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Verification of Construction Productivity Tables

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VERIFICATION OF CONSTRUCTION PRODUCTIVITY TABLES

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16. Abstract An updatable database was developed using the Microsoft Access spreadsheet and the Visual Basic programming language. Approximately 55 separate AHTD jobs were included in the database. Construction task rates were transcribed from RE Diaries and Contractor Payroll records and were placed into one of 29 different construction task categories. The entire database was sorted by Interstate jobs and Bridge jobs.					
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PREFACE

The objectives of this study were:

- (1) To develop an updatable database program using Construction Division records from recent Arkansas Highway and Transportation Department (AHTD) projects.
- (2) To verify and/or update and revise the existing Construction Productivity Tables.
- (3) To sort the data developed in part (1) to obtain specific information, such as on “Bridge jobs” or “Interstate jobs”.

An updatable database was developed using the Microsoft Access spreadsheet and the Visual Basic programming language. Approximately 55 separate AHTD jobs were included in the database. Construction task rates were transcribed from RE Diaries and Contractor Payroll records and were placed into one of 29 different construction task categories. The entire database was sorted by Interstate jobs and Bridge jobs. For *each* job studied, all 29 construction tasks were tracked. Also, for each Bridge job 11 additional special tasks were tracked. There was an indication that several of the existing AHTD Construction Rates should be revised to reflect the capabilities of more modern equipment and techniques. Also, Interstate-related jobs exhibited higher productivity on certain tasks as compared to non-Interstate jobs.

INTRODUCTION

The Arkansas State Highway and Transportation Department (AHTD) assigns specific time allowances for “Staged” projects. In theory, these time allowances should represent the appropriate amount of time required by contractors to perform certain construction tasks. In some cases, AHTD construction projects seem to last longer than they should, especially when public opinion is taken into account. Some construction projects may seem to take longer than necessary even when they are completed within the assigned time allowed by the AHTD. In some cases, these projects are cited as examples of poor planning and time management because the AHTD appears to have allowed too much time for the completion of the work.

The “Productivity Rates” used to establish the allowed contract times for particular construction projects were developed using various techniques in the past, and these rates have not been kept up to date with regard to improvements in construction technology and equipment. It is possible that the current rates being used by the AHTD are not representative of the actual capabilities of today’s modern contractors and equipment.

This research project was undertaken specifically to meet the need to update the productivity rates so that tables and production charts can be obtained that accurately predict realistic construction contract times. These updated productivity rates can then be used in conjunction with a database program to aid estimators in the determination of contract times for

AHTD construction projects.

OBJECTIVES

This project consisted of three major objectives. They were as follows:

- (1) Develop an updatable database program using Construction Division records from *recent* AHTD projects.
- (2) Verification and/or revision of the existing Productivity Tables by utilizing the database developed in objective (1).
- (3) Use the database developed in objective (1) to sort the data so as to obtain specific information about Bridge jobs, Interstate jobs, Days Worked vs. Time Charged, and other special information of interest.

METHODOLOGY

In order to achieve the objectives of this project, the following procedures were carried out:

Phase 1

A background literature review was completed by the end of January, 1998. Approximately 15 articles and reports were reviewed. Several of these reports were particularly useful and relevant to this project, including:

- (a) "Managing Contract Research Programs", NCHRP Synthesis 231

- (b) "Evaluation of Contract Time Estimation", Louisiana Transportation Research No. 296
- (c) "Determination of Contract Time for Highway Construction Projects", HCHRP Synthesis 215
- (d) "Construction Contract Time Determination", Texas Trans. Inst. Research Report 1262-1F
- (e) "Pre-construction Management System: Procedures Manual", Center for Trans. Research, University of Texas at Austin, Research Report 922-1F

The second part of Phase 1 included organizing and developing a database from existing Construction Division records. This was accomplished using the Microsoft Access spreadsheet and the Visual Basic programming language. After consultation with the Research Committee, a list of 29 highway construction tasks was compiled. The *original* Construction Productivity Tables which were in use at the beginning of this project contained 27 construction tasks. The *new* list of tasks compiled for this project included most (but not all) of the tasks from the original Tables as well as several new tasks. The original Construction Productivity Tables (27 tasks) are included in Attachment A, and the 29 tasks for this project are included in Attachment B.

In order to make the database as "user-friendly" as possible, a windows-type environment was selected. The 29 tasks chosen for tracking were further separated into the following four construction categories:

- (A) Concrete Paving (8 tasks)
- (B) Roadway Construction (13 tasks)
- (C) Miscellaneous Construction (6 tasks)
- (D) Bridge Items (2 tasks)

Attachment C contains visuals of the main menu and different sub-menus available to the user.

The initial project goal was to transcribe 60 jobs into the database. 55 actual AHTD construction projects were transcribed, including projects ranging from the year 1994 to the year 1999. Each of the 29 tasks were tracked for each of the 55 jobs included. Most of the tasks being tracked were in units of (quantity)/day. The rate for each task was calculated as follows:

(1) For each 2-week period during the course of the project, the total *quantity* of a particular item indicated by the Contractor Payroll records was entered into the database spreadsheet. The total number of days spent working on that particular item was then determined from the RE Diaries for the same 2-week period, and entered into a separate spreadsheet in the database.

(2) The average rate for each task being tracked was calculated by dividing the quantity for each task by the total time spent on that particular task. The database is configured so that the average rate for each task is continually updated as additional data are entered into the master spreadsheet.

Of the 55 jobs transcribed, about 24% (13 jobs) are Interstate jobs. During the course of the project, it was determined by the Research Committee that it would be useful to track each of the 29 tasks for Interstate jobs only. This was accomplished by adding another sub-window to the main menu, which included a filtering algorithm to calculate each rate using only data from Interstate jobs. Interstate jobs were identified on the spreadsheet as they were entered into the database by AHTD Research Division personnel.

Phase 2

RESULTS

The results from the 55 jobs transcribed to date are shown in the following tabular format:

<u>Task</u>	<u>Unit</u>	<u>All Jobs</u>	<u>Interstate Jobs</u>
PC Concrete Base	(yd ² /day)	NA	NA
ACHM Surface Course	(tons/day)	841	749
ACHM Binder Course	(tons/day)	855	1213
ACHM Base Course	(tons/day)	1102	1322
Shoulder Seal	(gal/day)	47	47
PCC Pavement	(yd ² /day)	3065	4259
PC Concrete Driveway	(yd ² /day)	47	6
Concrete Pavement Patching	(yd ² /day)	103	101

<u>Task</u>	<u>Unit</u>	<u>All Jobs</u>	<u>Interstate Jobs</u>
Box Culverts	(per day)	8	NA
Concrete Barrier Wall	(linear feet/day)	555	794
Minor Drainage Structures	(linear feet/day)	269	902
Concrete Curb and Gutter	(linear feet/day)	73	32
Fencing	(linear feet/day)	1829	1246
Guardrail	(linear feet/day)	268	375
R&R Base Course	(tons/day)	1027	1027
Trench & Shoulder Preparation	(linear feet/day)	85	241
Proc Lime Treated Subgrade	(yd ² /day)	3032	NA
Proc Cement Treated Subgrade	(yd ² /day)	NA	NA
Aggregate Base Course	(tons/day)	712	2175

<u>Task</u>	<u>Unit</u>	<u>All Jobs</u>	<u>Interstate Jobs</u>
Reconstructed Base Course	(tons/day)	739	NA
Asphalt Surface Treatment	(gal/day)	5041	5788
Clearing/Grubbing	(acres/day)	8	18
Trench Existing Shoulder	(linear feet/day)	62	62
Presplitting	(yd ² /day)	141	31
Borrow/Embankment	(yd ³ /day)	840	482
Seeding/Mulch	(acres/day)	19	25
Unclassified Excavation	(yd ³ /day)	1588	883
Remove Existing Bridge Str.	(per/day)	.85	2.35
Cost in Dollars/Day	(\$/day)	6347	12956

DISCUSSION OF RESULTS

As can be seen from the previous results, on approximately half (13 of the 29 tasks) of the items tracked the rates for Interstate Jobs exceeded the rates for *all* jobs. On several of the items where the Interstate rate did not exceed the rate for all jobs, there was simply insufficient data to arrive at a meaningful conclusion about that particular task. For example, the rate for Unclassified Excavation was almost twice as much for all jobs as it was for Interstate Jobs, but this was because there were only 1 or 2 jobs used to calculate the average rate for Interstate Jobs only, and this is not a good indicator of the capability of today's contractors for that particular task. When compared to the *old rates from the original Productivity Tables*, most of the same items which were tracked in this research showed in improvement in the average rate.

BRIDGE DETAIL

After consultation with the Research Committee, it was decided to further break down the bridge jobs and separately track 11 additional tasks associated mainly with bridge construction. Each of the 16 bridge jobs included in the database were analyzed for the 11 tasks. The results are shown in tabular form as follows:

RESULTS FROM BRIDGE DETAIL ANALYSIS

<u>Task</u>	<u>Unit</u>	<u>Avg. Rate</u>	<u>No. Jobs</u>
Unclassified Excavation	(yd ³)	95	11
Class S Concrete	(yd ³)	18	11
Class S(AE) Concrete	(yd ³)	41	11
Re Steel Roadway	(lb)	1293	14
Re Steel Bridge	(lb)	3841	15
Piling	(linear feet)	145	15
Beam/Girder	(lb)	38554	8
Elastomeric Bearing	(in ³)	14070	4
Filter Blanket	(yd ²)	359	13
Dumped Riprap	(yd ³)	119	13
Detour Bridge	(linear feet)	15	3

ATTACHMENT A

Original AHTD Construction Productivity Tables

ARKANSAS HIGHWAY AND TRANSPORTATION DEPARTMENT
PRODUCTION RATES

(Guide for Computing Project Completion Time)

ITEM	<u>SMALL QUANTITIES</u> SMALL JOBS	<u>LARGE QUANTITIES</u> LARGE JOBS
Move In	5 Days	5 Days
Clearing &	5 Sta. or Acres / Day (5 Day Min.)	10 Sta. or Acres / Day (5 Day Min.)
Grubbing	5 Sta. or Acres / Day (5 Day Min.)	10 Sta. or Acres / Day (5 Day Min.)
Roadway Excavation	600 Cu. Yd./Day	1500 Cu. Yd./Day
Borrow	600 Cu. Yd./Day	1500 Cu. Yd./Day
Presplitting	200 Sq. Yd./ Day	300 Sq. Yd./ Day
Base Course	600 Cu. Yd. or Tons/Day	1000 Cu. Yd. or Tons/Day
Soil Aggregate in Stab. Base Crse.	2000 Sq. Yd/Day	3600 Sq. Yd/Day
Processing Cement Trtd. Base Crse.	2000 Sq. Yd/Day	2000 Sq. Yd/Day
Processing Lime Trtd. Base Crse.	2000 Sq. Yd/Day	2000 Sq. Yd/Day
Prime Coat	5000 Gal. / Day (+ 3 day cure)	7500 Gal. / Day (+ 3 day cure)
Asphalt Surface Treatment	5000 Gal./ Day	7500 Gal./ Day
ACHM Stab. Base, Binder & surface Crses.	600 Ton / Day	800 Ton / Day
Concrete Pavement	5000 Sq. Yd / Day	10000 Sq. Yd / Day
Shoulder Seal	2500 Gal./ Day	2500 Gal./ Day
Concrete Curb & Gutter	250 Lin. Ft./ Day	350 Lin. Ft./ Day
Concrete Walks	100 Sq./ Day	200 Sq./ Day
Concrete Driveways	100 Sq./ Day	200 Sq./ Day
Erosion Control	\$1,200 per Day	\$2,000 per Day
Minor Drainage Structures	\$800 per Day	\$3,000 per Day
Major Structures (Box Culverts)	\$2,500 per Day	\$3,000 per Day
Major Structures (Bridges)	\$2,500 per Day	\$3,000 per Day
Major Structures (Multiple Structures)	\$5,000 per Day	\$7,500 per Day
Fencing	1000 Lin.Ft./ Day	1500 Lin.Ft./ Day
Traffic Signals	8 months from Advertising	8 months from Advertising
Traffic Signals (Two Intersections)	9 months from Advertising	9 months from Advertising
Clean Up	5 Days	5 Days

TYPE WORK

- 1 PE
- 2 EMERGENCY
- 3 RECONSTRUCTION
- 4 MAJOR WIDENING (Adding one or more lanes)
- 5 MINOR WIDENING (passing lanes see #35)
- 6 REHABILITATION (pavement restoration, patching, heat scarifying, planing & texture)
- 7 RESURFACING (overlay, hot mix seal)
- 8 BASE
- 9 BRIDGE REHAB (Bridge deck grinding)
- 10 SAFETY & TRAFFIC ENG. (Intersection improvements, signals, logo signing, RR signals pavement markings)
- 11 SHOULDER IMPROVEMENTS (Note: length will be included in jobs, but excluded from outgoing reports)
- 12 BASE STABILIZATION & SLIDE REPAIRS
- 13 BASE & DRAINAGE
- 14 BASE & SURFACING
- 15 GRADING, DRAINAGE, & BASE
- 16 GRADING & STRUCTURES
- 17 GRADING
- 18 SURFACING (gravel roads only)
- 19 STRUCTURE & APPROACHES (includes MDS, bridge replacement, grade separation)
- 20 SUBSTRUCTURE
- 21 SUPERSTRUCTURE
- 22 ENHANCEMENT
- 23 MISCELLANEOUS (includes leveling, under drain, joint rehab., Removal w/no replacement, salvage yards, Br. painting, fencing, Br. Removal W/ no replacement, AHP insp. pads (new))
- 24 INTERCHANGE (AHTD purposes including district offices, chemical storage buildings)
- 25 BUILDINGS (Public purposes including rest areas, tourist information centers, weigh stations, roadside parks, commuter facilities, landscaping, wheelchair ramps)
- 26 ROADSIDE APPURTENANCES
- 27 RESURFACE & SHOULDER
- 28 NEW LOCATION
- 29 SEALING
- 30 FRONTAGE ROAD
- 31 CLEARING & GRUBBING
- 32 STUDY
- 33 RIGHT-OF-WAY (Applicable only to jobs with programmed status)
- 34 UTILITY (Applicable only to jobs with programmed status)
- 35 PASSING LANES

ATTACHMENT B

List of 29 Highway Construction Tasks which were tracked for this research.

PRODUCTIVITY RATE CATEGORIES

Concrete Paving

PC Con Base (yd²/day)
ACHM Sur Course (ton/day)
ACHM Bin Course (ton/day)
ACHM Base Course (ton/day)
Shoulder Sear (gal/day)
PCC Pave (yd²/day)
PC Con Drive (yd²/day)
Concrete Pavement Patching (yd²/day)

Turf and Roadway Preparation

Clearing/Grubbing (acres/day)
R&R Base Crs and Asp Sur (ton/day)
Trench and Shoulder Prep (lin ft./day)
Trench Existing Shoulder (lin ft./day)
Proc Lime Treated Subgrade (yd²/day)
Proc Cement Treated Subgrade (yd²/day)
Presplitting (yd²/day)
Borrow/Embankment (yd³/day)
Aggr Base Course (ton/day)
Recon Base Course (ton/day)
Seeding/Mulch (acres/day)
Unclassified Excavation (yd³/day)
Asphalt Surface Treatment (gal/day)

Misc. Construction

Box Culverts (\$/day)
Concrete Barrier Wall (lin ft./day)
Minor Drainage Strs (\$/day)
Concrete Curb and Gutter (lin ft./day)
Fencing (lin ft./day)
Guardrail (lin ft./day)

Bridge Items

Remove Existing Bridge Str (#)
Bridge Items (\$/day)

ATTACHMENT C

Windows Environment Main Menu and Submenus

**AHTD
Productivity
Calculations**

Select Construction Category

Interstate Jobs

AHTD District Info

Concrete Paving

Turf and Roadway

Misc. Construction

Bridge Items

Exit

Concrete Paving

Please select a construction task.

PC Concrete Base

Shoulder Seal

ACHM Surface Course

PCC Pavement

ACHM Binder Course

PC Concrete Driveway

ACHM Base Course

Concrete Pave Patching

Close

Turf and Roadway Preparation

Please select a construction task.

R and R Base Crs and Asp Sur

Clearing/Grubbing

Trench and Shoulder Prep

Trench Existing Shoulder

Proc Lime Treated Subgrade

Presplitting

Proc Cement Treated Subgrade

Borrow/Embankment

Aggregate Base Course

Seeding/Mulch

Reconstructed Base Course

Unclassified Excavation

Asphalt Surface Treatment

Close

**Miscellaneous
Construction**

Please select a construction task.

Box Culverts

Concrete Barrier Wall

Minor Drainage Structures

Concrete Curb and Gutter

Fencing

Guardrail

Close

**Bridge
Items**

Please select a construction task.

Remove Existing Bridge Structure

Dollar Cost of Bridge Items

Close