12 Aug 1985

Trip Report: Texas A&M, August 6-8, 1985, T.E. Toohig

This meeting was initiated by Texas A&M to present to DOE (Ed Temple et al) a series of proposals for R&D funding for SSC tunneling and site related projects. A second purpose was to demonstrate the possibility, based on current experience, of constructing tunnels in Texas at costs substantially below the national average figures projected in the Reference Design.I went along at DOE request. A list of the attendees at the Texas A&M presentation at College Station on the 7th is appended.

A total funding request of something over $2M was projected for the tunneling and site-related R&D. Temple pointed out that this would not be new money, but would have to come from CDG. Since the two aspects of the visit are quite different I will treat them under separate headings.

R&D PROPOSALS.

1. COSTUN, Dr. Thompson.

   TAMU has COSTUN running on a VAX computer and has done some studies using it. They propose to use this to do the costing of the tunnels in the site evaluations for DOE. I pointed out that the CDG sees some merit in the use of a program like COSTUN, that the database for the program is quite old and we have discussed with Harza Engineering, who wrote the program for DOT, the needed updates in the program (see 7 May memo to J.Sanford appended), finally that RTK is working with all of this to produce a recommendation.

2. Cost-optimized Site Selection, Dr. Benton.

   It is Dr. Thompson's contention that DOE should not passively accept site proposals from the states, but should do an independent search for the best cost-optimized site in the country. An asssumption is that this is in the arid or semi-arid regions of the country. In line with this they propose an elaborate photo-grammetric survey of those parts of the country to identify all flat sites of appropriate size for the SSC using existing Landsat and other photography.

   This would be followed by subsurface investigation of these sites, using available drilling logs, etc. COSTUN would then evaluate the tunneling costs.

   Finally a systems analysis would be done of the sites and the best selected. See handout:Location reconnaisance for Optimum SSC Site, and Preliminary Study to Develop Scheme to Accumulate Data Base of Boring Logs and Geotechnical Test Data.

3. Site-location Systems Analysis Approach, Dr. Samson

   Dr. Samson presented a proposal for a mathematical decision-making model for making site appraisals. This was interesting, and it is clear that something like this - weighting of criteria, combining judgments, etc. - would be desirable.

4. State-of-the art Tunneling, Dr. Thompson.

   Dr Thompson discussed the current state of the art in tunneling. A proposal was put forth to produce a primer on this subject for non-specialists involved in the SSC program. As discussed, it sounded like it would cover the same ground already covered by the Final Report of the MX Deep Basing Project. Copies of the summary of this last have been sent to Ed Temple and Dr. Thompson.

5. Design and Development of an Automated Tunnel Lining Scheme Using Shotcrete, Dr. Tiner.

   Dr. Tiner presented a major proposal to set up on campus a development facility for an automated tunnel lining scheme using shotcrete. The estimate for this was about $2M.

6. Design of a Continuous Muck Handling Facility, Dr. Rozgonyi.

   It was pointed out that tunnel projects are usually "muck bound". Dr. Rozgonyi presented a proposal to develop a continuous muck handling scheme based on frequent mucking shafts with vertical conveyors for transporting the muck out of the tunnel. The scheme as presented requires mucking shafts every 1000 feet, and blocks the access to the tunnel for moving personnel and equipment to the face. I talked with Rozgony and pointed out these problems. I urged him to examine the use of conveyors in modes that are more consistent with the SSC design and respecting environmental constraints, since conveyor handling of the muck seems to have many desirable attributes.

TUNNEL EXPERIENCE

1. Onion Creek Waste Water Tunnel Project, Upper Tunnel. 7K Construction Co. (non-union arm of Kenny Const. of Chicago)

Tunnel length -	20,780 l.f.		
Engineer's est. -	$18,309,431		($881/l.f.)
Bid price -	$8,850,000		($426/l.f.)
Claims -	$2,027,000	→	($523/l.f.)
Job status -	84% complete.		

   The project manager for 7K, Ted Budd, discussed the project at College Station on the 7th and we visited the site at Austin on the 8th. The inexperienced, non-union labor is a problem with high turnover and needing two people to do the work of one experienced person. "You get what you pay for." The RFQ for the project was for a 72" i.d. tunnel with a sacrificial concrete lining. 7K proposed to do an 84" tunnel with a cast-in-place lining for a better price and this was accepted. Subsequently the client modified the rest of the line to match the 84" 7K section.

The tunnel is in claystone. Lining is with lagging followed by a monolithic cast-in-place lining using a 150-foot long form that is moved forward in two pieces. They prepare a section on the midnight shift, set the form and pump in the concrete on the day shift, and let it cure on the afternoon. The concrete is carefully controlled for slump with a computer-controlled batching plant. Sensors measure the amount of moisture in the sand before adding the proper amount of water.

Access to the tunnel was by a ladder down the shaft. The last about 50 feet of the ladder had no safety ring. Ventilation in the tunnel was provided by closing off the tunnel with a bulkhead and mounting a fan in the bulkhead. We relied on flashlights for lighting. Personnel on the job were very helpful and very cooperative.

2. OCWWTP, Lower Tunnel. Mole Construction Co. (non-union arm of S&M Construction of Ohio).

Tunnel length -	29,368 l.f.	
Engineer's est. -	$14,981,996	($506/l.f.)
Bid price -	$8,592,569	($293/l.f.)
Change orders -	$2,704,908 →	($385/l.f.)
Job status -	38% complete	

The project manager on this job had the same comment about the quality of the workers as the 7K project manager.He had gone through 480 workers already for a crew of 70 workers. He had had one man killed a few days before and didn't seem overjoyed to have a group of tourists crawling through the tunnel. Again access was by going down a ladder in the shaft. The TBM was down while they switched over the power source. This also left the tunnel without any lights, which was a bit scary with the constricted space quite full of equipment. The mucking was accomplished with a single train, relying on frequent shafts to get the muck out without excess delay for the TBM while waiting for the mucking train.

3. Johnson Creek Outfall Tunnel, Syco Construction Co. from Utah.

We have no data on this project. Ted Budd of 7K told us to pay attention to the TBM on this job. It is a state-of-the-art Lovat machine, a soft-ground machine fitted for hard rock tunneling. They are putting in a precast lining in three sections. The tail skid of the TBM has a handling system for putting the elements of the lining in place. They had just gotten the machine into the tunnel (access here was through a grade level portal) and were having learning problems. The workers were awkward handling the precast. They were going to start up the mole, but the operator (new) overstressed the hydraulics and blew a fitting. The super anticipated that once they got through the learning curve they would go very well.

1592S

AGENDA

DOE-TAMU Duscussion on Tunneling for SSC Project

Wednesday, August 7, 1985

SUBJECT: How to Lower Cost of SSC Tunnel Through Site Selection, Better Construction Methods, and Improved Contracting Procedures

8:30 a.m.	I.	Introduction and History of Tunnel Research for SSC Project - Charles H. Samson
8:45 a.m.		Film from TEKKEN Construction Company
9:00 a.m.	II.	State of the Art of Tunneling as Applied to SSC Tunnel - Louis J. Thompson
9:45 a.m.		COFFEE/TEA/DOUGHNUTS
10:00 a.m.	III.	Research That Can Improve Tunneling Advance Rates - Louis J. Thompson
10:20 a.m.		Film from Lovat Company
10:40 a.m.	IV.	Computer Program to Estimate Tunnel Costs - Louis J. Thompson
11:00 a.m.	V.	Major Factors That Influence Tunnel Costs - Louis J. Thompson
11:20 a.m.		Film #2 from Lovat Company
11:40 a.m.	VI.	Validation of the COSTUN Program - Louis J. Thompson
12:00 Noon		LUNCH
1:30 p.m.	VII.	Preliminary Study to Develop Scheme to Identify the Sites That Will Yield Lowest First Cost - A. R. Benton and William Sprinsky
2:00 p.m.	VIII.	Preliminary Study to Develop Scheme to Accumulate Boring Logs and Geotechnical Test Data for Possible Sites
2:15 p.m.	IX.	Decision Making Model for Comparing Alternative SSC Sites - Charles H. Samson

3:00 p.m.	X.	Design and Development of Automated Tunnel Lining Scheme Using Shotcrete - Douglas Tiner
3:30 p.m.		COFFEE/TEA
3:45 p.m.		Film from UTL Company
4:00 p.m.	XI.	Design of a Continuous Muck Handling Scheme - Tibor Rozgonyi
4:45 p.m.	XII.	Future Tunneling Demonstration - Louis J. Thompson
5:00 p.m.		TRAVEL TO AUSTIN, TEXAS
7:00 p.m.		QUALITY INN IN AUSTIN, TEXAS
8:00 p.m.		DINNER AT CASA BLANCA ON HIGHWAY 35 SOUTH

Thursday, August 8, 1985

7:00 a.m.	VISIT TO 7K CONSTRUCTION COMPANY SITE ON SOUTH SIDE OF BERGSTROM AFB, AUSTIN, TEXAS
10:00 a.m.	VISIT TO MOLE CONSTRUCTION COMPANY SITE, ONION CREEK, SOUTH SIDE OF AUSTIN, TEXAS
1:30 p.m.	VISIT TO SAYCO CONSTRUCTION COMPANY SITE, JOHNSON CREEK IN AUSTIN, TEXAS
3:30 p.m.	TO AUSTIN AIRPORT OR RETURN TO COLLEGE STATION, TEXAS

Texas A&M Tunneling Meeting

August 7, 1985

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7 May 1985

To: J.R.Sanford

From: T.E.Toohig

Subject: Updating COSTUN: Cost and Schedule

Harza Engineering Co. has made the following estimate to update their program COSTUN from the existing 1973 edition:

	Manhours	Cost
1. Update TBM advance rate database	160	$9280
2. Update labor, equipment and materials equations	320	$18560
3. Introduce new softground tunneling methods (e.g. Japanese full face slurry method)	320	$18560
4. Update rates of cast-in-place lining	32	$1856
5. Introduce shaft boring	160	$18560
Subtotals	992	$57536
Computer charges for development		$6000
TOTALS:	992	$63536

For reference the original work involved 15000 manhours.

The preferred person to do the updating is E.M.Cikanek, one of the two original authors. He is scheduled to return in June from a project in Europe. The program is in Fortran 77. They could supply a tape to us, or, if we preferred, we could run it remotely on their computer, which is a Harris.

cc. P.Conroy
R.Matyas
M.Tigner

LOCATION RECONNAISSANCE FOR OPTIMUM SSC SITE

AN OUTLINE

* OVERALL APPROACH
* INITIAL EDITING PROCEDURE
* REFINED SEARCH PROCUDURE
* FINAL SELECTION PROCEDURE
* AVAILABLE DATA
* COST ANALYSIS

LOCATION RECONNAISSANCE FOR OPTIMUM SSC SITE

AN OUTLINE

* OVERALL APPROACH

  Limit search to arid and semi-arid areas in contiguous U.S.

  Edit out unsuitable terrain on 1:1,000,000-scale topo sheets

  Refine search with Landsat, contour pattern recognition on 1:250,000 maps to detect planar SSC areas

  Final screening using 7 1/2-minute quads, photogrammetric analysis of 1:20,000 photos and local geologic data

* INITIAL EDITING PROCEDURE

  Scale SSC template on 1:1,000,000-scale topo sheets - eliminate all areas exceeding topo variation criteria

* REFINED SEARCH PROCEDURE

  Use larger-scale SSC template on 1:250,000-scale topo sheets and/or contour pattern analysis to find areas whose surfaces of optimum intersection with the SSC oval have acceptably low relief. Refine search using Landsat analysis and photoanalysis with very small scale photography, if available.

* FINAL SELECTION PROCEDURE

  Do photogrammetric modeling of final candidate areas at large scale
  Do pattern analysis with topo data from 7 1/2-minute quads
  Superimpose local geologic data
  Select best area based on appropriate criteria

* AVAILABLE DATA

  1:1,000,000 maps (WAC's or ONC's)
  1:250,000 maps (USGS 1x2 degree quads)
  1:24,000 USGS maps
  1:24,000 topo data pulls for digitization
  Photography at about 1:65,000 scale from National High Altitude Program
  Photography at 1:20,000 scale (ASCS) or 1:24,000 scale (USGS, others)
  Landsat computer-compatible tapes (CCT's) for interactive machine analysis
  County geologic maps for surface data
  Well-drilling core data

* COST ANALYSIS

  Time and cost for initial and refined search (3 investigator months)
  Per-site time and cost for final selection analysis (to be worked up)

IV. PRELIMINARY STUDY TO DEVELOP SCHEME TO ACCUMULATE DATA BASE OF BORING LOGS AND GEOTECHNICAL TEST DATA

A. Sources of Information

1. U.S. Corps of Engineers
2. U.S. Bureau of Reclaimation
3. U.S. Geological Survey and State Geologic Survey
4. Soil Conservation Service
5. State Highway Department
6. City Government
7. Private Geotechnical Engineering Firms

B. Evaluate Computer Readers to Digitize Records Independent of Format

C. Evaluate Compact Laser Disk System to Store Digital Information

D. Develop Program to Sort and Reformat Data

E. Develop Program to Construct Profiles on Arbitrary Planes

F. Develop Program to Develop Nodes for SSC Tunnel Design and Cost Estimate with Appropriate Geotechnical Data

Decision Making Procedure for SSC Site Selection

It is proposed to develop a procedure for use in the site-selection process for the SSC. The procedure would be based on "multiattribute utility theory" — an approach that has been used in a wide variety of decision problems. The following features would be provided:

1. Any number of probabilistic conditions (states) could be considered, with assigned probability estimates (e.g., different soil/rock conditions that could be encountered with associated probabilities).
2. Any number of decision criteria could be selected (e.g., construction costs, operational costs, accessibility, etc.).
3. Different weights (scaling factors) could be established to reflect the relative importance of different decision criteria.
4. The value system model would accommodate the value judgments ("utilities") of any given decision maker.
5. Any number of alternative sites could be compared.
6. The procedure would be programmed for use on an IBM AT.
7. An example analysis would be provided.

The procedure itself would not be biased, would permit expansion, and would be amenable to sensitivity studies that would reflect the effect of changes in various parameters.

PRELIMINARY WORKING COPY

OUTLINE OF PROPOSED SITE-LOCATION SYSTEMS ANALYSIS APPROACH

SSC PROJECT--

Charles H. Samson

August 7, 1985

I. Define the Problem

A. State problem in general terms.

B. Establish states s_k and state probabilities p_k.

II. Establish Value System

A. Develop heirarchy of values.

B. Establish decision criteria y_j and their measurement scales.

C. Develop preliminary utility function $u_j(y_j)$ for each decision criterion y_j.

1. Specify range of interest $\bar{y}_{Lj}$ to $\bar{y}_{Rj}$ for each decision criterion y_j.

2. Identify threshold $\bar{y}_{Tj}$ for each decision criterion y_j.

3. Define utility scales where

a. $\bar{y}_{Mj}$ = most preferred amount of decision criterion y_j

b. $u(\bar{y}_{Mj})$ = utility of $\bar{y}_{Mj}$ = 1.00

4. Develop preliminary utility function $u_j(y_j)$ for each decision criterion y_j.

D. Establish scaling factor (importance weighting factor) W_{jk} for each decision criterion y_j and each state s_k.

E. Using Steps IIC and IID, determine final utility function $U_{jk}(y_j)$ where

$$U_{jk}(y_j) = W_{jk}\, u_j(y_j)$$

TUNNELING TECHNOLOGY

SLIPFORMING AND SHOTCRETING

TUNNEL LINING

by

TEXAS A & M RESEARCH FOUNDATION
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August 1985

MUCK AND MATERIAL HANDLING SYSTEM FOR TUNNELING IN CONNECTION WITH SSC PROJECT

TEXAS A&M UNIVERSITY

August, 1985