

2011 CEE 404 Final Examination (2 hours)

ANSWERS

- Please write your name on this cover.
- Please write your last name on all other exam pages

- This examination is open-book, open-note.
- There are 6 questions worth a total of 100 points.
- Each question lists the point value for that question.

- Please work quietly and respect other people's space.
- Carefully read each question and ensure that you answer what is asked.
- If you need additional workspace, use the back of the page or the "work space" page provided after some of the problems.

Name (first, last): _____

Question 1: Potpourri (30 points total)

(2 points) In Matt Preedy's Alaska Way Viaduct and Seawall replacement program presentation he covered one project that is currently underway in construction. That project is (circle one):

1. S. Holgate to S. King viaduct replacement
2. Seawall replacement
3. SR 99 bored tunnel
4. North tunnel portal

(4 points) In Mike Krulc's U-Link Light Rail Tunnel, what type of tunneling techniques did he say would be employed on the project for the twin main tunnels and cross-connection tunnels? (circle 2)

1. Digger shield
2. Sequential excavation method
3. Compressed air shield
4. Earth pressure balance tunnel boring machining (TBM)
5. Slurry pressure balance TBM

(2 points) In Larry Kyle's SR 520 Bridge Replacement and HOV Program presentation, he mentioned that one portion of this project is not yet funded. Which portion is it? (circle one)

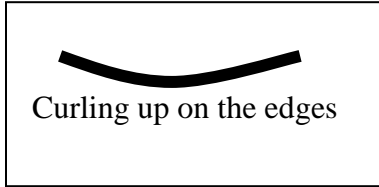
1. West end raised viaduct (I-5 to the floating bridge)
2. Floating bridge across Lake Washington
3. East end highway improvements (floating bridge to Redmond)

(4 points) In the Flyvbjerg, Holm and Buhl paper, *Underestimating Costs in Public Works Projects: Error or Lie?*, what evidence do the authors cite for their conclusion that "the cost estimates used in public debates, media coverage, and decision making for transportation infrastructure development are highly, systematically, and significantly deceptive"? (they list several, I am only asking for one)

Full credit for any of these 3

- Cost underestimation has not decreased over the past 70 years indicating that no learning has occurred
- Cost underestimation cannot be explained by error since estimates are not centered about zero but are rather highly biased towards underestimating. Many also listed statistics on the number that were underestimated.
- Deception and lying in politics as tactics in power struggles, making profits, etc.

(4 points) A PCC slab is poured in Riyadh, Saudi Arabia at 6 a.m. and sets at 9:00 a.m. when the air temperature is 85°F and the ground temperature underneath the slab is 72°F. Five years later you go back to measure slab curling. At 11 a.m. the air temperature above the slab and the base temperature under the slab are equal; both are 91°F. Which way would you expect the slab to be curling? (Circle one)



(3 points) According to a number of the CA4PRS-related readings, which of the following has the biggest impact on a contractor's production rate? (circle one)

Concrete cure time

Paver speed and number of pavers

Materials hauling and loading/unloading constraints

(6 points) In the I-10 Pomona freeway rehabilitation project, they used Rapid Set; a proprietary cement from CTS Cement Manufacturing Company. This cement was referred to as fast setting hydraulic cement concrete (FSHCC) in the article. What was their general conclusion as to how the FSHCC influenced their productivity? Give at least one reason they gave to support this conclusion.

(3 points) They concluded that they could have been more productive by using regular PCC rather than FSHCC.

(3 points) The basic reason was that the FSHCC set quickly causing (1) washout to take longer, (2) the per truck capacity was less due to caking on of material inside the drum, and (3) they had to use truck mixing rather than central mixing. All of these resulted in more trucks being used and longer paving time than they would have had with regular PCC. Also, they did conclude that FSHCC would be useful for very short closures where a few slabs needed to be replaced.

(5 points) You are working for the \$3.1 billion Alaskan Way Viaduct replacement project that includes all the work describe by Matt Preedy in his presentation to the class (Holgate to King job, bored tunnel, viaduct removal, etc.). If it costs \$2 million to hire a public relations firm for the project, do you think this expense is justified? Why?

Any answer that says the PR firm's role (be in charge of information dissemination about the project) can provide great benefit by (list any of the following)

- Better public support by more clearly communicating options, closures, impacts, relations to other projects
- Savings in user delay cost by informing public of construction schedule and potential delays as well as alternative routes
- Involving more of the public in project decisions

Extra Credit: Name a movie that features an under-construction piece of transportation infrastructure (e.g., bridge, highway, tunnel, etc.). I have a couple in mind, but I am sure there are many more.

Question 2 (10 points)

The picture below shows your resource use for a CA4PRS HMA Mill and Fill Rehabilitation Deterministic run. Additional information:

- 1 demolition team
- Demolition hauling truck cycle time: 35 minutes

What is the minimum number of demolition trucks you would need to hire to meet the requirements pictured below?

Resource	Allocated	Utilized
Demolition Hauling Truck (per hour per team)	14.0	7.3
Batch Plant (ton/hour)	300.0	279.7
HMA Delivery Truck (per hour)	14.0	14.0
Milling Machine (cu. yd/hour)	147.1	147.1

Demolition Truck

You need 7.3 trucks to show up on site every hour. The cycle time for each truck is 35 minutes so each truck can make 3 cycles/hour.

Most common errors:

- forgetting that although there were 14 trucks allocated to Demolition Hauling, only 7.3 were used.
- Assuming truck capacities or load times that did not need to be assumed.

Question 3 (10 points)

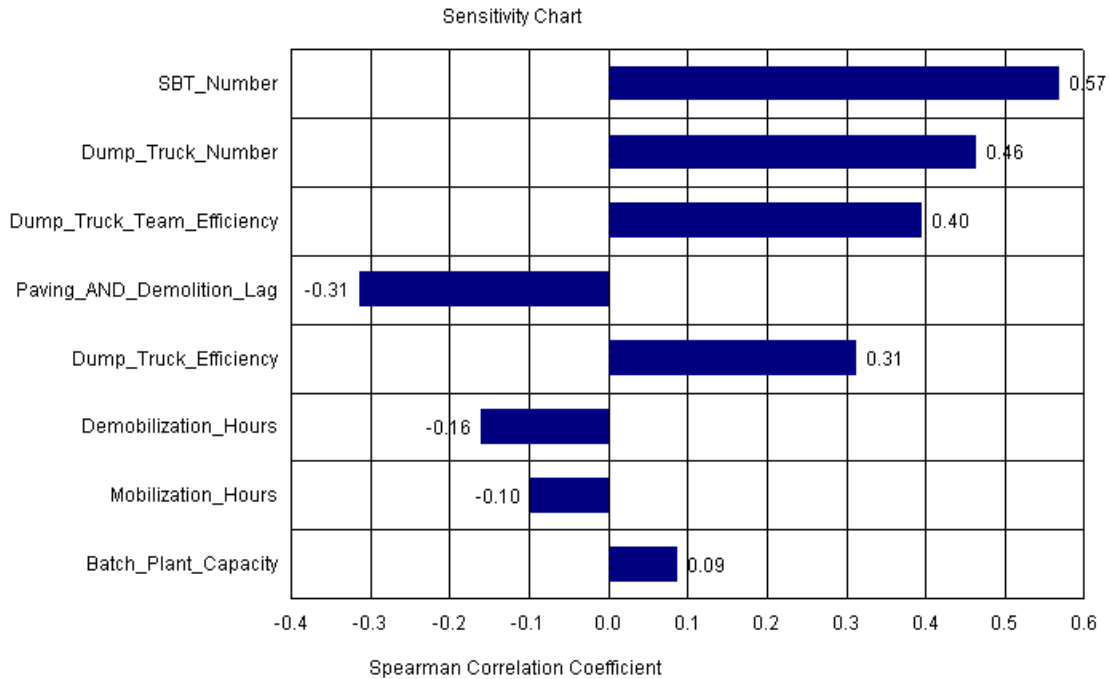
The chart below is a Spearman Correlation Coefficient graph for CA4PRS. Based on this chart, answer the following 2 questions:

1. (3 points) What item has the highest influence on overall CA4PRS productivity?
(just give me the name as it is listed in the chart).

SBT_Number

2. (3 points) Demobilization has a negative Spearman correlation coefficient. What does that mean?

As the value for demobilization goes up, the overall productivity goes down. This makes sense because as more hours are spent on mobilization, fewer hours can be spent on construction so productivity goes down.



Question 4 (15 points)

The 2 graphs on the following page are from a HIPERPAV III analysis of a PCC slab poured on I-82 in Yakima at 12 noon on July 11th, 2010. The reliability level used for this analysis was 95%. Answer the following questions:

1. (5 points) Is there a possibility the slab will crack within the first 72 hours based on the information presented here?

 YES

NO

(circle one)

2. (3 points) Is there greater than a 50% chance the slab will crack in the first 72 hours?

YES

 NO

(circle one)

3. (2 points) Why did you answer #2 the way?

At 95% reliability level you get a situation where stress is about equal to strain. This suggests the chances are somewhere in the 5-10% range at most. Far less than 50%.

4. (5 points) What is the primary cause of the slab stress during hours 19-24? Note that this stress is occurring at the top of the slab (colored yellow in HIPERPAV graph). Hint: the stress is a combination of a couple of things but does not include every stress mentioned in the HIPERPAV manual.

In the first few days after construction axial expansion caused by the concrete heat of hydration in combination with expansion/contraction associated with environmental temperatures (air and ground) tend to control the stresses in the slab. Anything involving expansion from hydration countered by contraction from environmental temperatures gets full credit. If you cited a combination of plastic shrinkage, autogenous shrinkage, drying shrinkage, curling/warping and creep/relaxation you get 2 points.

Question 4 (graphs)

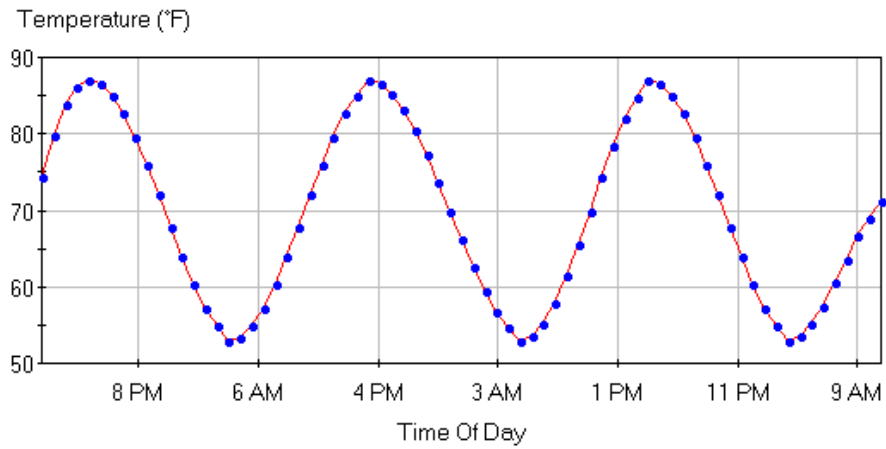


Figure 1. HIPERPAV III air temperature profile for Yakima starting at 12 noon on July 11th, 2010.

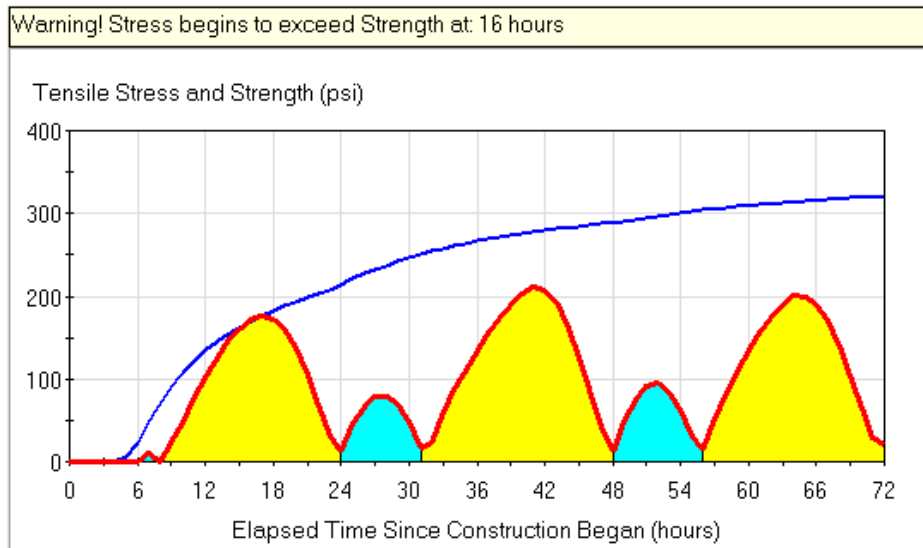


Figure 2. HIPERPAV III strength vs. stress plot for first 72 hours after slab pour.

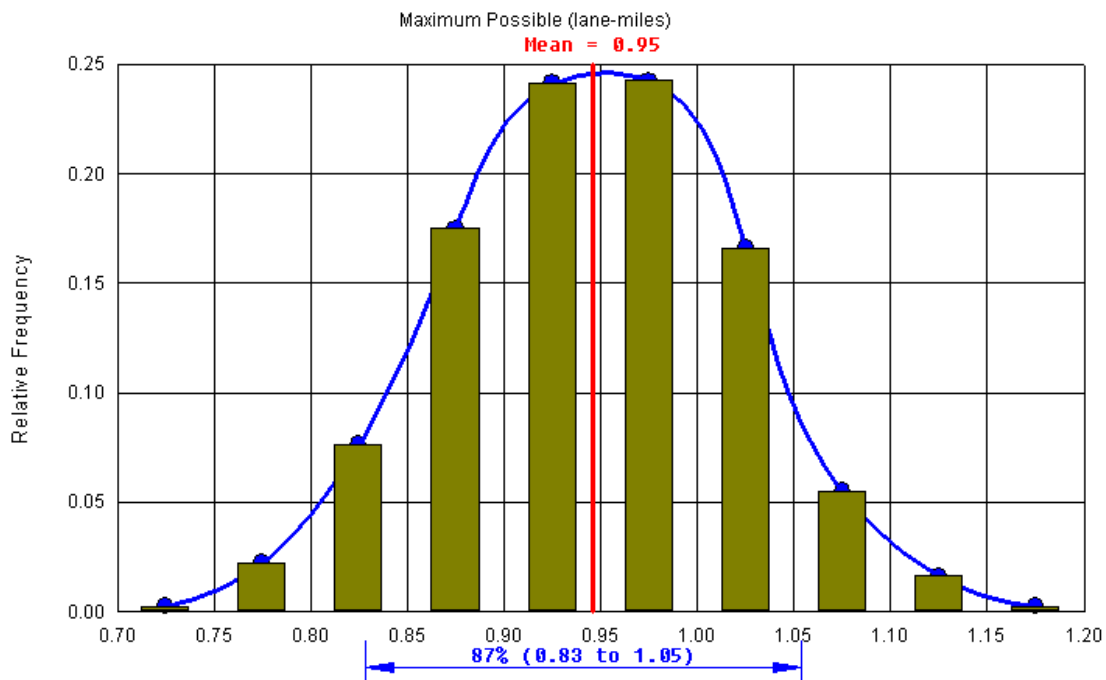
Question 5 (20 points)

A section of I-90 near Easton, WA (MP 70-72, a total of 4 lane-miles) is critically damaged and must be replaced by WSDOT in the Summer of 2012. The WSDOT traffic office is considering two closure scenarios:

1. A series of 8-hour night time closures (close at 9pm, open at 5am the next day)
2. A series of 55-hour closures (close at 10 pm, open at 5 am on the third day)

The CA4PRS probabilistic results for the lanes-miles that can be constructed during one 55-hour closure are shown below. Report the following:

- **(10 points) The minimum, most likely and maximum number of weekends it would take to do this job.** Use the 87% confidence interval to define minimum and maximum. Round up the number of weekends for each to the nearest whole number.
- **(10 points) Your assessment of the feasibility of the series of 8-hour closures plan.** The combined time for mobilization and demobilization is 5 hours for the weekend closure scenario show in the graph. You must include some rough numbers here. There is enough information on this page to make a reasonable educated guess as to how many weekday 8-hour closures it would take.



Question 5 (work space)**(10 points) Range of weekends**

This is just like the HW. Since the only interval you're given is the 87% confidence interval; use that. This gives:

$$\text{number of weekends} = \frac{4 \text{ lane miles}}{\text{productivity from graph}}$$

$$\text{max weekends} = \frac{4 \text{ lane miles}}{0.83} = 4.82 \text{ round up to 5 weekends}$$

$$\text{min weekends} = \frac{4 \text{ lane miles}}{1.05} = 3.81 \text{ round up to 4 weekends}$$

$$\text{avg weekends} = \frac{4 \text{ lane miles}}{0.95} = 4.21 \text{ round up to 5 weekends}$$

Some used other intervals, which is okay but I'm wondering why you might choose the interval you did.

(10 points) 8 hour closure plan

Mobilization takes 5 hours total for the 55-hour plan so it will likely take about the same for the 8-hour plan leaving 3 hours for construction. The mean for the 55-hour plan is 0.95 lane-miles per closure. Taking away the 5 hours of mob/demob that gives a productivity of about 0.95 lane-miles in 50 hours or about 0.019 lane-miles/hr. So, one could expect about three times this (there are 3 hours remaining for construction on the 8-hour closure scenario) or 0.057 lane-miles per closure. At this rate it would take 70 night closures to get the work done. Probably not realistic since you are doing two lanes at once so the actual centerline miles done each night is half or just 0.0285 miles. That is only about 150 ft or 20 slabs...and that's only if you use FSHCC for everything which drastically increases cost. Not a good use of resources so it's not practical to do night closures.

Some even noted that productivity would be less during a nighttime closure (as we learned in class and in the readings) so they said it would probably take even longer than 70 nights. Upwards of 80-90.

Question 6 (15 points)

You are the construction expert at a public hearing to discuss the reconstruction of a portion of I-5 north of Mount Vernon (MP 234.08 to 243.39). A concerned citizen asks you, “Which type of pavement costs more; portland cement concrete or hot mix asphalt?”

List and briefly describe the talking points you would use to answer the citizen’s question. In your discussion address the following 3 things:

1. (10 points) What costs should be considered when comparing the 2 options?
2. (5 points) Over what time period should you compare the alternatives?

Costs to consider:

- (5 points) Agency costs. This includes everything the agency spends for preliminary engineering, contract administration, initial construction, construction supervision, maintenance, rehabilitation, administration as well as the salvage value of the pavement at the end of the analysis period. Everyone discussed these in various ways.
- (5 points) User costs. This includes costs associated with normal operation and work zone user costs. General categories are: VOC, user delay and crash costs. User costs are difficult to quantify because in order to monetize them one must make assumptions as to the value of driver/passenger time, which are tenuous at best. User costs are typically an order of magnitude larger than agency costs. If you missed points it was most likely because you neglected user costs.

Time period (5 points). Use a long analysis period (at least 35 years according to the Walls and Smith 1998). Anything 35 years or over gets credit.