state roads of gravel and macadam construction.

### IVTH DIVISION'S HIGHWAY MILEAGE

1. Ankara - Cankiri - Kastamonu - Inebalu	= 354 km.
2. Kastamonu - Boyabat - Sinop	= 214 km.
3. Ankara - Gerede - Bolu - Dearek - Zongulda	= 397 km.
4. Ilgaz - Gerede	= 148 km.
5. Ankara - Galbase - Eskisehis	= 274 km.
6. Ankara - Goyunuk	= 200 km.
7. Ankara - Bala - Kulu	= 200 km.
8. Golbase - Cogun	= 149 km.
9. Ankara - Corum	= 284 km.

Total = 2,220 km. = 1,400 miles

The climate of this section of the land changes as we leave the Black Sea coast and travel inward. Near the coast, it is mild and rainy; then as we go inland on high plateaus, it gets dry, with hot summers and cold dry winters. Snow stays on the ground for about two months of the year in most regions of this division.

This part of the country is more or less a plateau which des-

cends as we travel north and west. There are no high mountains.

According to the statistics of the Ministry of Public Work, Ankara, Turkey, actual working days for this part of the country have been set to be 210 days in a year.

## GENERAL ROAD SPECIFICATIONS

### Factors Governing Type and Size of Roads

In planning the type of surfacing and size of roads to be built, for a certain place, there are many factors which enter into consideration. These determine the type, quality and size of roads that have to be built, and which will face the needs of that piece of land quite efficiently.

Among important factors to be considered in the selection of the size of a highway are:

1. - Current and anticipated traffic.
2. - Availability of materials and equipment.
3. - Available funds.

The thickness of the pavement and the type of surfacing is governed by the:

1. - Climatic conditions
2. - Availability of materials and equipment.
3. - Load requirements.
4. - Traffic.
5. - Relative cost.
6. - Local engineering practice.

### Width of the Highways

In putting down specifications for the construction of the roads of the IVth Division, the author has to accept the width that the Public Roads Administration in Ankara has set for all the state highways in Turkey. These specifications call for 12 yards from ditch to ditch; 9 yards of which will be bituminous treated.

### Thickness of Pavement

The forces on a pavement by the wheels of a standing vehicle

can be determined without difficulty.

There are two general types of roadway pavements. These are known as the rigid type and flexible type. The principal rigid types are concrete pavement and concrete base with bituminous surface. Flexible types consist of a well-compacted base course of suitably graded gravel, stone, slag or other acceptable granular material, on which is placed a bituminous surface course. A bituminous base course may be used instead of, or in addition to, the gravel or stone base. Subbases or gravel or selected borrow may be necessary under base courses where the subgrade soils have low bearing power.

The structural strength of a given type of pavement is dependent on its thickness and support.

The specifications given by the Principles of Highway Construction of Public Roads Administration, Washington, D. C., 1943 are: for a 10,000 pounds wheel load the combined thickness of subbase, base course, and surface course is from 0"- 6", 2"- 8", 9"-18", 9"-24", and 12"-24" depending on the variations in the soil characteristics, degree of compaction, natural soil moisture, and climate. In a dry climate and where the distance to ground water is great, soil will require less thickness of cover than in a wet climate where the elevation of the ground water is high and the moisture content of the soil is greater due to heavier rainfall.

#### Subbases

As the highways which the author is undertaking to reconstruct and surface treat have been used for at least a couple of centuries, and the region has a dry climate, by having a good grading, the need of a subbase can be eliminated.

### Base Courses

Base courses should range in thickness from approximately 6 to 12 inches depending on the character of the subbase. When the subbase is of material closely approaching the specified requirements for base course construction, a base course 6 inches in thickness should be adequate. If the subbase material is of lower quality due to poor grading or relatively high plasticity, the thickness of the base course should be increased. In many instances, substantial economies may be effected in the cost of base course construction by the use of local materials. Bituminous base courses are commonly constructed with a uniform thickness of 3 to 6 inches.

For nonbituminous base courses which will be the type that the author is accepting for the construction of the highways, aggregates and screenings should consist of angular fragments of crushed stone or crushed slag.

Crushed stone for base courses may be a crusher-run product that is suitable for use without screening, or it may be composed of fractions that have been separated and recombined.

An example of gradations of aggregated for use in water-bound macadam base course construction is shown in the following table.

Inches	Per cent course aggregate
3	100
$2\frac{1}{2}$	90 - 100
$1\frac{1}{2}$	25 - 60
$\frac{3}{4}$	0 - 10

### Bituminous Surfaces

Bituminous surfaces are commonly placed on flexible bases by the general methods of construction, known as surface treatments,

road mixes, plant mixes, and penetration macadam. The usual thicknesses of bituminous surface courses are: for surface treatment types,  $\frac{1}{2}$  to 1 inch; for road-mix types,  $1\frac{1}{2}$  to 3 inches; and for the plant-mix types, 2 inches or more. For penetration macadam, a minimum thickness of  $2\frac{1}{2}$  to 3 inches is generally required. The thicker bituminous surfaces are more likely to give satisfactory service at lower maintenance costs than the thinner surfaces. The general practice is to use surfaces not thinner than 1 inch and not thicker than 5 inches.

#### Composition of Bituminous Bases and Surfaces.

Probably the most important single factor influencing the selection of the bituminous base or surface is the character of the materials available and, more particularly, the nonbituminous materials. For economic reasons, local aggregates should be used if possible and with the minimum of change, but the bituminous material will usually have to be shipped in.

The quantity of a given type of bituminous material that should be used with an aggregate of a given grading is affected by the size, shape, and absorptive property of the aggregate, by the method of construction used, by the workability of the mixture, and by the character of the finish required.

#### Types of Construction

The types of bituminous construction most generally used in highway paving as stated before are:

1. - Surface treatment.
2. - Penetration macadam
3. - Mixed in place
4. - Traveling plant mix

## 5. - Stationary plant mix

The particular type that should be used for a given set of conditions will be influenced primarily by the thickness of the surface course required, the materials and equipment available, the extent of control necessary, and relative costs.

Before selecting the type of construction for the Turkish State Highways, the author would like to give a brief description of each method.

### 1. - Surface Treatment

This type of construction is known by such names as inverted penetration and carpet coat, but is more commonly referred to simply as surface treatment. It is relatively inexpensive and is suitable as the wearing course for any type of stable base and for water-bound macadam.

The general practice in the construction of surface treatments is, first, to prime the base with a liquid bituminous material of low viscosity and after this has penetrated and dried, to make an application of heavier bituminous material. This is covered immediately with clean, coarse, one size aggregate which is rolled. In some instances, this may complete the construction, but usually a second coat of bituminous material is applied and covered or mixed with a small amount of finer aggregate. A seal coat of bitumen and fine aggregate may be applied shortly afterwards.

Probably the most used type of treatment and one which may serve as an illustration of sizes and quantities is the double surface treatment. In the majority of cases, the coarse aggregate will be graded from 1 -  $\frac{1}{2}$  inch and the amount used will be 45 - 50 pounds per square yard. This will require .45 - .50 gallons of bituminous



material.

## 2. - Penetration Macadam.

Bituminous macadam bases and surfaces are constructed by spreading and compacting a layer of aggregate and then applying bituminous material and adding additional layers until the desired thickness of base or surface has been obtained.

The sizes and amounts of aggregate as well as the amount of bitumen that should be used will depend upon the thickness of the course, as a base, or as a surface. Normally a base course will be constructed of larger size aggregate, will contain less bitumen, and upon which, a dense, wear-resisting, surface would be placed.

Some idea of the normal variation in size and quantity of aggregate used in base and surface construction can be obtained from the table of a typical specification for macadam base and surface course construction, found on the following page.

## AMOUNT OF MATERIAL PER SQUARE YARD

	Macadam Base		Surface Course	
	size	amount	size	amount
coarse stone	3 - 2 inch	285 lbs.	2½ - 1½ inch	270 lbs.
bitumen		1.85 gls.	- - - - -	1.50 gls.
medium stone	1 - ¾ inch	30 lbs.	¾ inch - No. 4	30 lbs.
bitumen	- - - - -	0.3 gls.	- - - - -	0.5 gls.
fine stone	1 - ¾ inch	25 lbs.	¾ inch-No. 4	25 lbs.
bitumen	- - - - -	- - - - -	- - - - -	0.3 gls.
stone chips	½ - No. 4	10 lbs.	¾ inch-No. 8	15 lbs.
bitumen	- - - - -	- - - - -	- - - - -	- - - - -
Stone chips	- - - - -	- - - - -	¾ inch-No. 8	10 lbs.
Total Aggregate	- - - - -	350 lbs.	- - - - -	350 lbs.
Total Bitumen	- - - - -	2.15 gls.	- - - - -	2.3 gls.

### 3. Mixed - in - place

The road mix or mixed - in - place method of construction of bases and surfaces can be employed advantageously, (1) when the aggregate to be used is that already in place, (2) when the existing aggregate is to be supplemented by the addition of selected aggregate to provide the grading required or to produce a base or surface of the thickness desired, and (3) when the existing aggregate is to serve as a base or foundation course and all of the aggregate to be used in the mixture is to be brought in.

When the aggregate has been properly prepared, it is spread out to a level course and bituminous material is then applied in one or more increments by pressure distributors. After each application of bituminous material, the aggregate and bitumen are turned with disk harrows and, after the total amount of bituminous material has been applied and the disking has been done, the materials are mixed by repeated turnings with disk and spring-tooth harrows, pulled and self-propelled blade machines, or by some type of portable mixer that completes the mixing operation by passing over the materials. When the mixing operation has been completed, the mixture is spread and compacted.

The percentage composition of mixed - in - place bases and surfaces varies so widely in actual practice as to render meaningless a statement of satisfactory limits. Nevertheless, the basic principles of mixture composition previously discussed can be used as a guide in determining the bitumen content to be used for a start.

### 4. - Traveling Plant Method

As an outgrowth of the mixed - in - place method, traveling mixing plants have been developed. The machines are designed to

replace the distributors and various mixing devices by proportioning and mixing the bitumen and aggregate in a single continuous operation. In this operation, the prepared aggregate is windrowed instead of being spread out. The windrowed material is picked up, fed continuously through the plant, mixed with the bitumen, redeposited in a windrow, and then spread and compacted as in the road - mix method.

The factors affecting the quantity of bitumen and aggregate are the same as described in the road - mix method. However this method has the following advantages over the road-mixed method.

a) More accurate control of bitumen content. b) heavier grades of a given type of bitumen material can be used. c) more uniform thickness can be obtained, d) the tendency of partially mixed material getting wet is eliminated, e) delays caused by weather can be of shorter duration.

#### 5. Stationary Plants

A standard paving plant consists of a drier, a screening or grading unit, a batching system, and a mixer.

In this type of preparation of bituminous base or surface courses mixtures, a more definite control of temperature, moisture content, mixture composition and uniformity can be obtained.

APPROXIMATE PERIOD SET FOR THE  
VARIOUS STEPS OF THE PROJECT

The period for accomplishing the various steps of the construction may be accepted as follows:

First year:

- a) Grading of all the roads
- b) Crushing of base course

Second year:

- a) Crushing and spreading of base course
- b) Crushing of fine course
- c) Surface treatment

Third year:

- a) Crushing and spreading of base
- b) Crushing of fine course
- c) Surface treatment

Fourth year:

- a) Completion of crushing and spreading of base course.
- b) Completion of crushing of fine course.
- c) Completion of surface treatment.

Approximate calculations of the amount of earth to be moved per average mile in order to bring the highways to grade.

The average breadth of the highways of the IVth Division is roughly 12 yards from ditch to ditch. The operations in bringing the highways to grade before spreading the base course on them will consist mainly of:

- a) Widening on one or both sides in order to reach the required breadth.

- b) Opening new ditches.
- c) Grading the old road.

Selection and estimation of equipment for the above consideration.

In performing this operation, it is almost impossible to have the exact figures of the amount of earth that has to be removed, and the distance of haulage. For this reason, the author's estimations are approximate, and therefore, it will not be necessary to go into specific and detailed calculations in selecting and estimating the quantity of road equipment. Nevertheless, the results of the author's calculations seem to have not a large difference from the list of equipment which was prepared for the same area, by American specialists in 1947.

#### Selection of Equipment

a) The complete operation will call for the following major equipment:

1. - Rooters
2. - Bulldozers, Angledozer
3. - Scrapers
4. - Shovels
5. - Trucks
6. - Graders
7. - Compressors

b) Preliminary calculations for the estimation of equipment.

1. Rooters: This type of equipment will be used to break up and loosen hard material before it can be handled by scrapers and dozers.

As the mentioned roads have been under use for many years we

are up to meet hard earth where a bulldozer will not be sufficient to meet the requirements in moving earth. Off hand, it will be very hard to state as to which section and for how many miles rooters have to be used before the scrapers and dozers are applied.

For our rough calculations we may accept that  $\frac{1}{4}$  (one-fourth) of the total mileage namely 350 miles have to be root treated.

Work output can be estimated from tractor speed and the number of passes required to loosen material properly. Tractor speed is based on type and condition of material and number of roter shanks used. Estimates vary greatly in accuracy depending on the estimator, the tractor operator, and the uniformity of material.

As the present roads are not in a very bad shape in connection with grading; in using the roter we have to dig only deep enough to push the material and spread it on some other portion of the road which needs elevating to reach necessary grading.

Calculations:

- a) 3 shank roter of 29" penetration.
- b) D7 Tractor
- c) Material to be penetrated will be assumed to be at an average of 24".
- d) Tractor speed - 1.4 mph.
- e) Roter will loosen a strip of 3 yard wide per pass.
- f) Efficiency factor = 80%
- g) 350 miles, width 9 yards.

$$5280 \times 350 = 1,840,000 \text{ feet}$$

Total time required for one Roter for the above distance

$$\text{Time} = \frac{\text{Distance}}{\text{Rate}} = \frac{1,840,000}{1.4 \times 5280 \times .80} = 314 \text{ hrs per roter}$$

Using 3 rooters, we can obtain a 9 yd. breadth for the total distance in 314 hrs.

Accepting an 8 hr.-day work, we shall need  $314 \div 8 = 39$  days.

Bearing in mind the initial cost of equipment which is one of our major problems, we shall try to perform our operations with the minimum number of equipment. So for the above operations, we shall purchase 4 rooters which will allow for 1 spare to replace any that will be undergoing repairs.

2. Dozers: Dozers are a multipurpose machine capable of digging, pushing, dumping, and spreading. They are used primarily for short haul excavation and as an auxiliary to other earth-moving equipment.

In our operations the dozer will be used mostly for grading rooted or unrooted sections of road which, in most cases, will be spread within a short length. Another use will be for widening the roads to fulfill specifications, and pulling rooters and scrapers.

Considering the first operation we may use the formula:

$$\text{Output} = \frac{Q \times f \times 60 \times E}{C_m}$$

where, Q = haul capacity in loose cubic yards.

f = soil conversion factor

60 = minutes per hour

E = Dozer efficiency factor

C<sub>m</sub> = Total cycle time in minutes

For a D<sub>7</sub>, bowl capacity = 3.38 cu. yd.; average haul distance is 100 ft.

For compacted common earth, F = 1.00; E = 80%

Travel forward 1.5 M.P.H.

Travel backward 2.5 M.P.H.



Gear shifts 10 sec. each.

a) Fixed time:  $10 \times 2 = 20 \text{ sec.} = .33 \text{ min.}$

b) Variable time:

$$1) \frac{100 \times 60}{1.5 \times 5280} = 0.76 \text{ min.}$$

$$2) \frac{100 \times 60}{2.5 \times 5280} = 0.46 \text{ min.}$$

c) Total time:  $.33 + .76 + .46 = 1.55 \text{ min.}$

d) Output:  $\frac{3.38 \times .80 \times 60 \times .80}{1.55} = 83\frac{1}{2} \text{ cu. yd./hr.}$

In the majority of cases the earth removed from one place will be spread to a near by section in order to bring the roads to the required grading. This operation for distances up to 200 feet will be handled by dozers. Over that distance up to 1500(one way) will be done by scrapers; and over that, earth will have to be moved by trucks. The third type will be met only in a few cases as the type of operation does not require it very often.

Assuming that the moving of earth will be done mainly by dozers and scrapers, we may roughly calculate as follows:

From "TM5-252-War Dept. Technical Manual" table VII we have for a 150 ft., level terrain and workable soil of 2700 - 3000 lb. per cu. yd. output of a D 7 bulldozer as follows:

A) For 100% efficiency

a) Return speed 2.5 mph = 66 cu. yd. per hr.

b) Return speed 5 mph = 77 cu. yd. per hr.

c) Average = 71 cu. yd. per hr.

B) For 80% efficiency, and under the same conditions = 57 cu. yd. per hr.

For side hill cut which will be the operation in widening the

roads, for the same bulldozer, this time used as an angledozer, we obtain 72 cu. yd. per hr.

Amount of earth to be moved per mile.

For our rough calculations here, we may make the following assumptions:

a) For side hill cuts;

$\frac{1}{4}$  cu. yd. per yd. of length; we get 440 cu. yd. per mile.  
for 1400 miles.

b)  $1400 \times 440 = 620,000$  cu. yd.

b)  $\frac{1}{2}$  cu. yd. per yd. of length; we get 880 cu. yd. per mile.

For 1400 miles:

$1400 \times 880 = 1,240,000$  cu. yd.

Total excavation:

$620,000 + 1,240,000 = 1,860,000$  cu. yd.

For the total 1,860,000 cu. yds. of earth to be excavated, it will be quite safe to make the following distribution:

Bulldozers: 60% = 1,120,000 cu. yd.

scraper: 30% = 554,000

Trucks: 10% = 186,000

1,860,000 cu. yds.

Average output of a D<sub>7</sub> bulldozer:

$57 \div 72 = 65$  cu. yds. per hr.

For 8 hr. per day:

$65 \times 8 = 520$  cu. yds.

For 210 days per year:

$520 \times 210 = 110,000$  cu. yds.

$1,120,000 \div 110,000 = 11$  bulldozers.

3. Scrapers: The scrapers will be of the tractor drawn type, and will be of 8 cu. yds. struck capacity. They will be drawn by D7 tractors or equal. These types of scrapers are efficient on hauls between 300 and 1500 feet.

Estimating work output

$$\text{Output} = \frac{Q \times f \times 60 \times E}{C_m.}$$

Q = bowl capacity in loose cu. yds.

f = soil conversion factor

60 = minutes per hour

E = scraper efficiency

C<sub>m.</sub> = total cycle time in minutes

According to table XI of the TM5-252 War Department technical manual:

For 8 cu. yd. scraper - D7 tractor operating on a 700 ft. distance we get 86 cu. yds. per hour on level terrain.

For 8 hrs.  $68 \times 8 = 688$  cu. yds.

For 210 days:  $688 \times 210 = 144,000$  cu. yds.

$554,000 \div 144,000 = \underline{4}$  scrapers

5 Scrapers will leave us with a spare one. To these 5 scrapers, we shall have to add 5 more tractors, thus making a total of 16 bulldozers.

4. Shovels: Shovels will mostly be used in loading trucks for long distance haulage, the amount of which has been estimated to be 186,000 cu. yds. Selecting a shovel of  $3/4$  cu. yds. bucket capacity, we get for medium digging 95 cu. yds. per hour.

$95 \times 8 = 760$  cu. yds. per day.

$760 \times 210 = 160,000$  cu. yds. per year

$$186,000 \div 160,000 = 1.16 \text{ shovels.}$$

Here we may accept 2 shovels.

5. Trucks: The following formula is used to estimate the number of trucks required to keep a shovel in operation at highest capacity:

$$N = \frac{1 \div 60 \left[ \left( \frac{d}{V_1} \right) \div T_1 + \left( \frac{d}{V_2} \right) \div T_2 \right]}{n \text{ Cm.}}$$

N = number of trucks

n = number of cycles required to fill a truck

60 = seconds per minute

d = length of haul in feet

$V_1$  = speed of load truck feet per minute

$T_1$  = time required to dump truck (minutes)

$V_2$  = speed of unloaded truck (feet per minute)

$T_2$  = time required in minutes to spot truck under shovel

Cm = cycle time in seconds

For medium digging:

90° swing = 20 seconds

n = 3

d (assume) = 25,000 feet

$V_1$  " = 30 miles per hr.

$T_1$  " = 20 seconds

$V_2$  " = 50 miles per hr.

$T_2$  " = 30 seconds

Cm. = 20 seconds

$$N = \frac{1 \div 60 \left[ \left( \frac{25,000}{30 \times 88} \right) \div \frac{1}{3} + \left( \frac{10,000}{50 \times 88} \right) \div \frac{1}{2} \right]}{3 \times 20}$$

- N = 1 ÷ 6.83 = 7.83 Use 8 trucks

For the 2 shovels we get  $8 \times 2 = 16$  trucks, giving an allowance of 2 trucks per shovel. This number may be boosted to a total of 20 trucks.

6. Graders: Use of graders is controlled by the type of operation, distance material must be moved, and the type and condition of material to be handled. In our earth moving operations, graders will be used for ditching, light stripping, and levelling.

Estimating work output:

$$\text{Total time} = \frac{P \times D \times E}{S}$$

P = number of passes required

D = distance travelled on each pass

E = grader efficiency factor

S = speed of grader

a) Ditching: Use 1st or 2nd gear. For our ditching operations we shall make a rough estimation of  $\frac{1}{2}$  of the total millage, namely, for both sides, 1,400 miles of ditch. Assuming a 3 pass for the ditches, by using 3 graders operating tandem for each operation, we get:

$$S = 2.66 \text{ m.p.h.}$$

$$E = 80\%$$

$$P = 3$$

$$D = 1,400$$

$$\text{Total time} = \frac{3 \times 1,400 \times .8}{2.66}$$

$$\text{Total time} = 1260 \text{ hours}$$

$$\text{Total time} = 1260 \div 8 = \underline{158 \text{ days}}$$

b) Moving and leveling windrows: As ditch cuts are made, windrows are formed between the heel of the blade and the left rear wheel.

The windrow must be moved and leveled off. Also, the the roads should be leveled by graders after the bulldozer operation, before any base course is spread. For this operation, we may estimate as follows:

For the same distance, we may assume 3 more graders for the above following the graders that will be opening ditches. For the earth moving operation, therefore, we may estimate a total of 7 graders including one as a spare.

7. Compressors: Compressors will be used to power the pneumatic tools which are used for: rock drill, clay spade.

Work output: a) one operator may obtain 80 linear feet of 1" holes in hard rock per 10 hour day. b) One operator may obtain 12 cubic yards of tough clay loosened for shovel excavation in a 10 hour day. For our operations, we may estimate a 210 cu. ft. compressor per 200 miles, which will give us a total of 7 compressors.

#### TOTAL LIST OF THE EARTH MOVING AND GRADING EQUIPMENT

ITEM	QUANTITY
Rooters -----	4
Bulldozers -----	16
Scrapers -----	5
Shovels -----	2
Trucks -----	20
Graders -----	7
Compressors -----	7

Equipment Necessary for Preparing,  
Transporting, and Spreading of the Base,  
and Surface Treatment on the Graded Roads

Preparation of the base course:

Base courses should range in thickness from approximately 6 to 12 inches depending on the character of the subbase. When the subbase is of material closely approaching the specified requirements for base course construction, a base course 6 inches in thickness should be adequate.

In our case the roads already are of macadam and gravel construction so we shall use an average thickness of 3 inches new base made up of aggregate of  $1\frac{1}{2}$  to  $2\frac{1}{2}$  inches in size.

Total aggregate necessary for the 1,400 mile roads:

Width - - - - - 9 yds. = 27 ft.

Length - - - - - 1400 x 5280 = 7,350,000 ft.

Thickness - - - - - 0.25 ft.

Volume =  $27 \times .25 \times 7,350,000$  cu. ft.

" = 49,500,000 cu. ft.

=  $49,500,000 \div 27 = 1,840,000$  cu. yds.

The rock crushers accepted for this job will be of the 14 - 18 cu. yd. per hour of the portable type. In our case we may accept an average of 16 cu. yds. per hour.

Rock crushing may be started with the beginning of the project, and material may be stocked; so for base and finish spread the crushers will operate on a 4 year period.

a) Base course: from  $1\frac{1}{2}$ "-  $2\frac{1}{2}$ " size

b) chip spread:  $\frac{1}{2}$ "- 1" size.

For one crusher:

$$16 \times 8 \times 210 = 27,000 \text{ cu. yd./yr.} = 108,000 \text{ cu. yds./4 yrs.}$$

From chart XXXIV of FM5-252, War Department Technical Manual, we obtain 85 per cent of  $2\frac{1}{4}$ " size rock, and 15 per cent of  $\frac{1}{2}$ " size, with a roller opening of  $2\frac{1}{4}$ ".

$$108,000 \times 0.85 = 92,000 \text{ of } 2\frac{1}{4}"$$

$$108,000 - 92,000 = 16,000 \text{ of } \frac{1}{2}"$$

$1,840,000 \div 92,000 = 20$  crushers for the preparation of the base course.

Amount of chip for the surface treatment, using 1 inch thickness:

$$14,000 \times 5280 = 7,350,000 \text{ ft.}$$

$$\text{Volume} = 7,350,000 \times 9 \times 3 \times 1/12 = 610,000 \text{ cu. yds.}$$

$$610,000 - 16,000 = 594,000 \text{ cu. yds.}$$

For the same capacity crushers, we obtain 94,000 cu. yds. of fine aggregate per year per crusher.

$$594,000 \div 94,000 = \underline{6 \text{ crushers}}$$

Total amount of crushers:  $20 \div 6 = \underline{26 \text{ crushers}}$ .

Trucks necessary to spread the aggregate: Of the 26 rock crushers, we may use 2 units working on the same pit, thus decreasing on the amount of the shovels. This leaves us with 13 shovels necessary to feed the rock crushers on the job, and 13 bulldozers to serve the shovels, and the crushers.

For a rough approximation dividing the 1400 miles into 13 sections, we obtain 108 miles for each section.

Trucks necessary to spread one section:

a) Amount of cu. yds. of rock per section

$$1,840,000 \div 13 = 142,000 \text{ cu. yds.}$$



- b) Use trucks to run 54 miles on each side of the pit.
- c) Assume truck to run on a round trip at an average of 30 m.p.h.
- d) Accept a time for a round trip to the nearest point to the pit. For the farthest point, we shall need 216 minutes for a round trip.
- e) With the above assumptions, we get a mean time of 108 minutes for a round trip on one side of a pit.
- f) Yardage hauled per day per truck.

$$\text{number of hauls: } 8 \times 60 \div 108 = \underline{4.45}$$

$$\text{cu. yds. per day per truck: } 4.45 \times 2 = 8.90 \text{ cu. yd.}$$

$$\text{cu. yds. per truck per year: } 8.90 \times 210 = 1860 \text{ cu. yd.}$$

$$\text{cu. yds. per truck per 3 years} = 1860 \times 3 = 5580 \text{ cu. yds.}$$

- g) number of trucks:

1. - For the base course:

$$1,840,000 \div 5,580 = \underline{330}$$

2. - For the fine course:

$$610,000 \div 5,580 = \underline{110}$$

3. - Total amount :  $330 + 110 = \underline{440}$

Type of Surface treatment: For this operation, the author has accepted the most simple and inexpensive method of coating called, "Surface treatment".

This treatment will not exceed one inch of thickness, and will be applied as a double layer. For this method, specifications call for  $\frac{1}{2}$ " - 1" fine aggregate 45-50 lb. per yd.<sup>2</sup>, and this will require .45-.50 gls. of bitumen material.

Distributors: Using an 800 gls. distributor with a 16 ft. spray bar, we obtain 320 sq. yds. per minute. Having divided the

area into 13 sections, we shall need 13 distributors for this operation.

Chip spreaders: We have figured out that we shall roughly need 110 trucks for transporting and spreading the chip, therefore, we shall need the same number of chip spreaders.

Rollers: a) Three wheel type: There is an abundant quantity of this type in this Division which idle most of the time, and which can be used for the compaction of the base.

b) Tandem type: Here we have to accept that rolling of the surface treatment is directly depended on the bituminous spraying. Therefore, having accepted 13 distributors, we shall need the same amount of tandem rollers.

Graders: This type of operation requires that a grader must accompany an asphalt distributor. Therefore, we shall need 13 graders. For our previous earth moving operations, we have already accepted 7 graders which will be added to this operation. This leaves us with 6 more graders necessary for this operation, making a total of 13 graders, and we may accept a minimum of 20 graders.

All the above assumptions and calculations are preliminary and approximate, and slight changes on the figures will have to be considered in the field.

Nevertheless, the accepted list of equipment is the minimum that may be considered for the commencing of this project.

The rest of the equipment given in the list, is required for the efficient operation of the main construction equipment.

The quantity on the finallist has been increased slightly in order to compensate for that equipment that will be undergoing repairs.

## LIST OF EQUIPMENT

NAME	QUANTITY	APPROX. COST \$
1. Rooters	5	4,000
2. Bulldozers	30	280,000
3. Scrapers	8	24,000
4. Shovels	15	220,000
5. Trucks	440	710,000
6. Graders	20	240,000
7. Compressors	7	35,000
8. Crushers	26	400,000
9. H. D. Tractor - Truck and 15 - 20 ton semitractor	3	25,000
10. Double drum sheep foot rollers	5	6,000
11. H. D. Pneumatic tired wheel tractors	5	20,000
12. Over head loaders on crawler tractors	2	10,000
13. Complete gravel producing plant, (bin, conveyer, and vibrator screen with power- to be used with portable crushers.)	13	65,000
14. $\frac{1}{2}$ or $\frac{3}{4}$ ton pick up trucks	30	45,000
15. Small asphalt mixers, portable	6	6,000
16. Chip spreaders	108	30,000
17. 800 - 1000 gal. Truck mounted asphalt distributor	13	45,000
18. Tandem rollers 5 - 8 ton	13	45,000
19. 500 gal. asphalt relay tank on skids	15	7,000
20. 500 gal. water tanks on skids	5	2,500
21. 3" centrifugal water pump	10	4,000
22. Road brooms	7	3,000
23. Small asphalt pots	15	3,000
24. Steam asphalt car heater	10	30,000

## LIST OF EQUIPMENT

NAME	QUANTITY	APPROX. COST \$
25. One-way snow plows	50	8,000
26. "V" snow plows	30	15,000
27. Jeeps	30	30,000
TOTAL-----		<u>\$2,327,000</u>

## TECHNICAL SPECIFICATIONS OF ROAD EQUIPMENT

### 1. Rooters:

**Use:** Excavation of hard soil and rock, before the application of bulldozers and scrapers

#### Specifications:

1. For use with tractors of about 80 B.H.P.

2. Overall dimensions:

- a) Length - - - - - approximately 205"
- b) Width \* - - - - - " 100"
- c) Height - - - - - " 70"

3. Teeth:

- a) Number - - - - - 3
- b) dimensions - - - - - approximately 2.5" x 10"x5 1/4"
- c) Distance between centers of teeth approxi. 44"
- d) Clearance of teeth above ground in raised position about 15"
- e) Depth of teeth penetrate not less than 25"

4. Shoes:

Self sharpening and removable type.

5. Wheels:

- a) double disc - steel rims
- b) diameter 2.5' - 3.5'

6. Control:

- a) cable - improved plow steel
- b) size - minimum 1/2"
- c) length - minimum 75'

7. Shipping weight approximately 9,500 lbs.

## 2. Bulldozers:

- Use: a) clearing and grubbing  
 b) stripping  
 c) ditching and digging

### Specifications - Tractor

#### 1. Engine:

- a) Diesel type  
 b) Displacement - min. 700 cu. in.  
 c) Cylinders - min. 4  
 d) Auxiliary gasoline starting engine.

#### 2. Weight

minimum 21,000 pounds

#### 3. Gauge:

Center to center of track minimum 65"

#### 4. Track shoe:

Width min. 18"

#### 5. Transmission:

- a) Forward min. 5 speeds  
 b) Reverse " 3 "

#### 6. Fuel tank:

Capacity min. 50 gallons

### Dozer:

1. It will consist of: blade, frame, cable, sheaves, combination sheave support, and heavy duty radiator guard and necessary parts to connect with cable control.

#### 2. Blade:

- a) Length 132" - 156"

b) Height		30" - 42"
c) Thickness	min.	3/8"
d) Lift	min.	30"
e) Drop	min.	15"
f) Blade angle	approx.	25°

### 3. Cutting edge:

a) reversible		
b) Length (with end tips)		132" - 156"
c) Width	min.	8"
d) Thickness	min.	3/4"
e) Material		high carbon steel

### 4. Cable control:

Equipped for use with front and rear cable control, with rear cable of 60" - 65" in length.

### 5. Weight:

Approximately 6,300 pounds

## 3. Scrapers

Use: a) Excavating

b) For moderate hauls

c) Dumping and spreading in thin layers as required.

1. Method of operation: cable

2. Capacity:

a) Struck	7 - 8 cu. yd.
b) Heaped	10 - 12 cu. yd.

3. Dimensions:

a) Length	20' - 30'
b) Width	8' - 10'
c) Height	7' - 10'

## 4. Bowl:

- a) Height 40" - 54"  
 b) Bottom dimensions (40" - 54") (95" - 105")

## 5. Cutting edge:

- a) Width of cut approx. 8'  
 b) Thickness min. 3/4"

## 6. Tires:

- a) Front min. two 13.00 x 20 - 16 ply  
 b) Rear " " 13.00 x 20 - 16 ply

## 7 Cable Improved plow steel

- a) Apron lift 7/16"  
 b) Bowl lift, tailgate 1/2"  
 c) Sufficient cable for efficient operation

## 8. Weight:

- a) Maximum 20,000 pounds  
 b) Minimum 13,000 pounds

## 4. Shovels - Crawler type

Use: For excavation and embankment

## Specifications:

## 1. Dipper:

The dipper or bucket shall be 3/4 cu. yd. struck measure.

## 2. Swing:

Shovel shall be full revolving.

## 3. Shovel:

It shall have a min. 15' boom.

## 4. Dipper stick:

To be min. of 11 ft.; chain or cable crowd.



## 5. Dragline:

Boom to be minimum 30', with 1/10 boom extension, dragline fair lead, 3/4 cu. yd. dragline bucket and all necessary cables and fittings for converting above shovel to a drag unit.

## 6. Dimentions:

a) Length - without boom	approx.	16'
b) Width	approx.	8'
c) Height - without boom	approx.	9'

## 7. Crawlers:

a) Ground clearence	min.	12"
b) Width of crawlers	"	8'
c) Width of shoes	"	16"
d) Distance between tracks	"	5.5'

## 8. Cabin:

Full enclosed and locked, all steel construction, detachable rear or side cowls.

## 9. Engine:

a) Gasoline or diesel - 4 stroke, water cooled.		
b) Cylinders	min.	4
c) Displacement	"	300 cu. in.
d) Fuel tank cap.	"	30 gals.
e) H. P.	"	50
f) Self starter		

## 10. Travel speed:

a) Low gear	min.	$\frac{1}{2}$ M.P.H.
b) High gear	"	$1\frac{1}{2}$ M.P.H.

## 11. Weight:

- |                    |                          |
|--------------------|--------------------------|
| a) shovel complete | 23,000lbs. - 26,000 lbs. |
| b) dragline "      | 22,000 lbs.- 25,000 lbs. |

## 12. Complete lighting system.

## 5. Trucks:

Use: a) For hauling and dumping

b) With snow - plows.

## Specifications:

## 1. Engine:

- |                                     |      |             |
|-------------------------------------|------|-------------|
| a) Cylinders                        | min. | 6           |
| b) H. P.                            | min. | 100         |
| c) Torque at 1000 - 1500 RPM - min. |      | 150 lb.-ft. |

## 2. Rear axle

Eaton series 17,500, 2 speed, dual performance, or other approved.

3 Ratio: approx. 6.2 - 1

## 4. Transmission:

- |                   |      |   |
|-------------------|------|---|
| a) speeds forward | min. | 4 |
| b) speeds reverse | min. | 1 |

5. Gross weight min. 14,000 lbs.

## 6. Front axle, and springs:

Designed to handle truck satisfactorily and without failure when used with snow plow attachment.

## 7. Wheel base:

128" - 152", approx. 60" from back of cab to centerline of rear axle.

8. Tires: Front	7.50 x 20	10 ply
Rear - dual	7.50 x 20	10 ply

## 9. Body:

- a) Minimum 2 cubic yards of struck measure.
- b) Hydraulic dump system
- c) Overhead cabin protection.

## 10. Brakes:

- a) Four wheel, hydraulic
- b) Minimum surface brake area 336 sq. in.
- c) Emergency break

## 5. Graders:

- Use:
- a) clearing
  - b) ditching
  - c) diking
  - d) back filling
  - e) levelling
  - f) spreading

## Specifications:

## 1. Engine:

- a) Diesel
- b) Piston displacement min. 525 sq. in.
- c) B.H.P. min. 75
- d) number of cylinders min. 4
- e) Fuel tank cap. min. 40 gals.
- f) Self starter

## 2. Dimensions:

- a) Length approx. 23'
- b) Width " 7.5'
- c) Height " 9'

## 3. Blade:

- a) Size to be approximately 114" x 23", with a min. thickness of 5/8"
- b) Mechanical or hydraulic lifting mechanism.

c) Lift above	min.	16"
side shift	"	36"
Bank cutting angle	min.	90°

4. Road speeds:

- a) to have a minimum of 6 forward speeds
- b) First speed not less than 1.5 mph.
- c) Sixth speed not less than 20 mph.
- d) To have a minimum of 2 reverse speeds

5. Tires:

Front	9.00 x 24	10 ply
Rear	13.00 x 24	12 ply

6. Wheel base: approximately 18'

7. Turning radius: not to exceed 40'

8. Scarifier:

- a) "V" type
- b) Number of teeth 10 - 12
- c) Swath width approx. 46"
- d) Size of teeth " 3" x 1"
- e) Clearance above ground to be not less than 12"

9. Shipping weight approx. 20,000

7. Compressors:

Use: To supply air to:

- a) Paving breakers
- b) Rock drills
- c) Timber saws
- d) Clay spades
- e) Concrete vibrators

**Specifications:**

**1. Engine:**

- a) gas or diesel
- b) stroke                      2 or 4
- c) cylinders            min.            4
- d) B.H.P.                min.            60

**2. Compressor:**

- a) Capacity                min.            210 cu. ft./min.
- b) Pressure                min.            100 psi
- c) RPM                      850 - 1500
- d) stages                    min.            2
- e) Automatic control system

**3. Frame:**

- a) steel on steel springs
- b) Minimum 4 pneumatic tires
- c) Tay arm

**4. Dimensions:**

- a) Length                              10' - 12'
- b) Width                                5' - 6'
- c) Height                                5' - 8'

- 5. Weight:    Approx.                      6,500 lbs.

**8. Portable Rock Crusher:**

**Use:** To produce clean, graded aggregate for base courses,  
surfacing pavements and structures:

**Specifications:**

- 1. Capacity:                      14 - 18 cu. yd. per hr.
- 2. Unit:    The crusher will be portable and designed for

shovel or dragline feed.

The whole unit will consist of a crusher, vibrating screen, charging hopper, feeder, delivery conveyor, rotovator (elevator), under conveyor, and necessary chutes, and driving connections, all mounted on a steel gooseneck truck.

3. Crusher: Steel frame overhead eccentric force feed jaw type, reversible jaws, roller bearings.

Size of feed opening to be not less than 10"x16".

Size of flywheel to be not less than 30"x8" and R.P.M. of eccentric shaft approx. 200.

4. Screen: To be of the vibrating type, with roller bearings, and having a size of approx. 2' x 6'.

5. Charging hopper: All steel, and to be not less than 3 cu. yd.

6. Rotovator: It will consist of a drum, with built-in buckets. The drum will revolve, so that material from the conveyor is deposited into the drum and elevated and deposited onto the feeder conveyor.

To be not less than 5' in diameter and 15" wide.

7. Conveyors:

a) Feed conveyor width to be not less than 15"

b) Delivering conveyor width to be not less than 15".

c) Under conveyor width to be not less than 12'.

d) All conveyors to be channel frame type with roller bearings, head and tail bearings,

guards will be provided to return belts.

8. Truck: Gooseneck type, channel frame not less than 10". Equipped with towing bar, and brakes on rear wheels.

. Tires:

a) Pneumatic tires front - dual min. 7.50 x 20

8 ply.

b) Pneumatic tires rear-dual min. 7.50 x 20

8 ply.

10. Power: Unit to be equipped with a diesel or gas engine of not less than 30 H.P.

11. Dimensions:

a) Width approx. 8'

b) Length " 27'

c) Height " 12'

12. Weight: approx. 20,400 pounds

## 9. H. D. Tractor - Truck and Semitrailer

Use: For transporting heavy machinery.

Specifications: Tractor - Truck

### 1. Engine

a) Diesel or gas

b) B.H.P. minimum 126 at approx. 2300 R.P.M.

c) Piston displacement min. 515 cu. in.

d) Number of cylinders min. 6

e) Torque min. 3600 lb./ft.

f) Fuel tank min. 30 gals.

g) Oil system full pressure

2. Wheel base: to be approx. 155"
3. Gross weight: to be minimum 28,000 lbs.

4. Transmission:

- a) 4 wheel drive
- b) Forward min. 4
- c) Reverse " 1

5. Brakes:

- a) Service brakes on all 4 wheels
- b) Parking brakes.
- c) Air brakes will be hand controlled for operating trailer brakes. Brakes to be completely installed with compressor, necessary valves and supply tanks, together with necessary connection for semitrailer operation.

6. Tires:

- a) Front singel 11.00 x 20 8 ply
- b) Rear dual 11.00 x 20 8 ply

7. Cab:

Coupe type, 3 men cushion mounting, safety glass throughout "V" type windshield, cowl ventilator, rear window.

8. Lighting: Minimum 12 volt battery, head lamps, tail light, dome light, instruments group lights, electric fan, and dual windshield wipers.

Semitrailer:

1. Capacity: 15 tons minimum

2. Dimensions:

- a) Length including gooseneck approx. 26'
- b) Width: Platform width at front of gooseneck approx. 5'



- At rear of gooseneck approx. 8'
- c) Height under frame " 18"
- d) Thickness wood floor to be not less than 2"
3. Rear axle: There will be two oscillating type axles, flexibly attached to two rocking bolsters, so arranged that the four wheels adjust themselves to the irregularities of the road. A minimum distance of 40" between tandem axles to be equipped with wheels having a total of 8 7.50 x 15 heavy duty pneumatic tires.
4. Brakes: Total brake surface to be not less than 350 sq. in. Brakes to be straight air type, hand operated on all wheels, with everything furnished, including the air brake connecting hoses up to the rear of the truck cab.
5. Lights: To be equipped with rear lights.
6. Loading: to be equipped with complete loading devices.

#### 10. Sheep Foot rollers:

Use: For compacting all plastic soil. Effective on most base-course materials containing soil binder. Can be used on layers of loose, well graded soils not over 9" thick. Will not compact broken rock, gravel or sand.

#### Specifications:

1. It will be of two section oscillating type - double drum sheep foot roller. The drum and heads to be a minimum of 3/8" steel plate welded construction, with intermediate heads for strength. Flanges and plugs for filling and draining to be furnished in each end of drum. Intermediate heads must be so that drums can

be entirely drained. Frames to be constructed so that rollers can be used with single or double drum with tongues furnished on each operation, a minimum of two tongues, equipped with H. D. swivel levises and I - bolt hitch.

Each drum to have a minimum of 110 tamping feet. Drums shall be equipped with H. D. Timken rollers, or other approved, bearing enclosed in dust and moisture proof housing attached to tongue. Shaft to be fixed on the drum, and will rotate in the bearing housed on the tongue. Balast will be water and sand. Tamping feet to have a minimum  $5\frac{1}{2}$  sq. in. of bearing surface.

2. Length of each drum to be approx. 48"
3. Diameter without feet to be approx. 40"
4. Diameter with feet to be approx. 54"
5. Number of feet on ground for each drum min. 4
6. Weight:
 

a) Empty	min.	6,200 lbs.
b) Loaded (water)	min.	9,950 lbs.
c) Loaded (sand)	"	11,540 lbs.

#### 11. H. D. Pneumatic Tired Wheel Tractor

- Use: a) For pulling sheep - foot rollers,  
 b) Trailer type graders  
 c) Other uses.

#### Specifications:

1. Engine:
  - a) Gas or diesel

b) Cylinders	min.	4
c) Displacement	min.	33 $\frac{1}{4}$ cu. in.
d) R. P. M.		1000 - 1500
3) B. H. P.	min.	45

## 2. Transmission

a) Speeds forward	min.	4
b) Speeds reverse	min.	1
c) Speed range		
1. low gear	approx.	2 mph.
2. high gear	"	12 mph.

## 3. Tread:

a) Front wheels	50" - 64"
b) Rear wheels	65" - 82"

## 4. Tires:

a) Front	12.00 x 20	14 ply
b) Rear	21.00 x 25	20 ply

## 5. Dimensions:

a) Length	132" - 145"
b) Width	77" - 96"
c) Height	68" - 88"
d) Wheel base	83" - 93"
e) Turning radius	max. 190"

6. Weight: To be between 8,500 lbs. - 10,500 lbs.

7. Brakes: Shall be equipped both with service and parking brakes

## 12. Overhead Loaders on Crawler Tractors

Use: For loading into trucks from confined structural excavation areas.

**Specifications:**

1. **General:** To be mounted on crawler-tractor and to be of the overhead swing type.

2. **Dimensions:**

a) Length (without boom)	approx.	11'
b) Width	"	6.5'
c) Height (without boom)	"	9'
d) Truck width	min.	14"

3. **Boom:** To have a length of approx. 13'

4. **Engine:**

a) Diesel

b) B. H. P. min. 30

5. **Bucket:** To have a capacity of  $\frac{1}{2}$  cu. yds. and will be designed for tough digging. It will have tripping mechanism controlled from the cab, and it will be equipped with teeth made of special steel.

6. **Cable:** Length of cable to be not less than 38', made of plow steel of minimum 9/16". Cable speed not less than 200 ft. per minute.

7. **Weight:** To be about 14,700 lbs.

**13. Complete Gravel Producing Plant**

**Use:** a) To produce and store aggregate

b) To load trucks

**Specifications:**

1. **General:** Plant will include Bin, conveyor, vibrating screen and power unit.

2. **Bin:** To have a capacity of 10 - 12 cubic yards. It

will be equipped with jack type legs for raising and lowering the hopper. The lower part of the legs will be removable for transportation. Top dimensions to be about 8' x 10' and will be constructed of minimum #10 plates, strongly reinforced rivetted and welded. Discharge to be at the bottom and it will be of two way opening type with long handles permitting operator to work easily. Under hopper to have ample space for trucks to go under.

3. Screen: To be of the vibrating two deck type, size of which will be approximately 3' x 6', and not to exceed 1550 lbs. weight. Screen to be mounted on a frame on top of the hopper. To have a shaft throw between  $\frac{1}{4}$ " - 1/8", and shaft to rotate about 1100 R.P.M. In case a separate motor is used, it should not be less than 3 H.P. air cooled engine. Inclination of the screen to be adjustable. Screen will be equipped with a set of 2", 1 $\frac{1}{2}$ ", 1" 3/4",  $\frac{1}{2}$ " and  $\frac{1}{4}$ " size wire gauges.
4. Conveyor: To be of the sectional lattice type with support frame (horse) conveyor to have head and tail shaft bearings, and antifrictional going and return rollers. Going rollers to be of "V" type. Bottom bearing to be adjustable, so that belt can be tightened. A trough to be fitted over the bottom of the conveyor, of about 2' x 4'. Frame to move on a minimum 2 pneumatic tired wheels, and conveyor to be raised and lowered in the frame by means of cables operated by levers at the bottom of the frame.

## 5. Dimensions:

- a) Length of conveyor to be about 60'
- b) Width of belt minimum 20"
- c) Belt thickness minimum 4 ply
- d) Top rubber cover min. 5/32"
- e) Bottom rubber cover min. 1/32"

6. Motor: An air cooled gas engine of not less than 10 H.P. In case a single unit is used to drive the conveyor and screen shafts, an air cooled gas engine of not less than 15 H.P. to be used. Engine can be mounted on skids on the ground, or on bin.

7. Weight: Total weight of plant to be about 11,000 lbs.

14.  $\frac{1}{2}$  - 3/4 Ton Pick-Up Trucks

Use: Transportation of personnel, and light machinery, spare parts, etc.

## Specifications:

## 1. Engine:

- a) Gas engine
- b) Displacement min. 134 cu. in.
- c) H. P. min. 60
- d) Cylinders min. 4
- e) Torque at approx. 2,000 RPM - min. 106-lb.-ft.

## 2. Transmission

- a) Speeds forward min. 3
- b) Speeds reverse min. 1

3. Gross weight approx. 5,000 lbs.

4. Wheel base : " 115"

5. Body: Steel body approx. 78" x 49" x 16" with steel mounted canvas cover.
6. Cabin: Safety, steel cab, soft, deeply padded seats.
7. Brakes: Hydraulic service brakes on 4 wheels, and mechanical parking brake.
8. Tires:
 

a) Front	7:00 x 16	6 ply
b) Rear	7:00 x 16	6 ply
9. Shock absorbers: Hydraulic double acting front and rear.

#### 15. Portable Asphalt Mixer

Use: to mix chip with bitumen.

Specifications:

1. Mixing drum: Horizontal type, either tip discharge, power operated with unloading chute, or side discharge power or manual operated with unloading chute.

Heat chamber shall be properly baffled to distribute the heat. Extra set of renewable blade tips on paddles to be furnished.

2. Skip Loader: Shall have a capacity of about 14 cu. ft. complete with protected ball or roller bearings.
3. Heater: Littlefort - Aeroil, or equal, and fuel tank to be a minimum capacity of 20 gals.
4. Engine: Gas engine, 4 cylinder air cooled type, with a minimum 30 H.P. with clutch for operating mixing drum and charging skip.
5. Trailer: Mixer unit to be mounted on a 4 wheel pneumatic tire trailer with a minimum 6:00 x 16 - 6 ply tires. Length of trailer tongue to be approx. 6 feet.

6. Oil Measuring Tank: Tip over type, lever operated,  
15 gallons capacity.

#### 16. Chip Spreader

Use: To spread sand and other aggregate evenly on road and runway surface at controlled rates of spread.

#### Specifications:

##### 1. Spread box:

a) Length	approx.	10'
b) Width	"	45"
c) Height	"	35"
d) Number of support wheels	min.	4
e) Tires (heavy duty)	6:00 x 9 min.	6 ply
f) Spread box capacity	approx.	27 cu. ft.

##### 2. Method of feed: Cylindrical rollers

##### 3. Hopper material

To be minimum of 3/16" welded steel plate.

##### 4. Feed roll: To be approximately 6" in diameter and to have dust-proof self-aligning, heavy duty ball bearings.

##### 5. Gate: To be of minimum 3/16" steel plate

##### 6. Transmission: Dust-proof years run in oil bath. Hardened years with forward, reverse, and neutral speeds on the feed roll.

##### 7. Agitator: Right and left hand, spiral, reversible, transferring material to the ends of the box.

##### 8. Automatic couplers: Adjustable vertically, swiveled to follow contour of road surface. Truck hitch, adjustable to fit in various trucks.

##### 9. Weight approx. 1950 lbs.



## 17. Truck - Mounted Asphalt Distributor

Use: To spray bitumen.

### Specifications:

1. General: 800 gals. elliptical in shape with surface plates and bulk heads to prevent sudden shifting of contents. Tank to, be insulated with first-grade insulation and to be covered with sheet iron shell or jacket. Tank to be complete with a minimum of 14' x20" oval shaped or 16" round man hole, with quick opening cover. Tank guage to be so mounted, that it is readable from the rear of the tank, capable of registering the amount of fluid in tank at all levels.

Thermometer well constructed within tank and complete with engraved armour coat covered. Steel measuring stick graduated to 25 gals. increments.

Tank to have sufficient flu gas piping for the heating of the bitumen. Tank to be provided with 3" diameter overflow.

### 2. Engine:

Suitable gas engine not mounted at rear of tank, capable of operating a pump with a delivery capacity of approximately 375 gals. per minute. Engine to be equipped with self starter, and transmission.

Transmission to have a minimum of 2 speeds. Controls to be accessible for engine operation from rear operator platform.

3. Pump: Pump to be mounted at rear of distributor and to have a capacity approximately 375 gals. per minute.

and to transfer asphalt to other cars.

4. Other equipment:

- a) Oil burners
- b) Fuel tank capacity 30 gals. min.
- c) Hand spray attachment
- d) 25 ft. of 1" metallic hose with hand spray bar.
- e) Signal system between driver and operator.

5. Truck:

- a) Double truck frame
- b) Engine - 6 cylinder with a minimum 235 cu. in. displacement.
- c) Wheel base to be approximately 160" with rear of cab to center rear axis of approximately 83".
- d) Frame to be of reinforced double section.
- e) Heavy duty front and rear springs
- f) Tires:

Front	7.50 x 20	min.	8 ply
Rear (dual)	9.00 x 20	"	8 ply

• Tandem Rollers:

Use: Compaction consolidate bitumen and aggregate.

Specifications:

1. Engine:

- a) gas or diesel
- b) Displacement min. 220 cu. inches
- c) Number of cylinders min. 4
- d) B.H.P. between 1400 - 1600 R.P.M. - min.
- e) Fuel tank capacity min. 20 gals.
- f) Electric starter and generator

## 2. Transmission Speeds

- |               |         |               |
|---------------|---------|---------------|
| a) Low speed  | minimum | 1 mi. per hr. |
| b) High speed | "       | 2 mi. per hr. |

## 3. Dimensions:

- |                     |       |             |
|---------------------|-------|-------------|
| a) Length           | to be | 170" - 180" |
| b) Width            | " "   | 60" - 70"   |
| c) Height           | " "   | 80" - 90"   |
| d) Wheel base       | " "   | 100" - 125" |
| e) Ground clearance | "     | 10" - 15"   |

## 4. Compression Roll

- |                                      |         |           |
|--------------------------------------|---------|-----------|
| a) Width                             | to be   | 50" - 55" |
| b) Diameter                          | " "     | 50" - 55" |
| c) Water capacity                    | approx. | 360 gals. |
| d) Axle shaft diameter min.          |         | 3"        |
| e) Bearing - Roller or ball bearings |         |           |

## 5. Steering roll

- |                                      |       |           |
|--------------------------------------|-------|-----------|
| a) Width                             | to be | 50" - 55" |
| b) Diameter                          | " "   | 35" - 45" |
| c) Axle shaft diameter min.          |       | 2½"       |
| d) Water capacity                    | "     | 200 gals. |
| e) Bearing - Roller or ball bearings |       |           |

## 6. Brakes: Parking brakes

## 7. Sprinkler System:

- |  |      |          |
|--|------|----------|
| a) Cravity type                            |      |          |
| b) Tank capacity                           | min. | 70 gals. |
| c) To be equipped with a mat on each rolls |      |          |
| d) Distribution pipes to both rolls        |      |          |

## 8. Weight of Roller

- |                   |       |                           |
|-------------------|-------|---------------------------|
| a) Empty          | to be | 10,000 lbs. - 12,500 lbs. |
| b) Rollers filled |       | 16,000 " - 18,500 "       |

## 9. Steering mechanism: Hydraulic type

## 10. Electric lights:

- |          |   |
|----------|---|
| a) Front | 2 |
| b) Rear  | 2 |

## 19. Asphalt Relay Tank:

Use: To transport asphalt from stationary tanks to the distributors.

## Specifications:

## 1. Capacity

Approximately 500 gals.

Elyptical type

## 2. Dimentions:

- |           |         |     |
|-----------|---------|-----|
| a) Length | approx. | 72" |
| b) Width  | "       | 57" |
| c) Height | "       | 35" |

## 3. General:

The shell shall be of 10 ga. and heads of 7 ga. steel plates, with single return V - type flu, and stack, minimum of 5" diameter located in lower 1/3 of tank. Over flow pipe minimum 1/4" oil burner, and approximately 10 gals. pressure tank and head pump, connected to burner.

A 3" gate valve outlet at burner end. Minimum 16" quick opening manhole. Tank shall be all skid mounted. Skids to be insulated from tank.

## 20. Water Tank on Skids

Use: For distributing water to the projects, and job areas.

### Specifications:

#### 1. General:

The tank shall be of approximately 500 gals. in capacity, and will be of the oval type, with approximate dimensions of 38" x 57" x 66" constructed of No. 10 ga. galvanized all welded material.

Tank to be mounted on wooden skids. Manhole to be approximately 16" in diameter, fitted with approximately 5" screw plug.

Outlet to be 2" with gate valve equipped for attaching hose.

Baffle plate to be welded to shell with openings cut out at top and bottom.

## 21. Centrifugal Water Pump

Use: To pump water from rivers and lakes.

### Specifications:

The pump to be of motorized self priming type with 3" discharges. To have a maximum capacity of 15,000 gls. per hour, also to be capable of pumping at least 215 gls. per minute under a total head of 40'.

Pump to be furnished with vacuum gauge and suction strainers for hose. Whole unit to be mounted on two or four pneumatic tired wheels with appropriate handle for easy movement.

Power to be supplied by an air or water cooled gasoline engine of not less than 5 H.P.

Hose to be not less than 40' with filter for suction,

and 40' for discharge.

## 22. Trailer Type Road Brooms

Use: For removing extraneous loose material from surface to be treated.

### Specifications:

#### 1. Broom dimensions:

- a) Length to be between 6' - 8'
- b) Diameter to be between 2' - 3'
- c) To be mounted on a shaft not less than  $1\frac{1}{2}$ " diameter, with end ball, dust sealed bearings.
- d) Broom will be raised and lowered, and held to any adjustment by means of quick acting mechanical or hydraulic jack.
- e) Broom to be two direction type, to be adjusted to sweep either right or left, or locked at central position.

#### 2. Transmission:

To be driven from the rear wheels. Welded steel gear box containing heavy gears and mounted on the rear axle. To have a minimum of two speeds. Transmission to be accomplished by steel chain. At 5 mph. minimum R. P. M. of brush at low gear to be not less than 30.

#### 3. Frame:

Main frame shall be all welded, and not less than 5" channels, or tubes.

#### 4. Wheels:

To have minimum 3 wheels with a minimum 6.00 x 16 4 ply pneumatic tires.

5. Pulling tongue: to be not less than 5'

6. Weight approx. 2000 lbs.

### 23. Small Asphalt Pots

Use: For repair work

#### Specifications:

##### 1. Capacity

To be approximately 150 gls., and to have a double heat circulation and an inverted "V" shape screen to keep the cold materials out of the reservoir of hot stuff. A single or double torch burner capable of producing enough heat.

##### 2. Frame

Cattle to be mounted on a steel frame trailed on two pneumatic tired wheels, and a hitch at front for attaching it to the truck.

##### 3. Hand spray attachment:

To be equipped with hand operated pump, and a hose with spray pipe not less than 10.

##### 4. Fuel Tank

To be equipped with a fuel tank and a fuel line running to the burner. Fuel tank to have a pressure gauge, and heater to be equipped with a thermometer.

### 24. Steam Asphalt Car Heater

#### Use:

- a. To melt asphalt in stationary and relay tanks.
- b. To wash machinery before doing repairs.

#### Specifications:

Unit to have a steam generator for heating asphalt tank

and, through coils. It will provide steam at any pressure up to 200 psi in about 7 - 10 minutes time, and super heated steam in about 8 - 15 minutes time. It will be coil type steam generator oil fired.

Completely automatic with safety factors to govern the operation. Water or air cooled engine operating the water pump, and blower for the burner, and fuel pump.

It will contain a feed water tank of not less than 125 gls. capacity. Pressure gauges for steam and water, water strainer, fuel controls, thermometers etc.

Two 3" flexible metal hose between 10' - 16' in length and all regularly furnished hose couplings, valves, fittings and tools.

## 25. One-Way Snow Plow

Use: To plow snow not more than 12" thick

### Specifications:

1. To be mounted on  $1\frac{1}{2}$  ton trucks.

2. General:

Heavy reinforced arc welded construction, high carbon steel cutting blades. Plow shall have under-slung push frames which attach to truck frame. Hand or power hydraulic hoist pump. Quick unhooking features.

3. Dimensions:

a. Cutting width	7' - 9'
b. Height at front	2' - 3'
c. Height at rear	3' - 4'



- d. Moldboard thickness 8 ga.
4. Weight Approx. 600 lbs.
5. Angle  $35^{\circ} - 50^{\circ}$

26. "V" type snow plows

Use: To plow snow not more than 20" thick.

Specifications:

1. To be mounted on heavy-duty trucks.
2. General:

Heavy reinforced arc welded construction. High carbon steel cutting blades. Plow shall have underslung push frames which attach to truck frame. Hand or power operated hydraulic hoist. Quick unhooking features.

3. Dimensions:

- |                           |           |
|---------------------------|-----------|
| a) cutting width          | 7' - 9.5' |
| b) height at front        | 3' - 4'   |
| c) height at rear         | 5' - 5.5' |
| d) top width              | 7' - 10'  |
| e) thickness of moldboard | 3/16"     |

4. Weight:

Complete unit	approx.	2000 lbs.
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## MACHINE AND AUTOMOTIVE REPAIR SHOPS

For the repair and maintenance of the road construction equipment, we shall need a certain number of such shops which will be located at certain districts of the area.

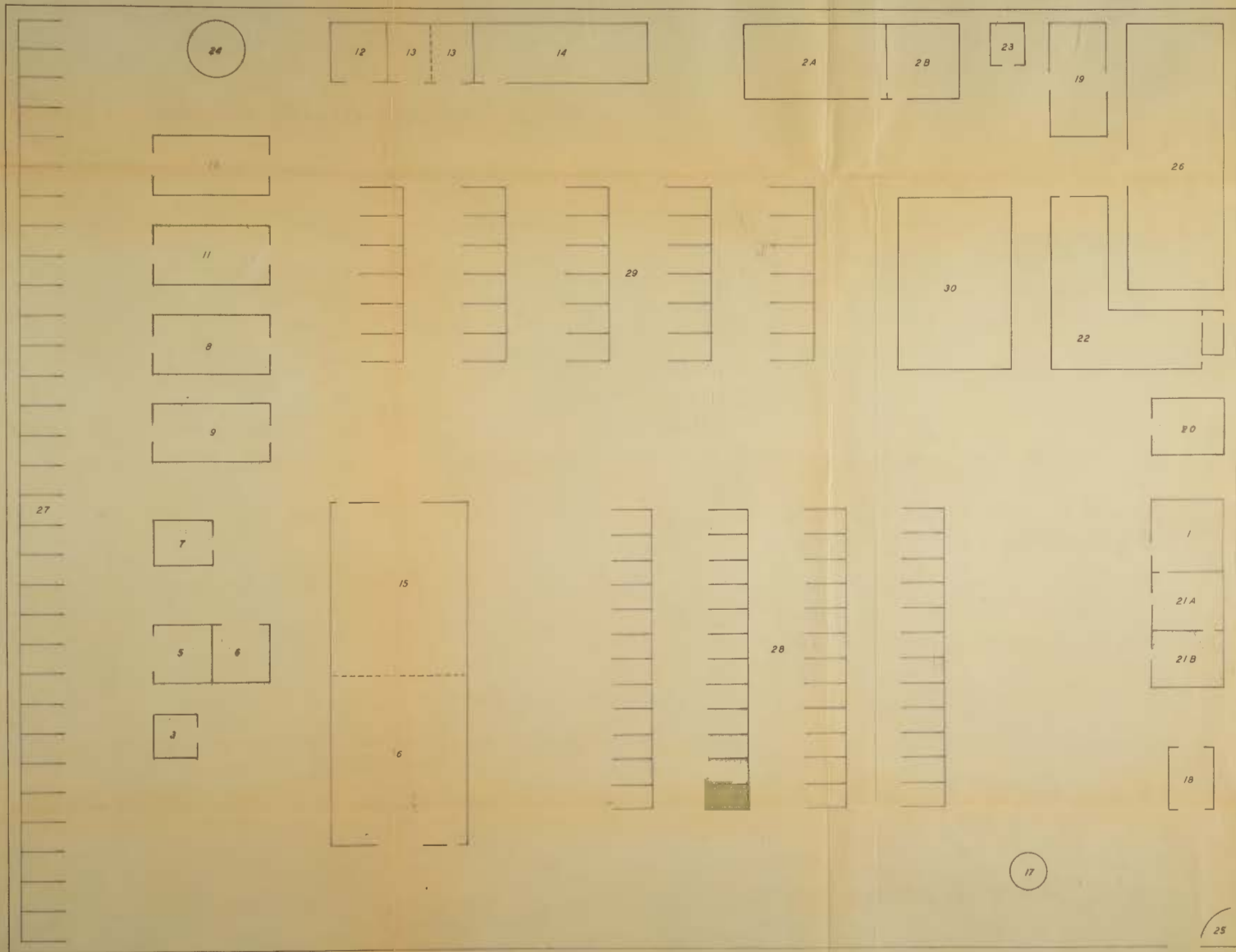
The erection and installation of these shops will be completed before the project on the reconstruction of the roads commences.

For this purpose, I have selected one central, and five district shops in smaller capacity, the location of which are as follows:

Central shop:	Ankara
District shops:	
No. I	Bolu
No. II	Kastamonu
No. III	Eskisehir
No. IV	Cankiri
No. V	Karabuk

## BRIEF SPECIFICATIONS OF THE BUILDINGS

All buildings will be of the hangar type, all bolted steel frame construction, and which will be covered with galvanized metal sheets on outside, and wall boards on the inside for heating efficiencies. The floor will be of concrete base of not less than 10 inches thickness. These shops under necessity may be dismantled and erected at some other location of the country.



CENTRAL SHOPS  
 FOR IX DIVISION  
 SCALE: 1" = 30'

## CENTRAL SHOP DEPARTMENTS

1. Administration
- 2a. Cafeteria
- 2b. Lounge room
3. Mens room
4. Shower room
5. Lubrication
6. Washing
7. Power house
8. Spare parts, Machine shop
9. Spare parts, Equipment
10. Welding and Forge shop
11. Wood shop
12. Wheel alignment
13. Paint shop
14. Tire repair and relining
15. Repair shop, Heavy duty
16. Repair shop, Light duty
17. Gas station
18. Trucks and Cars inspection
19. Warehouse, Construction materials
20. Infirmary
21. Civil Engineers
- 21b. Mechanical Engineers
22. Dormitory
23. Warehouse, Luboil
24. Water tower
25. Main Gate

26. Junk yard
27. Open truck garage
28. Parking, trucks and cars
29. Parking, Heavy duty

List of machinery, tools, and their distribution to each department.

Heavy and light duty equipment repair and machine shop.

Item	Quantity	Est. Cost
1) Bars, wrecking & pinch	4	6.00
2) Clamps, "C", 4" & 6" heavy duty (6 of each size)	2 sets	150.00
3) Blocks, "V", with clamps	2 pair	60.00
4) Calipers, machinist, 4", 6", 8", 10", 16" inside	1 set	30.00
5) Calipers, machinist, 4", 6", 8", 10", 12", 18" outside	1 set	90.00
6) Clamps, saw filing	2	10.00
7) Cans, oil, $\frac{1}{2}$ pint size	10	10.00
8) Clamps, machinist, strap type, 6"	6	18.00
9) Cleaners, piston ring groove	4	12.00
10) Cleaners, valve grinder	1 set	15.00
11) Compressor piston ring	4	12.00
.. Cutters, woodruff Key seat high speed	2 sets	60.00
3/4" x 1/8" 1"x3/8"		
3/4" x 5/32" 1 1/4" x 1/4"		
3/4" x 1/4" 1 1/2" x 5/16"		
1" x 3/16" 1 1/2" x 1/4"		
1" x 7/32" 1 1/2" x 3/8"		
Cutters, side milling, high speed	2 set	130.00
4" x 1" x 1 1/4"		
6" x 1" x 1 1/4"		
8" x 1" x 1 1/4"		
Cutter, milling, plain, high speed	2 sets	45.00
3" x 2" x 1 1/4"		
3" x 3" x 1 1/4"		
Cutter, spiral end mill., high speed taper shank.	2 sets	
3/8", 1/2", 3/4", 7/8", 1", 1 1/4"		
12) Cutters, gasket	2	30.00

13) Cutters, bolt, 36"	2	15.00
14) Cutters, Bolt, 18"	2	10.00
15) Calipers, 5", pocket slide	2	12.00
16) Clamps, brake lining, tightening	1	5.00
17) Cords, extension, 25' long	6	9.00
18) Chucks, drill, 0" - $\frac{1}{2}$ ", with arbors	2	20.00
19) Dies, steel figures, 3/16"	2 sets	10.00
20) Dies, steel letters, $\frac{1}{4}$ "	2 sets	10.00
21) Dies, steel letters, 3/16"	2 sets	10.00
22) Dies, steel letters, $\frac{1}{4}$ "	2 sets	10.00
23) Dies, with collets & stock, $\frac{1}{4}$ " - $1\frac{1}{2}$ " N. C. Thread	1 set	100.00
24) Dies with collets & stock $\frac{1}{4}$ " - $1\frac{1}{4}$ " N. F. Thread	1 set	100.00
25) Dies, with stock, machine screw 6 - 32, 6 - 40, 8 - 32, 8 - 36, 10 - 24 10 - 32, 12 - 24, 12 - 28	1 set	35.00
26) Dies, taper pipe with reversable <del>reversable</del> ratchet handle 1/8", $\frac{1}{4}$ ", 3/8", $\frac{1}{2}$ ", 3/4", 1", $1\frac{1}{4}$ "	1 set	100.00
27) Dividers, machinist, 6" & 12"	2 sets	8.00
28) Dressers, emery wheel	4	18.00
29) Drill, portable, electric $\frac{1}{4}$ " heavy duty	2	90.00
30) Drill, portable, electric 5/16" heavy duty	2	100.00
31) Drill, portable, electric 5/8" heavy duty	2	160.00
32) Drills, twist, high speed taper shank $\frac{1}{2}$ " - $1\frac{1}{2}$ " by 1/32"	1 set	30.00
33) Drills, twist, straight shank 1/32" x $\frac{1}{2}$ " x 1/32"	2 sets	50.00
34) Drills, twist, straight shank, #1-60, wire gauge(manufacturers standard)	2 sets	24.00



35) Drills, combination drill & countersink (3 of each size) 1/16", 1/8", 3/16"	1 set	7.00
36) Drills, hand, ratchet type, 9/16" chuck capacity	2	15.00
37) Dogs, lathe, 1/2", 3/4", 1", 1 1/2" 1 3/4", 2", 2 1/2", 3"	1 set	16.00
38) Extinguishers, fire, 2 gal size	4	80.00
39) " " 1 qt. size	3	30.00
40) Easy outs	2 sets	5.00
41) Grinder, pedestal type, electric 12"	1	250.00
42) Grinder bench type, electric 8"	2	150.00
43) Grinder, valve seat, concentric type, electric, for comple range, from passenger cars to D-8 Caterpillar Tractor, with abrasive wheels for same complete range, with 15°, 30°, 45°, 75° wheels.	1	830.00
44) Grinder, piston pin hole and hydraulic brake cylinder bore, electric	1	200.00
45) Grinder, valve, hand	3	12.00
46) Grouler, for armature (generator, motor, magnets)	1	60.00
47) Gauge, center	2	3.00
48) Gauge, cylinder, dial type	2	70.00
49) Gauge, thickness	4	16.00
50) Gauge, thread	2	8.00
51) Gauge, surface	1	5.00
52) Gauge, wire drill	1	3.00
53) Gauge, tap drill size	1	2.00
54) Gauge, for adjusting ring, gear, and pinion	1	35.00
55) Gauge, twist drill sharpening	1	3.00

56) Gauge, tire pressure	4	12.00
57) Gauge, diesel pressure tester with adapters	1	75.00
58) Gun, air blow	4	8.00
59) Grinder, tool post, heavy duty	1	200.00
60) Hammers, all types under 4 lbs. each (set of 20)	1 set	30.00
61) Hammers, all types over 6-16 each (Set of 6)	2 sets	60.00
62) Hoist, chain, geared type 1½ ton	2	150.00
63) Hoist, chain, geared type 3 ton	1	245.00
64) Hone, engine cylinder, for passenger car	1	50.00
65) Hone engine cylinder, for large trucks	1	50.00
66) Indicator, speed	2	8.00
67) Irons, soldering	2	4.00
68) Jack, 5-ton hydraulic	8	120.00
69) Jack, 4-ton hydraulic floor type	2	300.00
70) Jack, 10-ton, floor type hydraulic	1	200.00
71) Lights, timing	2	15.00
72) Lamps, extension, with 25' cords	10	36.00
73) Ladles, for babbit	2	4.00
74) Lathe, 12" swing x 6' between centers, with taper attachment, face plate, steady rest, centers, chucks, tool holders, knurling tool.	1	4,500.00
75) Lathe, brake drum, stationary spindle type, heavy duty for all passenger cars and trucks, complete with all adapters and clutch plate grinding attachment	1	2,000.00
76) Lifters, valve, universal type	3	15.00
77) Machine, cylinder rebaring, passenger cars and light trucks	1	475.00

78) Machine, cylinder reboring heavy duty trucks	1	630.00
79) Machine, brake re-lining complete with drilling and countersinking equipment.	1	215.00
80) Micrometer, outside 0" - 1"	2	20.00
81) Micrometer, outside 0" - 2"	2	20.00
82) Micrometer, outside 2" - 8"	1	25.00
83) Micrometer, inside 1½" - 18"	2	40.00
84) Mandres, lathe	1 set	150.00
85) Outfit, drill steel shanking and bit sharpening	1	50.00
86) Outfit, carburator repair	2	150.00
87) Pliers, tire chain repair	2	3.00
88) Pullers, clutch pilot bearing	2	8.00
89) Pullers, wheel, universal type	2	25.00
90) Pullers, for engine sleeves	2 sets	60.00
91) Pullers, gear and axle	1 set	500.00
92) Pullers, bearing and bearing race	1 set	150.00
93) Press, drill, upright, 1½" capacity, multispeed, with back gear, complete with drill chuck 0" - ½"	1	250.00
94) Press, hydraulic, 60-ton vertical, hand operated	1	150.00
95) Press, arbor	1	45.00
96) Press, tractor track pin	1	150.00
97) Rules, flexible, steel, 6' with case	4	12.00
98) Rules, steel, 6"	4	4.00
99) Reamers, high speed, straight shank, 3/8", 7/16", 15/32", ½", 17/32", 5/8", 9/16", 19/32"	1 set	32.00

100) Reamers, high speed, taper shank, 17/32", 9/16", 19/32", 5/8", 21/32", 11/16", 23/32", 3/4", 25/32", 13/16", 27/32", 7/8", 29/32", 15/16", 31/32", 1"	1 set	75.00
101) Reamer, cylinder ridge, medium size	2	30.00
102) Reamer, cylinder ridge, large size	2	36.00
103) Reamer, taper pin, #1 -#10, spiral	1 set	15.00
104) Reamer, expansion, spiral type, with pilots to cover complete range from 3/8" - 1 1/2"	1 set	385.00
105) Reamer, hand, solid, spiral type to cover a range from 1/4" - 1 1/2" x 1/64"	1 set	200.00
106) Refacer, valve, wet type, 5/8" capacity, electric	1	250.00
107) Removers, stud, up to 5/8"	4	14.00
108) Square combination, with steel scale & protractor	4	12.00
109) Saw, hand, hack, 12"	4	12.00
110) Saw, power, hack 6" capacity wet type	1	600.00
111) Sleeves, taper, Morse, 1-2, 1-3, 2-4, 3-4, 3-5, 4-5, 4-6,	1 set	24.00
112) Shaper, 18" stroke, with tool holder, electric	1	3,500.00
113) Tool, kiks, mechanics, hand	15 sets	1,500.00
114) Tool, copper tube flaring 1/4" - 5/8"	1 set	25.00
115) Tool, ring gear riveting	1	35.00
116) Tools, special, with pullers, for tractors	1 set	1,500.00
117) Tool, valve seat insert replacement	2	170.00
118) Tool, clutch plate aligning	2	16.00
119) Taps, with tap wrench 1/4" - 1 1/2" N. C.	2 sets	120.00

120) Taps, with tap wrench $\frac{1}{4}$ " - $1\frac{1}{4}$ " N.F.	2 sets	140.00
121) Taps, machine screw, 6-32, 6 - 40, 8-32, 8-36, 10-24, 10-32, 12-24, 12-28	2 sets	30.00
122) Taps, taper pipe, $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ "	2 sets	60.00
123) Taps, taper pipe, $\frac{3}{4}$ ", 1", $1\frac{1}{4}$ ", $1\frac{1}{2}$ ", 2", $2\frac{1}{2}$ "	2 sets	90.00
124) Torch, gasoline, blow 1 - qt. size	2	15.00
125) Taps, for spark plugs	2 sets	30.00
126) Tester, condenser	1	30.00
127) Tester, coil	1	25.00
128) Tester, generator	1	100.00
129) Tester and cleaner, spark plug	1	15.00
130) Tester, battery voltage	1	15.00
131) Tester, compression with adapters	1	25.00
132) Tester, vacuum tune-up, with adapters	1	10.00
133) Vise, machinists, 4" jaw	10	100.00
134) Vise, pipe, up to $2\frac{1}{2}$ " capacity	2	20.00
135) Vise, saw filing	2	6.00
136) Wrench, tap, "T" type	5	15.00
137) Wrench, pipe, stilson, 12"	4	12.00
138) Wrench, pipe, stilson, 18"	4	20.00
139) Wrench, pipe, stilson, 24"	3	24.00
140) Wrench, piper, stilson, 36"	2	40.00
141) Wrench, monkey, 18"	5 sets	15.00
142) Wrench, Crecent, 6", 8" , 10", 12"	4 sets	60.00

143) Wrench, Crescent, 18"	3	30.00
144) Wrench, open end for tappent adjusting	3 sets	40.00
145) Wrench, deep socket, for spark plugs, 14 mm, 18 mm, 7/8"	2 sets	20.00
146) Wrench, wheel lug, cross type	4	20.00
147) Miscellaneous		1,500.00
148) Crankshaft grinder, ranging from passenger card to D <sup>8</sup> Caterpillar	1	3,000.00
149) Universal milling machine	1	3,000.00
150) Aligner, connecting rod, with expanding type sleeves	1	125.00
151) Charger, battery	1	200.00
152) Screw drivers, different sizes, set of 6 each	2 sets	20.00
153) Lift, hydraulic, 2-post, 5 ton capacity		
154) Outfit, electric, for testing, and running in starters, generators, magnetos, complete with panel board not less than 5 H.P.	1	200.00
155) Outfit, Diesel infector and spray nozzle testing and repair	1	60.00
156) Pencils, electric marking, with transformers	2	24.00
157) Press, drill, bench type $\frac{1}{2}$ " capacity, multispeed, with drill chuck 0" - $\frac{1}{2}$ " capacity	1	150.00

## WELDING SHOP

<u>Item</u>	<u>Quantity</u>	<u>Est. Cost</u>
1) Goggles, welder	2 pair	5.00
2) Gloves, arc welder	2 pair	10.00
3) Hammers, under 6 lb.	4	10.00
4) Helmets, arc welder	1	5.00
5) Outfit, acetylene welding and cutting	1	165.00
6) Vise, 4" jaw	2	16.00
7) Welder, arc, 300 ampere	1	500.00
8) Goggles, clear	2 pair	4.00
9) Generator, Acetylene	1	250.00
10) Extinguishers, fire 2 gal. size	1	20.00
11) Dollies, fender, various assorted - 1 set of 8 each	1 set	20.00
12) Snips, tin 10"	2	5.00
13) Pots, babbit melting	2	2.00
14) Laddles for babbit	2	4.00

## WOOD SHOP

1) Brace, carpenters	2	60.00
2) Chisels, wood, $\frac{1}{4}$ " - $1\frac{1}{2}$ " (by 1/16 s)	1 set	20.00
3) Bits, wood, expansion type $1\frac{1}{2}$ " - 3"	1	3.00
4) Bits, wood $\frac{1}{4}$ " - $1\frac{1}{2}$ " (by 1/16 s)	1 set	30.00
5) Clamps, adjustable bar type 48", carpenters	4	20.00

6) Chisels, wood turning	1 set	18.00
7) Drill, hand, ratchet type 9/16" chuck capacity	2	15.00
8) Gauge, carpenter's marking	2	6.00
9) Hammers, $\frac{1}{2}\#$ - 2#	2 sets	20.00
10) Levels, carpenter's spirit	1	5.00
11) Planes, carpenters	2	15.00
12) Pots, glue	2	16.00
13) Planes, wood, 18" capacity	1	1,600.00
14) Rules, flexible, steel, 2'	2	6.00
15) Rules, steel 12"	2	3.00
16) Square, carpenters	2	8.00
17) Saw, carpenter's rip	2	8.00
18) Saw, carpenter's cross-cut	2	8.00
19) Stone, grind, foot operated	1	15.00
20) Saw, table type, 8" capacity, electric	1	500.00
21) Saw, cross-cut, with tilting arbor electric	1	450.00
22) Vise, carpenter's quick opening	2	16.00
23) Mallet	2	3.00
24) Clamps "C", screw type, 3", 6", 8", 10", 12", (2 of each size)	1 set	90.00
25) Cutters, glass	2	5.00
26) Drill, breast, 9/16"	1	7.00
27) Drill, electric, portable 3/8"	1	60.00
28) Jointer, with 6" table, electric powered	1	800.00
29) Extinguishers, fire 2-gal. size	1	20.00



30) Extinguisher, fire 1-quart size	1	10.00
31) Screw drivers, different sizes, 6 pieces	1 set	10.00

## LUBRICATION

<u>Item</u>	<u>Quantity</u>	<u>Est. Cost</u>
1) Outfit, lubricating, service station typ, complete with grease guns and dispensors for chasis, differential and transmission lubricants	1	750.00
2) Measures, oil, 1-qt. size with swing spout	3	7.00
3) Measures, oil, 2-qt. size, with swing spout	2	6.00
4) Measures, oil, 4-qt. size, with swing spout	1	5.00
5) Extinguishers, fire 2-gal. size	1	20.00
6) Extinguishers, fire 1-qt. size	1	10.00
7) Outfit, hydraulic brake refillers and bleeder, with pressure tank	1	40.00
8) Hydrometers, battery testing	2	6.00
9) Hydrometers, anti-freeze	2	20.00

## WASHING

1) Outfit, car washing, high pressure for water	1	430.00
2) Outfit, radiator flushing	1	75.00

## TIRE REPAIR AND RELINING

1) A complete outfit for repair and relining of tires, which shall include dies for the following tire sizes.

- a) Tires for passenger cars
- b) Tires for pick-ups
- c) Tires for graders
- d) Tires for trucks
- e) Tires for tractors and trailers

Estimated cost 25,000.00

## WHEEL ALIGNMENT

1) Outfit front end, and steering gear aligning	1	750.00
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## FORGE SHOP

<u>Item</u>	<u>Quantity</u>	<u>Est. Cost</u>
1) Anvil, blacksmith 170 lbs.	1	35.00
2) Hammers from 24 to 48 oz. (4 pieces)	1 set	5.00
3) Blacksmith's pincers 12"	2	5.00
4) " Pickup Tongs 1"	2	3.00
5) " Straight lip tongs 20"	2	3.00
6) " Rivet tongs 20"	2	4.00
7) Forge, 32" x 45"	1	60.00

### WAREHOUSES

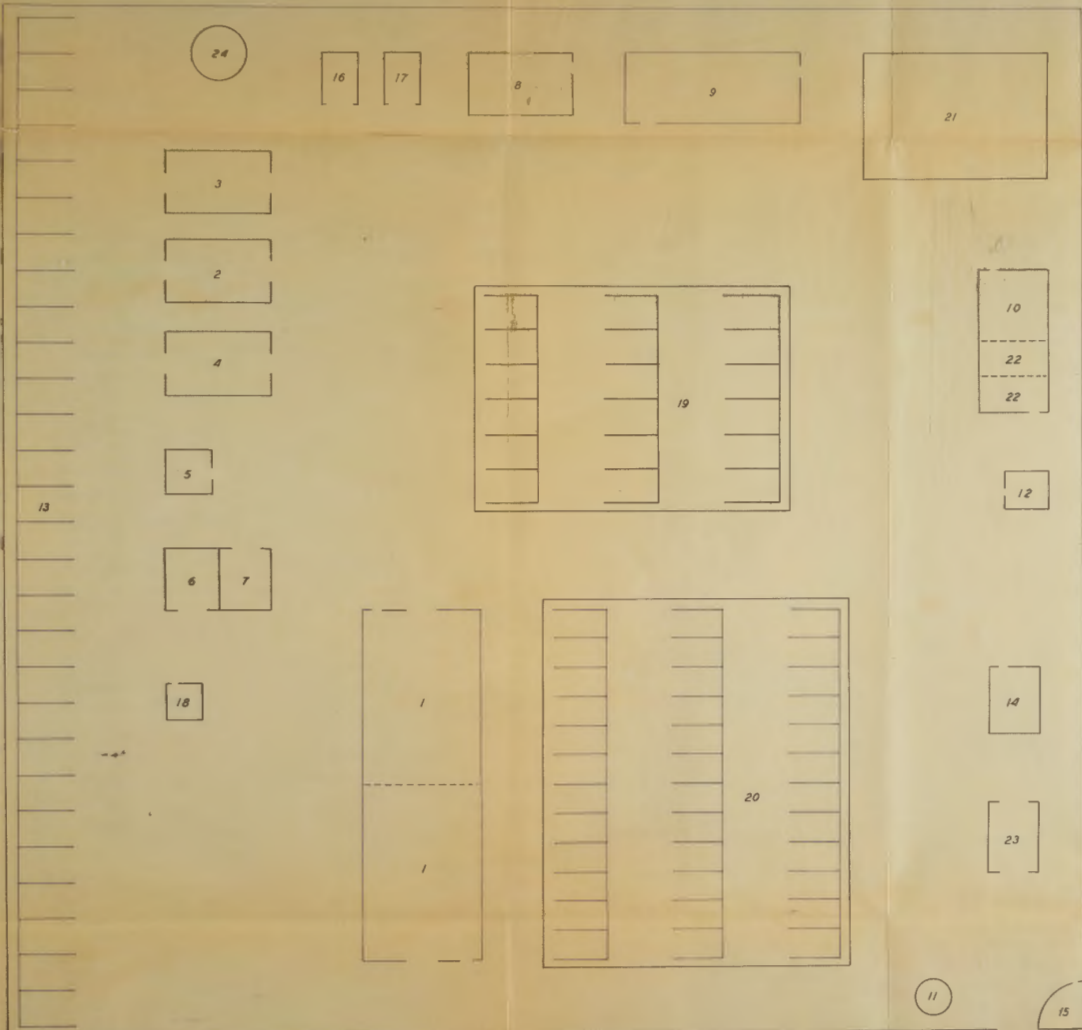
Spare parts and Machine Shop Warehouses shall be installed with sectional steel shelves of different sizes of variable depth type to allow for the storage of sizes of spare parts of road equipment and shop machinery.

### PAINT SHOP

Item	Quantity	Est. Cost
1) Air Compressor, with receiver, 16 c.f.m., electric	1	750.00
2) Spray guns - 1 qt. with about 25' hose each	2	120.00
3) Brushes, paint, different sizes	8	15.00
4) Burning accessories	4	5.00
5) Respirators	2	4.00
6) Goggles	2	5.00

### POWER HOUSE

1) Generators, of 50 K.W. Diesel, complete with panel board, 110/220 volts	2	10,000.00
Miscellaneous supplies		15,000.00
<b>Total</b>		<b><u>65,000.00</u></b>



DISTRICT SHOPS  
 FOR IX DIVISION  
 SCALE: 1" = 30'

## DEPARTMENTS OF DISTRICT SHOPS

1. Heavy and light duty repair shop and machine shop.
2. Wood shop
3. Welding shop and forge shop
4. Warehouse
  - a) Road equipment
  - b) Machine shop
5. Power house
6. Lubrication
7. Washing
8. Cafeteria
9. Dormitory and showerroom
10. Administration
11. Gas station and lubeoil storage
12. Infirmary
13. Open truck garage
14. Drivers and operators waiting room
15. Gates
16. Wheel Alignment
17. Paint shop
18. Mens room
19. Parking for heavy equipment
20. " " trucks
21. Junk yard
22. Engineers
23. Inspection room
24. Water tower

## SHOP EQUIPMENT AND TOOLS FOR ONE DISTRICT SHOP

Item	Quantity	Est. Cost
1) Aligner, connecting road with expanding type sleeves	1	125.00
2) Anvil, blacksmith, 170 lb.	1	35.00
3) Bars, wrecking and pinch	3	4.00
4) Bits, wood, expansion type 1½" to 3"	1	3.00
5) Bits, wood, ¼" to 1½" x 1/16s	1 set	30.00
6) Brace, carpenters	1	5.00
7) Blocks, "V", with clamps	1 pair	30.00
8) Compressor, air, with receiver, 16 c.f.n. electric	1	750.00
9) Charger, battery, 2 - bulb	1	200.00
10) Calipers, machinists, outside 4", 6", 8", 10", 12", 18"	1 set	30.00
11) Calipers, machinist, inside 4", 6", 8", 10", 16"	1 set	30.00
12) Cans, oil, ½ pint size	15	15.00
13) Clamps, saw filing	1	5.00
14) Clamps "C", screw type 3", 6", 8", 10", 12"	2 sets	70.00
15) Clamps, "C", machinists, 4", 6" heavy duty	4 sets	80.00
16) Clamps, machinists, strap type 6"	4	12.00
17) Cleaners, piston ring groove	2	6.00
18) Cleaners, valve guide	1 set	15.00
19) Compressor, piston ring	2	6.00
20) Cutters, gasket	1	12.00
21) Cutters, glass	2	5.00
22) Cutters, bolt, 36"	1	7.50

23) Cutters, bolt, 18"	1	5.00
24) Chisels, wood, $\frac{1}{4}$ " to $1\frac{1}{2}$ " x $\frac{1}{16}$ " s	1 set	20.00
25) Clamps, brake lining tightening	1	5.00
26) Calipers, 5" pocket slide	2	12.00
27) Cords, extension, 25' long	6	9.00
28) Chucks, drill, 0° to $\frac{1}{2}$ " with arbors	1	10.00
29) Clamps, adjustable bar type, 48", carpenters	4	20.00
30) Charger, magneto	1	60.00
31) Chisels, wood turning	1 set	18.00
32) Dies, steel figures, $\frac{3}{16}$ "	1 set	5.00
33) Dies, steel figures, $\frac{1}{4}$ "	1 set	5.00
34) Dies, steel letters, $\frac{3}{16}$ "	1 set	5.00
35) Dies, steel letters $\frac{1}{4}$ "	1 set	5.00
36) Dies, with collets and stock, $\frac{1}{4}$ " to $1\frac{1}{2}$ " N. C. thread	1 set	100.00
37) Dies, with collets and stock $\frac{1}{4}$ " to $1\frac{1}{4}$ " N. F. thread	1 set	100.00
38) Dies, with stock, machine screw, 6-32, 6-40, 8-32, 8-36, 10-24, 10-32, 12-24, 12-28	1 set	35.00
39) Dies taper pipe with reversable ratchet handle, $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{3}{4}$ ", 1", $1\frac{1}{4}$ "	1 set	100.00
40) Dividers, machinists, 6" and 12"	2 sets	8.00
41) Dollies, fender, various assorted	1 set	20.00
42) Dressers, emery wheel	2	8.00
43) Drills, breast, $\frac{9}{16}$ "	1	7.50
44) Drills, portable, electric $\frac{1}{4}$ "	1	45.00
45) Drill, portable, electric, $\frac{5}{16}$ "	1	50.00
46) Drill, portable, electric, $\frac{3}{8}$ "	1	60.00

47) Drills, portable, electric, 5/8"	1	80.00
48) Drills, twist, high speed, taper shank, 1/2" to 1 1/2" by 1/32"	1 set	30.00
49) Drills, twist, high speed, straight shank, 1/32" to 1/2" by 1/32"	2 sets	50.00
50) Drills, twist, high speed, straight shank #1 to #60, wire gauge	2 sets	24.00
51) Drills, combination drill and countersink 1/16", 1/8", 3/16"	3 sets	7.50
52) Drills, hand, ratchet type 9/16" chusk capacity	1	7.50
53) Dogs, lathe, 1/2", 3/4", 1", 1 1/2", 1 3/4", 2", 2 1/2", 3"	1 set	16.00
54) Extinguishers, fire, 2 gal. size	5	100.00
55) Extinguishers, fire, 1 quart size	6	60.00
56) Easy outs	2 sets	5.00
57) Forge, blacksmith, portable	1	35.00
58) Grinder, pedestral type, electric .. 12" with buffer	1	250.00
59) Grinder, bench type, electric 8"	1	75.00
60) Grinder, valve seat, concentric type electric, With pilots for complete range from passenger cars to 0-8 Caterpillar tractor, with abrasive wheels for same complete range, with 15°, 30°, 45° and 75° wheels	1	830.00
61) Grinder, piston pin hole and hydraulic brake cylinder hone, electric	1	200.00
62) Grinder, valve, hand	2	8.00
63) Generator, 25KW, diesel, complete with panel board 110/220 volts	1	2,500.00
64) Grouler, for armatures	1	60.00
65) Generator, Acetylene	1	200.00
66) Gauge, carpenter's marking	1	3.50



67) Gauge, center	1	1.50
68) Gauge, cylinder, dial type	1	35.00
69) Gauge, thickness	2	4.00
70) Gauge, thread	2	8.00
71) Gauge, surface	1	5.00
72) Gauge, wire drill	1	3.00
73) Gauge, tap drill size	1	2.00
74) Gauge, for adjusting ring gear and pinion	1	35.00
75) Gauge, twist drill sharpening	1	3.00
76) Gauge, tire pressure	4	12.00
77) Gauge, diesel pressure tester with adapters	1	75.00
78) Gun, air blow	4	8.00
79) Goggles, welders	2 pair	5.00
80) Goggles, clear	2 pair	4.00
81) Gun, paint spray, with hose	2	120.00
82) Gloves, arch welders	2 pair	10.00
83) Grinder, tool post, heavy duty	1	200.00
84) Hammers, all types under 4-lb. Set of 20	1 set	30.00
85) Hammers, all types over 6 lb. Set of 6	1 set	30.00
86) Helmets, arch welders	1	5.00
87) Hydrometers, battery testing	2	6.00
88) Hydrometers, anti freeze	2	20.00
89) Hoist chain, geared type 1½ ton	2	150.00
90) Hoist, chain geared type, 3 ton	1	245.00
91) Hone, engine cylinder, for passenger car	1	50.00

92) Hone, engine cylinder, for large trucks	1	50.00
93) Indicator, speed	1	4.00
94) Irons, soldering	2	4.00
95) Jack, 5-ton hydraulic	4	60.00
96) Jack, 4-ton, floor type, hydraulic	1	150.00
97) Jack, 10-ton, floor type, hydraulic	1	200.00
98) Jointer, with 6' table, electric	1	800.00
99) Levels, carpenter's spirit	1	5.00
100) Lights, timing	1	7.50
101) Lamps, extension, with 25' cords	10	36.00
102) Ladles, for babbit	2	4.00
103) Lathe, 12" swing x 6' between centers, with taper attachment, face plate, steady rest, centers, chucks, tool holders, knurling tool, 1 set draw in collets	1	4,500.00
104) Lathe, brake drum, stationary spindle type, heavy duty for all passenger cars and trucks, complete with all adapters and clutch plate grinding attachments	1	2,000.00
105) Lifters, valve universal type	2	10.00
106) Measures, oil, 1qt. size, with swing spout	3	7.50
107) Measures, oil 2 qt. size, with swing spout	1	5.00
108) Measures, oil 4 qt. size with swing spout	1	6.00
109) Machine, banding	1	18.00
110) Machine, cylinder reboring, passenger cars, and light trucks	1	475.00
111) Machine, cylinder reboring, heavy duty trucks	1	630.00

112) Machine, brake relining, complete with drilling and countersinking equipment	1	215.00
113) Micrometer, outside 0" - 1"	1	10.00
114) Micrometer, outside 0" - 2"	1	10.00
115) Micrometer, outside 2" - 8"	1	25.00
116) Micrometer, inside, 1 - $\frac{1}{2}$ " - 18"	1	20.00
117) Mandrels, lathe, assorted size	1	150.00
118) Outfit, drill steel shanking and bit sharpening	1	50.00
119) Outfit, car washing, high pressure for water	1	450.00
120) Outfit, radiator flushing $\frac{1}{2}$	1	75.00
121) Outfit, front end and steering gear aligning	1	750.00
122) Outfit, lubricating, service station type, complete with grease guns and dispensers for chassis, differential and transmission lubricants	1	750.00
123) Outfit, carburetor repair	1	75.00
124) Outfit, acetylene welding and cutting	1	165.00
125) Outfit, hydraulic brake refillers and bleeder with pressure tank	1	40.00
126) Planes, carpenter's	1	7.50
127) Pliers, tire chain repair	1	1.50
128) Pots, glue	1	8.00
129) Pots, babbitt melting	2	2.00
130) Pullers, clutch pilot bearing	1	4.00
131) Pullers, wheel, universal type	1	12.50
132) Pullers, for engine sleeves	1 set	30.00
133) Pullers, bearing and bearing race, various	1 set	150.00

134) Pullers, gear and axle, various	1 set	50.00
135) Press, drill, upright, 1½" capacity, multispeed, with back gears, complete with drill chuck 0" - ½"	1	250.00
136) Press, hydraulic, 60-ton vertical, hand operated	1	150.00
137) Press, arbor	1	45.00
138) Planer, wood 18" capacity	1	1,600.00
139) Press, tractor track pin	1	450.00
140) Rules, flexible, steel, 6'	2	6.00
141) Rules, steel 6"	2	1.50
142) Reamer, high speed, straight shank 3/8", 7/16", 15/32", ½", 17/32" 5/8", 9/16", 19/32"	1 set	32.00
143) Reamer, high speed, taper shank, 17/32", 9/16", 19/32", 5/8", 21/32" 11/16", 23/32", 3/4", 25/32", 13/16", 27/32", 7/8", 29/32", 15/16", 31/32" 1"	1 set	75.00
144) Reamer, cylinder ridge, medium size	1	15.00
145) Reamer, cylinder ridge, large size	1	18.00
146) Reamer, taper pin, sizes #1-#10, spiral	1 set	15.00
147) Reamer, expansion, spiral type, with pilots, to cover complete range from 3/8" - 1½"	1 set	385.00
148) Reamer, hand, solid spiral type to cover complete range from ¼" - 1½" by 1/64"	1 set	200.00
149) Refacer, valve, wet type, 5/8" capacity, electric	1	250.00
150) Removers, stud, up to 5/8"	2	7.00
151) Square, combination, with steel scale and protractor	2	6.00
152) Square, carpenters	2	8.00
153) Saw, hand, hack, 12"	2	6.00

154) Saw, power, hack, 6" capacity, wet type	1	600.00
155) Saw, carpenter's, rip	2	8.00
156) Saw, carpenter's cross-cut	2	8.00
157) Saw, mitre, with mitre box	1	6.00
158) Snips, tin, 10", with curved jaw	1	2.50
159) Snips, tin, 10", with straight jaw	1	7.50
160) Stone, grind, foot operated	1	15.00
161) Sets, saw	1	3.00
162) Sleeves, taper, Morse	1 set	24.00
163) Shaper, 18" stroke, with tool holder, electric	1	3,500.00
164) Saw, table type, 8" capacity, electric	1	500.00
165) Saw, cross-cut, with tilting arbor, electric	1	450.00
166) Tool, kits, mechanics, hand	5 sets	500.00
167) Tool, copper tube flaring $\frac{1}{4}$ " to $\frac{5}{8}$ "	1 set	25.00
168) Tool, ring gear riveting	1	35.00
169) Tools, special, with pullers for tractors	1 set	500.00
170) Tool, valve seat insert replacement	1	85.00
171) Tool, clutch plate aligning	1	8.00
172) Taps, with tap wrench, $\frac{1}{4}$ " - $1\frac{1}{2}$ " N.C.	1 set	60.00
173) Taps, with tap wrench, $\frac{3}{4}$ "- $1\frac{1}{4}$ ", H.F.	1 set	70.00
174) Taps, machine screw, 6-32, 6-40, 8-32, 8-36, 10-24, 12-28	1 set	15.00
175) Taps, taper pipe, $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ "	1 set	15.00
176) Taps, taper pipe, $\frac{3}{4}$ ", 1", $1\frac{1}{4}$ ", $1\frac{1}{2}$ ", 2", $2\frac{1}{2}$ "	1 set	45.00
177) Torch, gasoline, blow, 1-qt. size	2	15.00

178) Taps, for 14mm, 18mm 7/8" spark plug thread	1 set	15.00
179) Tester, condenser	1	30.00
180) Tester, coil	1	25.00
181) Testor, generator	1	100.00
182) Tester and cleaner, spark plug	1	15.00
183) Tester, battery voltage	1	15.00
184) Tester, compression with adaptors	1	25.00
185) Tester, vacuum tune-up with adaptors	1	10.00
186) Vise, machinists, 4" jaw	5	40.00
187) Vise, blacksmith, 5" jaw	1	15.00
188) Vise, carpenter's, quick opening	1	8.00
189) Vise, pipe, up to 2½" capacity	1	10.00
190) Vise, saw filing	1	3.00
191) Wrench, tap "T" type	3	10.00
192) Wrench, pipe, 12"	2	6.00
193) Wrench, pipe, 18"	2	10.00
194) Wrench, pipe, 24"	2	16.00
195) Wrench, pipe, 36"	2	20.00
196) Wrench, monkey, 18"	1	3.00
197) Wrench, Crescent, 6", 8", 10", 12"	1 set	15.00
198) Wrench, Crescent, 18"	1	10.00
199) Wrench, open end for tappot adjusting	1 set	15.00
200) Wrench, deep socket, for spark plugs, 14mm, 18mm, 7/8"	1 set	10.00
201) Wrench, wheel lug, cross type	2	10.00
202) Welder, arc, 300 amps	1	500.00
203) Miscellaneous supplies		2,000.00

Total:

\$33,555.00

For 5 District shops:

\$167,775.00

## BIBLIOGRAPHY

## 1. Books

- Highway Practice in the United States of America; Public Roads Administration, Washington, D. C., 1949.
- Work of the Public Roads Administration, Washington D. C., 1948
- Use of Road and Airdrome Construction Equipment; War Department Technical manual, 1945.
- Facts on Turkey, Turkish Information Office, New York.
- Public Works in Turkey, Turkish Information Office, New York.
- Information Directly from Ministry of Public Works in Turkey

## 2. Catalogues

- Tools and Supplies Inc., Catalog 46, Machine Shop and Industrial Supplies.
- McMaster - Carr Supply Co., Catalog - 50
- McMaster - Carr Supply Co., Catalog - 51
- Kochring - Milwaukee, Wisconsin
- Le Tourneau, Peoria, Ill.
- Iowa Manufacturing Company, Cedar Rapids, Iowa.
- Galion Iron Works, Galion, Ohio
- Ford, Detroit, Michigan
- Four Wheel Drive Auto Company, Clintonville, Wisconsin
- Garman - Rupp Company, Mansfield, Ohio
- Littleford Bros. Inc., Cincinnati, Ohio
- Caterpillar Tractor Co., Peoria, Ill.
- Etnyre and Company, Oregon, Ill.
- Austin - Wester, Aurora, Ill.
- Achramm Inc., West Chester, Pa.
- Jaeger Machine Company, Columbus, Ohio
- Marion Power Shovel Company, Marion, Ohio



Chevrolet Motor Division, Detroit, Michigan

Euclid Road Machinery Co., Cleveland, Ohio

Materials Handling Machinery, Sligo Iron Store Co., St. Louis, Mo.

Roger's Bros. Corp., Albion, Pa.

American Motor graders, Omaha, Nebraska

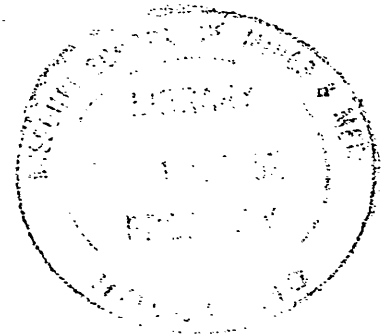
## VITA

The author was born September 18, 1921, at Istanbul, Turkey. After his primary education, he attended Robert College, Istanbul, Turkey, where he graduated with a Bachelor of Science in Mechanical Engineering in September, 1946.

Upon his graduation, he accepted a position with the British European Airways in Istanbul, Turkey, where he worked for a year, before being employed by the Bureau of Highways of the Turkish Government, Ankara, Turkey.

In March 1950, he was granted a two year leave to go to the United States of America for higher studies.

Since January 1951, he has been serving as a graduate assistant at the School of Mines and Metallurgy of the University of Missouri, in which capacity, he still serves.



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