

*“I’m an engineer—I don’t need to worry  
about writing.”*

Not quite:

Writing is critical – up to 50% of your  
time may be spent writing

Promotion depends on your writing and  
communication abilities

Anyone can learn to write adequately;  
put effort into this NOW (courses,  
Writing Center help, etc.)

## **Lab Reports: Who reads them and why?**

- **SELF:** Engineers draft their ideas to keep their own thinking organized
- **CO-WORKERS:** They may draw on your work to create plans, make decisions on a project
- **OTHER RESEARCHERS:** They might replicate your study or build on it to create/test new materials
- **INVESTIGATORS:** If there is a crisis, they may scrutinize your lab work for errors
- **STUDENTS & INSTRUCTORS:** You write reports to learn lab procedures and to learn to communicate methods, data, and interpretations clearly to others; your reports reflect your learning

# What are the Major Sections of Experimental Reports?

**INTRODUCTION**

(combined or separate)

**BACKGROUND**

(Literature Review)

**EXPERIMENTAL PROCEDURE**

(Methods)

**RESULTS**

**DISCUSSION/CONCLUSION**

**APPENDIX**

## **INTRODUCTION**

Pavement maintenance engineers need to make decisions on new pavement patching materials every year. When these materials fail, holes and cracks in pavement can cause accidents. Evaluating the performance of patching materials in a timely fashion is a challenge, however. The best way to evaluate these materials is in the field under actual traffic loads and environmental conditions. This approach is costly, time consuming and impractical, however. It may take weeks, months, or years to obtain feedback. What is needed is an accelerated evaluation method that can simulate realistic pavement conditions to adequately predict in-field performance.

*What's this lab about and why should I care?*

## **KEY MOVES**

**-Introduce the topic you are investigating and its importance**

**-Explain the problem or opportunity that calls for new research**

## **BACKGROUND**

Numerous factors affect pavement patch performance, including materials, patch construction, bond and interaction between patch and pavement, traffic loading, and. . . .

Previous studies to assess performance of pavement patching materials have focused on . . . Unfortunately, every method has its drawbacks, for example. . . Even prescriptive standards are not a guarantee for success (1, 2). The Circular Accelerated Test Track (CATT) facility at University of Central Florida is an example of an accelerated outdoor testing facility (3). There, patching performance studies were conducted on . . . . The 500,000 load repetitions of 44.5kN wheel load equated to approximately 15 years in the field. Note that such facilities are available at only a few institutions and cannot be used by most agencies on a regular basis.

Chatterjee et al. (4) have investigated performance of different cold mix patches. . . . They. . . . However, no accelerated tests of in-place mixes were conducted. It seems that there is a critical need for developing a suitable accelerated test protocol that can be widely used to evaluate patching material in potholes.

This paper describes a new accelerated experimental procedure for evaluating pavement patching materials under simulated traffic loading and environmental temperature effects. This test uses a simulated patched pothole with an angled pavement block. The patch. . . . .

*What technical concepts must I understand to follow this study?*

*How does this work build on other work in the field?*

## **KEY MOVES**

**-Define background concepts**

**-Review and evaluate previous studies, methods, standards**

**-Cite sources**

**-Overview objective and parameters of current study**

## **EXPERIMENTAL PROCEDURE**

The host pavement was constructed using Portland cement concrete. A pothole measuring approximately 13 inches in diameter and 8 inches in depth was precast in the concrete block, and. . . .

Two patch materials were used in this experiment. A proprietary cold patch material and an HMA patch material based on the MnDOT guidelines. HMA material was added to the pothole until it overflowed the pothole elevation by 1 inch. The patch was then compacted using a 182 lb steel roller. The pothole was left to cure overnight. For the cold patch, manufacturer recommendations for construction were followed. Average bulk specific gravities were 2.28 and 2.15 for the cold patch material . . .

### **Rutting and Shoving Elevation Profiles**

To assess performance of the patching materials, an elevation profile of the transverse and longitudinal segments was first determined. An initial “zero” elevation was determined prior to cyclic loading . . . Subsequent readings were obtained after . . . Elevation profiles in the transverse and longitudinal direction (see Figure 1 for designation) are defined as a “Rut Profile” and the “Shoving Profile” respectively. Examples of rutting and shoving profiles as a function of cyclic load, vertical load magnitude and block tilt angle are presented in Figure 2 and 3 respectively.

*What did you do and how?*

## **KEY MOVES**

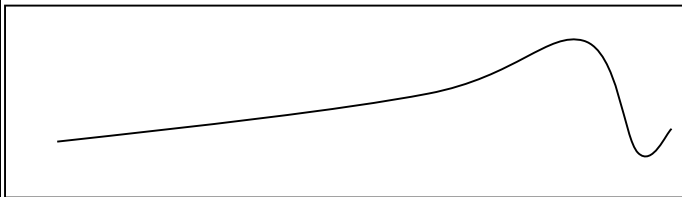
-Explain materials & methods (tests, steps), using past tense. If necessary, include visuals.

-Show formulas & refer to standards, so a reader can replicate what you did.

## RESULTS

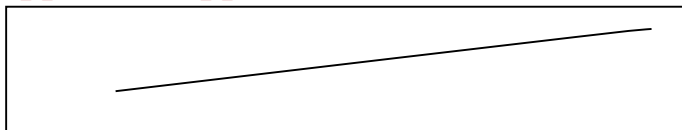
### **Rutting Area Index and Shoving Area Index for IRR Cold Patch Material**

Results of the rutting area index as a function of the number of load applications and the angle tilt of the pavement block are presented in Figure 6. The RAI increases with both an increase in the number of load applications and an increase in tilt angle. . . .



**FIGURE 6. Rutting Area Index as a Function of the Number of Load Applications and Pavement Block Angle for the 4500 lb Vertical Applied Load.**

Figure 7 shows the results of the RAI as a function of the number of load applications and the vertical applied load. The two vertical applied loads selected were 4,500 and 2,250 lbs., loads comparable to a truck tire load and light truck tire load. . . . Complete records of xxxx appear in Appendix A.



**FIGURE 7 Rutting Area Index as a Function of the Number of Load Applications**

. The shoving area index as a function of the number of load applications for the cold patch material is presented in Figure 8. The SAI also increases as the number of load cycles increases. This shows that more material is being displaced as the number of load applications increases and this has an influence on the resulting

*What happened?*

*Where's the evidence ?*

## KEY MOVES

- **Organize findings in distinct para/sections.**

- **In 1-2 sentences, sum up the finding for each test.**

- **Support the findings by labeling and referring to visual data summaries and/or discussing key measures (%s, psis, etc.).**

- **If necessary, remind reader how you arrived at the findings.**

- **Refer to Appendix for raw**

rutting area index as well.	data or calculations.
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<p><b><u>DISCUSSION/CONCLUSION</u></b></p> <p>The purpose of this paper was to introduce an accelerated test for pavement patching materials and to report on its effectiveness in testing these materials for pothole patching.</p> <p>The effect of different materials on pothole performance is evident between the HMA and the cold patch material. The HMA performed better than the cold patch material as expected. The HMA achieved an RAI and SAI similar to the cold patch but at an applied number of cycles that is an order of magnitude higher (see Figure 6 and 11).</p> <p>Results comparing the MMLS and the block test indicate that the block testing is a much harsher accelerated test. The MMLS rut curve was similar to the 17° block and much lower than the 13° and 22° block. This is predictable since the 4,500 lb vertical load simulates a truck tire load which has no wander and is dynamic along the same footprint.</p> <p>In conclusion, the proposed accelerated test has proved successful in assessing pothole patching materials with respect to cyclic load applications, load magnitude, shear to normal stress ratios and freeze thaw cycles. Based on this research, an acceptance criteria is proposed for patching materials: For HMA type materials, the RAI should not exceed 4 in2 at 20,000 cycles with a shear to normal stress ratio less than 40% with a vertical load of 4,500 lbs. For a stress ratio of 30% the RAI should not exceed 4 in2 at 30, 000 cycles. Figure 11 shows the selected</p>	<p><i>What does all of this mean? What are the implications?</i></p> <p><b><u>KEY MOVES</u></b></p> <ul style="list-style-type: none"> <li>-Remind reader of lab's purpose</li> <li>-Sum up key findings, describing patterns, principles or relationships your results show</li> <li>-Interpret findings and link to expected results/hypotheses or background literature</li> <li>-Discuss anomalies</li> </ul>
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<p>threshold limits. For the cold patch type material, the RAI should not exceed 4 in2 at 4,000 cycles . . .</p>	<p><b>in your data/study</b></p> <ul style="list-style-type: none"> <li>-Point out implications &amp; recommendations for future research, practical application, or theory.</li> </ul>
<p><b><u>APPENDIX</u></b></p>	<ul style="list-style-type: none"> <li>-Label each item: Appendix A, B, etc. as referred to in the report.</li> <li>-Include raw data/calculations or other material that might congest the text but that a reader might need to see</li> <li>-Students will include “lab sheet or notebook”</li> </ul>

## In-class Writing Exercise: Review of Rhetorical Moves and Sections

What sections do you think these excerpts came from? Circle the section you think each excerpt was taken from. Then label the “moves” you see the writer making in each excerpt.

A.       Intro/Bkground   Exp Procedure   **Results**

Temperature readings in Farenheit were recorded at three minute intervals over a 2-hour period, using a digital X-198 thermometer. Figure 7 illustrates the change in temperature over time in minutes across all four samples. <insert figure here>. Samples with higher levels of the admixture (Samples A, B, and F) were much more resistant to temperature changes than samples with low levels.

B.       **Intro /Bkground**   Exp Procedure   Results

Concrete is versatile, durable and economical, qualities that have contributed to making it the world’s most used construction material (1). It can be used for a variety of applications ranging from buildings to roads. In 2004 and 2005, the US constructed more than 11,000 new and repaired bridges. Approximately 75% of these bridges were concrete (1, 2). The American Society of Civil Engineers (ASCE), which rates the United States’ infrastructure, found in 2003 that 27.1% of the nation's bridges (160,570) were “structurally deficient or functionally obsolete”, however (2). To maintain public safety, engineers need accurate means to test concrete structures for strength and durability.

C.       Intro /Bkground   **Exp Procedure**   Results

Neoprene: Similar to the concrete, the neoprene was also tested to determine its properties. The neoprene was tested for both tension and compression. Photographs of the tension test are shown in Figure 4. Accepted material relationships were used to determine the Stress ( $\sigma$ ), the strain ( $\epsilon$ ) and the modulus of elasticity (E). Strain was defined as deformation divided by length. . .

**Intro /Bkground** Exp Procedure Results Discussion

Numerous theories on the possible frost damage in cementitious materials have been postulated. Powers (1) attributes the frost damage to the hydraulic pressure generated by the 9 percent volume expansion of water upon freezing in a cavity. Since the freezing process causes expansion as well as contraction of the cementitious matrix, the osmotic pressure theory (2) and capillary effect theory were introduced (3, 4) to account for this physio-chemical characteristic.

D. **Intro /Bkground** Exp Procedure Results Discussion

Previous research has employed neoprene to test the durability of a number of construction materials. The present research examined the possibility of using neoprene to dampen impulse waves in concrete and therefore reduce spalling. The success of the wave reduction in this study was evaluated through a series of three laboratory tests of concrete samples treated with neoprene.

F. Intro /Bkground Exp Procedure Results **Discussion**

Based on the these three laboratory experiments, it was determined that concrete mixes using the new XLP formula might withstand temperature changes more successfully than the formulas specified in the 2009 CS Guidelines. Additional testing of the XLP formula mixes under more realistic field conditions is recommended.

## **SUGGESTIONS TO STUDENTS:**

-Before submitting your work, review the key moves of the relevant sections (see handout and your grading rubric). Check your team's draft to make sure you covered these moves.

-Check my WPI for the document **PREPARATION FOR LAB REPORTS** to read more about lab report expectations.

-Look at real, professional reports and imitate the language and style. Notes the kinds of verbs used in the Results section.

-Read your TA's comments and apply to the next lab.

-For help with writing (style, organization, grammar, etc.) go to [wpi.edu/+writing](http://wpi.edu/+writing) and make a free, one-hour appointment with a writing tutor to review your draft.

## RESULTS are ARGUMENTS

Finding=**CLAIM**

Data summary + discussion=**SUPPORT**

Where is the finding (claim)? What sentences offer support? Do you see any other moves here?

In testing the 40-lb. slabs for tensile strength, we recorded both x and y over a 3-day period (see Appendix A for daily records). Average values for x and y appear in Table 2 and indicate that sample slabs constructed from the new formula surpassed older slabs in tensile strength as well as... The new sample slabs withstood .4 psi of xxx...

The first sentence reminds the reader of the methods they used to obtain the finding.

# VISUALS

## FIGURE

Anything that is NOT a table—a graph, pie chart, illustration, photo, diagram, etc.

Figures must have specific titles and be numbered in the order in which they appear (Figure 1, Figure 2).

Figure titles go UNDER the figure.

Y and X axes need to be labeled.

Provide a key or legend if needed. An interpretive caption can be added underneath or to the side.

## TABLE

Data in rows & columns.

Numbered and titled; parts labeled. Titles go ON TOP.

All visuals must be introduced in the text **before** they appear.

As shown in Figure 1, Samples 1-4 (alkaline treatment) had a mean temperature increase of 14 degrees as opposed to samples 5-8 (control group), which maintained stable temperatures. . .

Or ..... (see Figure 1).

## Common Problems in Results Section

No sentences summarizing the finding—just a visual thrown in (visuals cannot speak for themselves—write a sentence or two!).

Failure to refer to the visual at all or putting it in before it is referred to.

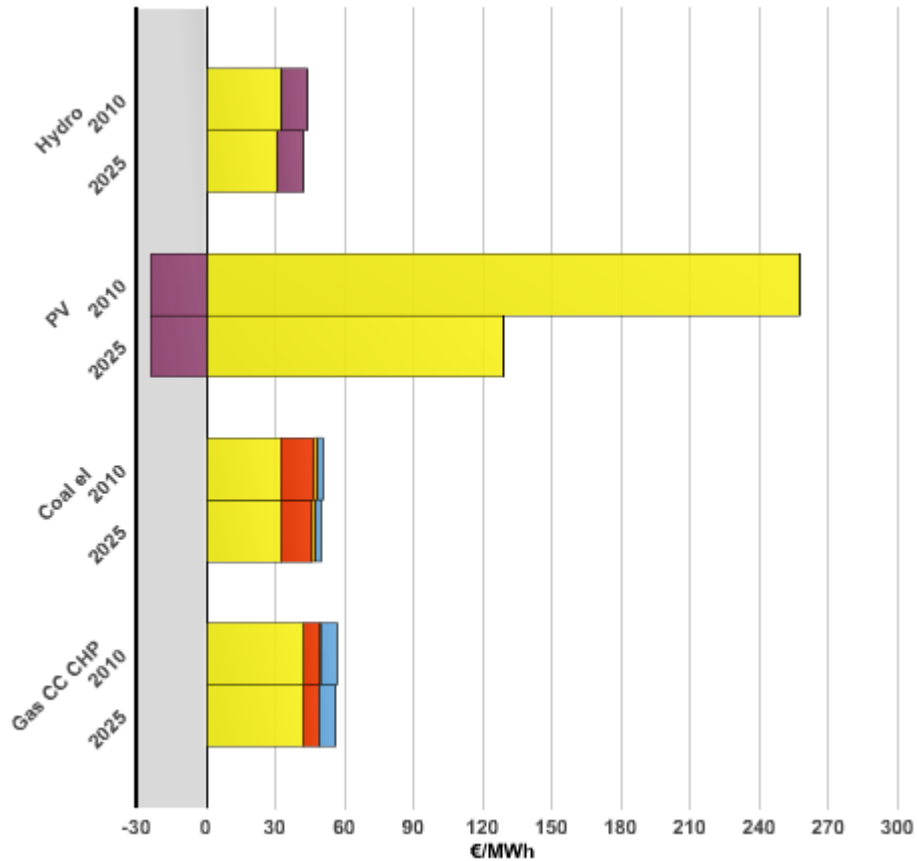
Ambiguous titles for visuals: “Figure 1. First Test” or “Table 2. Pavement Patch Test Result” and poor labels for columns and axes.

Improper usage (*proves* vs. *suggests*, this graph *finds* that..., this tensile strength *is stronger*).

Inclusion of raw data or of conclusions in Results.

POOR VISUALS TO CRITIQUE:

Figure 3: Fuel Cost Chart (Source: recabs.iea-rettd.org)



Revisions: → Vague title: What kind of fuel? What is compared?  
When? → Label axes: British pounds per megawatt? → Use key to explain the color markings. Flip the graph? → The figure title should go underneath, not on top of the visual.



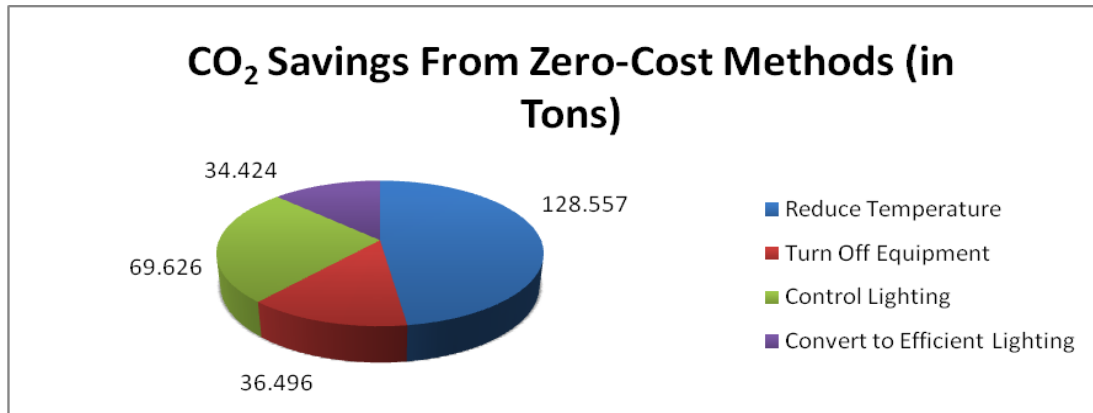


Figure 1: CO<sub>2</sub> vs. Method Reduction.

#### REVISIONS:

Title → Tons of CO<sub>2</sub> Saved by Implementing Four Low-Cost Energy-Saving Methods over a Five-Year Period—MUCH MORE SPECIFIC!

Figure → Round off numbers (34, 129, etc.); Order methods from highest to lowest.

#### Sample of how this data might be discussed in the results section:

Figure 1 displays the amount of CO<sub>2</sub> saved (in tons) by implementing each of four, low-cost energy saving methods over a period of five years. These simple, low-cost measures reduced CO<sub>2</sub> production by over 268 tons during the test period. Temperature reduction had the largest impact. Reducing the thermostat by 8 degrees in winter months and raising the thermostat by 5 degrees in summer months reduced CO<sub>2</sub> production by over 128 tons over the five year period, almost double the amount saved by installing lighting controls.

**TO DO: WRITE ONE PARAGRAPH OF YOUR RESULTS SECTION BASED ON THE GRADATION DATA YOU BROUGHT TODAY. INSERT YOUR FIGURE AND PROPERLY REFER TO AND LABEL IT. USE THE RESULTS CHECKLIST TO MAKE SURE YOUR PARAGRAPH COVERS EVERYTHING.**