# THE PST WITH A TWIST: COMPARING THE STANDARD PST TO THE CROSS SLOPE PST

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ABSTRACT: In recent years, the propagation saw test (PST) gained popularity for both avalanche professionals and backcountry recreationalists. A limiting factor of the PST is the additional time required to isolate a column on the sidewall of the snowpit. Since I often have limited time to dig multiple pits during a work day, this past season I examined the effectiveness of conducting cross-slope PSTs (CPST). The CPST is simply a PST done across, rather than up, the slope. It is more efficient than the PST, particularly after conducting an extended column test (ECT). I collected a total of 28 data sets, including standard PSTs, CPSTs and ECTs during the 2013/14 winter season. My data indicate that CPSTs share similar critical cut lengths as standard PSTs, with 75% of critical cut lengths falling within 10 cm of each other. Though it is necessary to collect more data to make solid conclusions, there may be a slope angle effect where CPSTs begin to have shorter cut lengths than standard PSTs as slope angles increase above 28 or 30 degrees. A drawback of the CPST is that some weak layers may be more difficult to follow than in a standard PST. Currently, the CPST cannot be qualified as a standardized stability test, but I hope to continue to collect additional data to better understand how CPSTs are related to PSTs and snowpack stability.

KEYWORDS: Propagation Saw Test (PST), Cross-slope Propagation Saw Test (CPST), Extended Column Test (ECT), critical cut length, slope-angle, fracture initiation, fracture propagation.

## 1. INTRODUCTION

Determining the propagation propensity of a slab/weak layer combination in the field is an important component of avalanche forecasting. The extended column test (ECT) and propagation saw test (PST) are two individually developed field tests designed to indicate the propagation propensity for a slab and weak layer combination to propagate a fracture (Ross & Jamieson, 2008). The ECT has become the most common stability test, used in nearly 80% of snowpits entered into Snowpilot in 2012 (Birkeland & Chabot, 2012). The PST was used in roughly 15% of snowpits entered into Snowpilot in 2012 (Birkeland & Chabot, 2012).

Conducting stability tests in the backcountry takes time. One reason the PST may be less utilized than the ECT is the time required to isolate a column on the sidewall of the snowpit, especially when the weak layer tested is more than one meter deep. The modification of the standard PST to a cross-slope orientation allows for the test to be performed more quickly.

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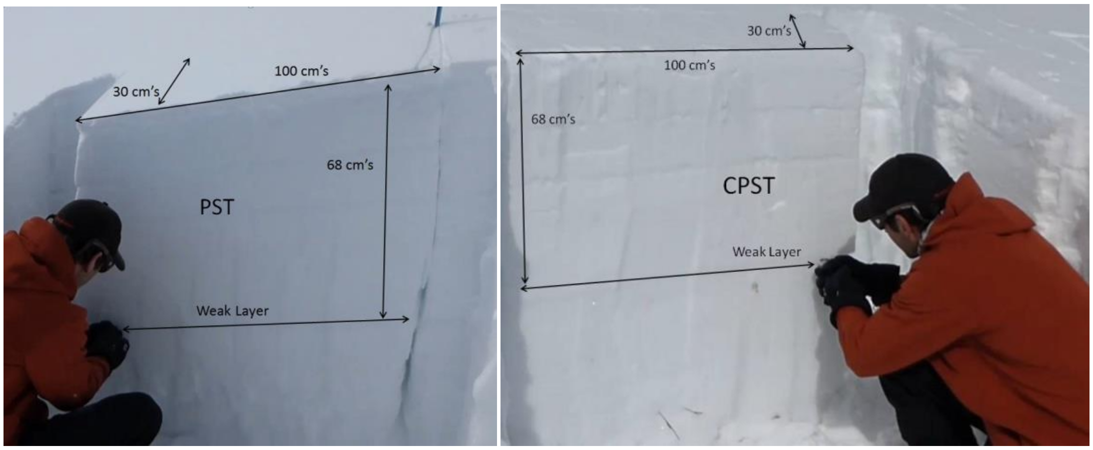


Figure 1: The photo on the left is a PST in process. The photo on the right is a CPST in process. In both tests, the blunt edge of the saw is pulled through the weak layer.

In an effort to show that the CPST and the PST give the user similar results, this research compares critical cut lengths of both the standard PST and CPST to evaluate similarities and differences of these two tests. This research also explores the influence that slope angle plays on critical cut lengths between the upslope PST and CPST.

## 2. METHODS

The CPST is a new variation of the PST designed to indicate the propensity of a slab/weak layer combination to propagate a fracture. The CPST uses column dimensions of 30 cm upslope by 100 cm+ cross slope, isolated to below the weak layer on all sides (The cross-slope column length will be equivalent to the depth of the targeted weak layer if the buried weak layer is deeper than 100 cm.).

The primary benefit of using the CPST over the PST is that it's less time intensive to perform the test, especially when the targeted weak layer is deeply buried. The CPST can be conducted immediately after an ECT, using the already excavated cross-slope pit wall from the ECT. Also, performing an ECT prior to the CPST allows for observation of active and unstable layers, facilitating easier identification of Layers of Concern (LOC).

The CPST is performed by inserting the blunt end of the saw into the targeted weak layer in the isolated column, then sliding the saw parallel across the slope. Test results for the CPST can be interpreted the same as the PST. If fracture propagation initiates and continues uninterrupted to the end of the column with a saw cut of less than or equal to 50% of the column length, then fracture propagation is determined to be likely (an unstable result) (Ross & Jamieson, 2008).

| PST | | ECT | | CPST | | | | |
|---|---|---|---|---|---|---|---|---|
| Cut Length (cm) | Column Length (cm) | Classification | Score | Cut Length (cm) | Column Length (cm) | Slope Angle | Depth (cm) | Difference in Cut Length Between PST & CPST (cm) |
| 33 | 100 | ECTP | 22 | 24 | 100 | 27 | 78 | 9 |
| 31 | 100 | ECTP | 18 | 29 | 100 | 25 | 62 | 2 |
| 28 | 100 | ECTP | 30 | 30 | 100 | 29 | 70 | -2 |
| 34 | 100 | ECTP | 18 | 23 | 100 | 27 | 93 | 11 |
| 25 | 100 | ECTP | 8 | 20 | 100 | 33 | 55 | 5 |
| 25 | 100 | ECTP | 13 | 25 | 100 | 20 | 50 | 0 |
| 25 | 100 | ECTN | 19 | 25 | 100 | 29 | 45 | 0 |
| 22 | 100 | ECTP | 13 | 25 | 100 | 15 | 50 | -3 |
| 80 | 100 | ECTN | 20 | 30 | 100 | 25 | 42 | 50 |
| 28 | 100 | ECTX | | 25 | 100 | 27 | 42 | 3 |
| 30 | 100 | ECTP | 14 | 24 | 100 | 15 | 45 | 6 |
| 33 | 100 | ECTP | 19 | 37 | 100 | 25 | 54 | -4 |
| 33 | 100 | ECTP | 19 | 35 | 100 | 25 | 54 | -2 |
| 30 | 100 | ECTP | 18 | 37 | 100 | 25 | 54 | -7 |
| 39 | 100 | ECTP | 24 | 33 | 100 | 25 | 89 | 6 |
| 35 | 100 | ECTP | 27 | 30 | 100 | 27 | 83 | 5 |
| 62 | 100 | n/a | n/a | 52 | 100 | 35 | 49 | 10 |
| 38 | 100 | ECTP | 31 | 48 | 100 | 33 | 89 | -10 |
| 25 | 120 | ECTP | 16 | 29 | 116 | 25 | 54 | -4 |
| 31 | 100 | ECTP | 21 | 30 | 100 | 25 | 68 | 1 |
| 40 | 100 | ECTP | 21 | 30 | 100 | 25 | 68 | 10 |
| 37 | 200 | ECTP | 23 | 53 | 200 | 25 | 68 | -16 |
| 63 | 100 | ECTX | | 45 | 100 | 35 | 77 | 18 |
| 29 | 100 | ECTP | 30 | 34 | 100 | 20 | 80 | -5 |
| 40 | 100 | ECTPV | | 27 | 100 | 32 | 145 | 13 |
| 37 | 120 | ECTP | 30 | 40 | 120 | 26 | 58 | -3 |
| 49 | 195 | ECTP | 21 | 38 | 100 | 27 | 28 | 11 |
| 35 | 100 | ECTP | 18 | 32 | 100 | 28 | 56 | 3 |

Figure 2: This table shows data set PST, CPST and ECT results collected throughout the 2013/14 winter season.

## 3. DATA AND RESULTS

A total of 28 CPST data sets were collected during the 2013/14 season (Figure 2). Most of the data collected was from Southwestern Montana, accounting for twenty five of the twenty eight data sets. The remaining data sets were collected near Irwin Lake Lodge near Crested Butte, Colorado. Each data set includes the test scores for ECT, PST and CPST. Data collected indicates that 75% of critical cut lengths between the standard PST and CPST were + / - 10 cm’s of each other when the weak layer propagated the entire length of the column (Figure 3). Although data sets are limited, they present enough information to indicate that the CPST shares similar cut lengths (test results) as the standard PST.

Test results also show a slight difference in critical cut lengths between the standard PST and CPST in relation to slope angle. There is an indication that critical cut lengths may become shorter for the CPST as slope angle increases. The difference in critical cut lengths begins to appear once the slope angle becomes greater than 28-30 degrees (Figure 4).

The influence slope angle plays on critical cut lengths may be the result of the addition of Mode III fracture in the CPST (figure 5). The PST takes place in two dimensions (Mode II fracture) (Gauthier, Ross, & Jamieson, 2008).

The influence slope angle plays on critical cut length is worth investigating; however, it is not the primary focus of this study. Fortunately data indicate that the CPST shares similar critical cut lengths as the PST on slopes less than 30 degrees. This information is valuable to avalanche professionals and backcountry recreationalists.

Although the CPST shows promise as a good test to measure slab/weak-layer propagation propensity, it does have some drawbacks. The CPST may give the same false-stable rates (between 30% and 44% ) associated with PST results (Simenhois & Birkeland, 2009). In addition, novice practitioners may find it difficult to follow the weak layer on their test cut during the CPST, giving inaccurate test results.

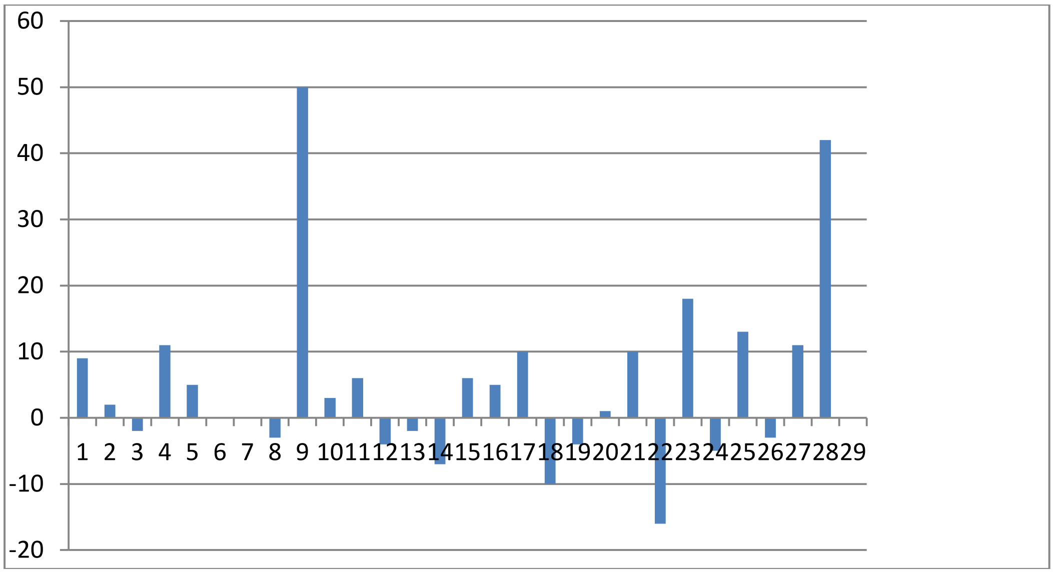


Figure 3: This graph shows the difference in cut lengths between the PST and CPST in the same pits.

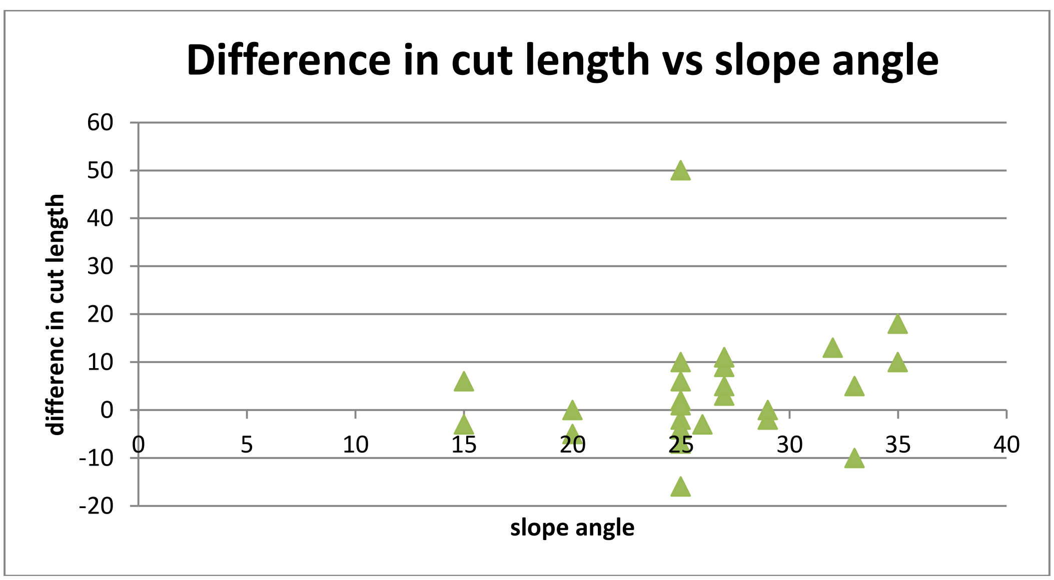


Figure 4: This graph shows the difference between CPST and PST cut lengths and slope angles. Notice there is a slight divergence in cut lengths once the slope angle gets steeper than thirty degrees.

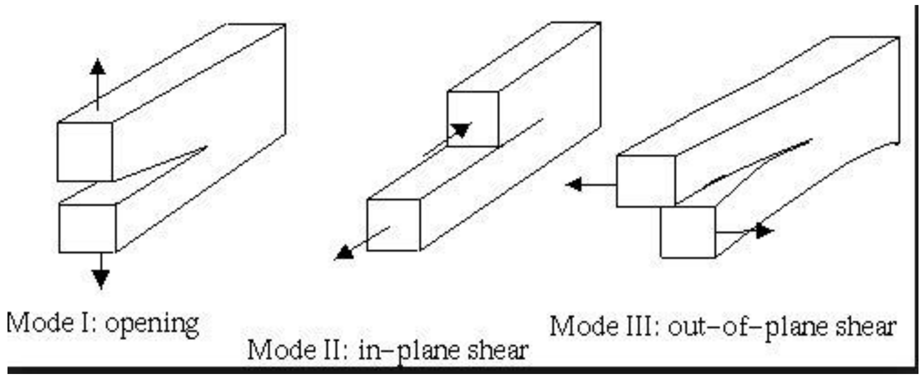


Figure 5: This diagram shows the three different modes of fracture. CPST occurs in Mode III fracture - PST occurs in Mode II fracture.

## 4. CONCLUSION

Early research suggests that the CPST has potential to provide valuable information when determining snowpack stability. The CPST shares similar critical cut lengths with the PST in most circumstances. The CPST is often easier to perform after conducting an ECT and the CPST is more time effective to dig than the PST, primarily when the layer of concern is buried more deeply. The CPST has demonstrated that it can produce reliable results on slope-angles less than 30 degrees; as a result, practitioners may conduct this test in 'safe' terrain. However, there appears to be a variation in CPST results as slope angle increases greater than 30 degrees. More data is required to correlate the relationship between slope angle and critical cut lengths for the CPST, but early results indicate critical cut lengths may become shorter as slope angle increases.

The CPST currently lacks sufficient data to qualify it as a standardized stability test, but it is my hope to continue to collect additional data to better understand how CPSTs relate to PSTs. Even with a limited data set, the CPST has demonstrated strong potential as a good resource for assessing snowpack stability.

## 5. ACKNOWLEDGEMENTS

Special thanks to Mark Staples, Doug Chabot, Karl Birkeland and Ian Hoyer for providing valuable support and data collection. Additional thanks to Zach Guy, Chris Bilbry, Pat Steron and Marcie Knoff for their time and input on this project.

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