Abstract

eCYBERMISSION Team Name	Knightettes of the Twisters
Team Grade	8th Grade
Project Start Date	9/2013
Project Finish Date	3/4/2014

Describe your project and explain how you used STEM (Science, Technology, Engineering and Mathematics) to improve your community (250 words or less)

The devastation of the Moore, OK tornado in May 2013 inspired us to find ways to increase tornado safety and preparedness for individuals in their homes. We conducted our project in two phases using scientific methodology. In phase one, we tested cost effective, easily accessible materials that could retrofit a pre-existing internal room of the house. Following research of different materials, and consulting varied engineering disciplines, we selected 5 materials which were assembled to create 5 target wall structures. These were tested using two different forms of missile release 1. A baseball pitching machine reaching speeds of 100 mph 2. A drop test where 20 and 30 pound weights were dropped from a height of 50 ft. Outcomes showed that there was little to no damage when all 5 layers were combined. We concluded that people who could not afford a FEMA certified shelter could use these materials to create an affordable DIY option and increase safety. Further and more stringent testing of the target wall structures would allow for ratings matching tornado severity. Phase two included a pre-post survey measuring both tornado safety knowledge and preparedness. Following the pre-survey we administered an educational intervention designed to increase knowledge in this area. Analysis of pre-survey results showed that middle school students in our sample had high levels of prior knowledge. Surprisingly 65% of our sample reported having a safety plan while only about 30% reported having a safety kit. This would indicate the need for interventions which increase preparedness.

Tips for writing your abstract:
- Do not go into too much detail about one certain area - be brief!
- Include a problem statement and/or your hypothesis
- Summarize procedures and the important steps you took to solve your problem
- Briefly discuss your observations and results
- Summarize conclusions and/or next steps
- Do not go over 250 words!

*Please e-mail completed abstracts to swhitsett@ecybermission.com or fax to 703-243-7177 by April 15.

State	Oklahoma
Grade	8th
Mission Challenge	Environment
Method	Scientific Inquiry using Scientific Practices
Students	rktwister (Submitted on: 3/4/2014 7:37:53 PM) mmackey (Submitted on: 3/4/2014 7:25:29 PM) lhilst (Submitted on: 3/4/2014 7:37:26 PM)

Team Collaboration

(1) Describe the plan your team used to complete your Mission Folder. Be sure to explain the role of each team member and how you shared and assigned responsibilities. Describe your team's process to ensure that assignments were completed on time and deadlines were met.

Knightettes of the Twisters - Uknighted Champions dedicated to the cause of increasing tornado safety and preparedness and serving the Oklahoma community. This was our mission.
The plan used to complete the mission folder was to initially generate a list of topics that we were interested in. We then researched each topic and narrowed down theoptions by a vote. Since we live in Oklahoma which is a state prone to tornadoes and has recently been dramatically affected by the devastating tornados in Moore, OK and Joplin, MO, we decided to focus on tornado safety and how to build a cost effective DIY (Do it yourself) tornado shelter. Our project was then divided into two phases.
1.We would research and test cost effective, easily accessible materials and construction methods for use in a DIY tornado shelter.
2. We would educate students on tornado safety and preparedness.

Each team member had a role that they fulfilled based on their interests and expertise.

Team member 1: Researched Oklahoma being in Tornado Alley, different kinds of foam as building materials, completed the PowerPoint and found links to videos for the educational intervention. She also coordinated emails and other communication.

Team member 2: Researched the cost of different types of tornado shelters, rubber and car bumper material. She created the surveys, wrote the analysis of the surveys, and completed all tables and survey data analysis.

Team member 3: Researched the Fujita Scale, bedliner, and other building materials. She also coordinated construction, assembly, scheduling and conducting testing of the materials for the DIY shelter. She coded and analyzed all the DIY shelter data.

We are a group of three girls who are great friends and share similar interests such as Band, Chinese, and Girl Scouts and work well as a team. To ensure our team was on track we would assign a research topic weekly that needed to be completed by the next meeting. We had team meetings every Monday after school. About every other week we would either meet with or talk on the phone with people who had expertise in this area (Refer Attachment A: TIME LINE) . We did all the testing as a team and approved all surveys, educational interventions, and the writing of the mission folder collaboratively.

Uploaded Files:

- [**View Attachment- A TIME LINE** (By: rktwister, 03/04/2014, .docx)]

Time line of tasks completed for mission folder.

Scientific Inquiry

Problem Statement

(1) What problem in your community did your team try to solve? Why is this problem important to your community?

May 20, 2013 was a very difficult day for Oklahomans when an EF5 tornado tore through Moore, OK taking the lives of 24 people. Not much later on June 1, 2013 another wave of tornadoes ripped through Oklahoma causing the loss of five more lives. Tornado sirens, watches, and warnings are all things Oklahomans are used to, but are we really prepared for a tornado? Oklahoma is part of Tornado Alley and each year there is severe damage and loss of many lives because of tornadoes. It is therefore extremely important in our community to keep loss of lives and injuries caused by tornadoes to a minimum. Tornado safety and preparedness was the focus of our project.
Traditionally having a FEMA standard tornado shelter has been considered the safest option. Unfortunately Tornado shelters are very expensive

and many people cannot afford them. Instead most people use the innermost room of their house which has no windows to keep safe - such as the bathroom or closet. Unfortunately a room made with drywall is not the safest way to survive a tornado. In this project we have researched materials that are shock absorbent, cost effective, and easily available that could be used to strengthen the walls of the innermost room of a home. Even though this may not be as safe as a FEMA certified Tornado shelter, we hope this would be safer than a closet or bathroom. In addition we also wanted to increase peoples tornado safety awareness and tornado preparedness. We did this by designing and conducting an educational intervention.

(2) List at least 10 resources you used to complete your research (e.g., websites, professional journals, periodicals, subject matter experts).

SUBJECT MATTER EXPERTS:
Mr. D. Babcock- Aerodynamics Engineer. Boeing.
Mr. Ed Calianese- Warning Coordination Meteorologist. National Weather Service Tulsa, OK.
Mr. Rama Challa- Structural Engineer, Director of Engineering; Environmental and Chemical Plants at Mitsubishi Heavy Industries America.
Mr. Andrew Connor - Engineer. SCFM Air Compressors.
Ms. Heather Duncan - Director of Donor Relations. Community Action Project. Tulsa.
Dr. E. Kiesling- Research Professor and Executive Director, National Storm Shelter Association (NSSA)
Texas Tech University.
Mr. John Mackey - Plant Engineer. CF Industries
Mr. L. Tanner- Research Associate and Instructor. National Wind Institute. Texas Tech University.
Mr. Jerry Crane and Mr Duane Culbert. Belger Cartage Service

DETAILED BIBLIOGRAPHY (Refer Attachment - B)
Primary Resources:
www.fema.gov
www.noaa.gov
www.depts. ttu.edu/nwi/

(3) Describe what you learned in your research.

"The United States averages about 1000 recorded tornadoes every year" as stated by Tornadoproject.com. The NOAA states that "Annually tornadoes cause and average of 1,500 injuries," the average number of tornado related fatalities are over 100 people per year and the average amount of money for property damage was $1,648.68 million in 2012 (http://www.nws.noaa.gov/) .Tornadoes are nature's most violent storms and can cause significant damage. According to Ready.gov the majority of tornadoes occur in a region of the United States which is called Tornado Alley, consisting of Texas, Kansas, Oklahoma and Arkansas. Tornado wind speeds can range anywhere from 65 to over 200 miles per hour. The Fujita scale is a way to measure the strength of the tornadoes. The Fujita scale ranges from an F0 - F5. F0 is the weakest type of tornado and F5 is the strongest tornado. Since the Fujita scale has been created, the scale has been changed and is now called the Enhanced Fujita scale or the EF scale. The EF Scale factors in both wind speeds and the damage caused by the tornado. About 95% of the tornadoes that occur are F0 - F3 tornadoes and only 0.1 percent of tornadoes reach the F5 rating. However the F5 tornados cause the most damage and fatalities (stormaware.mo.gov).
FEMA reports that approximately 10,000 lives are saved each year due to shelters and emergency plans (www.fema.gov). However, not having a shelter does not mean you can't have an emergency plan. Our research on tornado safety showed that if you don't have a shelter then a basement or the innermost room of your house that does not have any windows is the safest place to be. It is also important for safety to be listening to the local weather station on the radio or the NOAA during a tornado. The Red Cross and the NOAA recommend that a tornado safety emergency kit should include the following: a flashlight, food, water and a sledgehammer just in case you get trapped inside. Sturdy shoes, a helmet and work gloves are also recommended. Most people do not think about this but making copies of important documents and keeping cash in the emergency preparedness kit is also very important.
Our Research on FEMA certified tornado shelters showed that these are expensive. A shelter for 4 people can cost up to $4000. FEMA has guidelines for building your own in home shelter however the materials required are expensive and the construction methods are not for the average homeowner. These guidelines might be easy for a contractor to follow in new construction, however it would be expensive and difficult for a person without technical knowledge to do this on their own. Since the average Oklahoman can not afford to install a FEMA certified Tornado Shelter, they rely on the innermost room of their house for safety. These rooms are constructed of drywall and do not provide enough protection in severe tornadoes. We researched designs and materials that could be used to reinforce the walls of a regular room to make it more protective.
Our research from talking to engineers showed that circular shapes or dome shaped structures are more wind resistant. These structures are known as monolithic domes and have been a good model for community and school shelters. (www.monolithic.org) The Geronimo High School, OK has made all their buildings based on this model. However making a rounded structure within a house would be very difficult for a DIY structure. We then decided to focus our research on several different materials. These included various types foam including; memory foam which is viscoelastic, Sorbothane that is shock absorbent and styrofoam which is easily available. Car Bumper materials that are energy absorbent and made with foam cushioning materials help protect passengers in an accident. (www.nhtsa.gov). These materials would need to be special ordered. Kevlar which is bulletproof and is very expensive was already being used in some tornado shelters. (http://www2.dupont.com/Stormroom/en_US/). We were particularly interested in Line X (spray on bedliner) which was tested by the Mythbusters in an episode and found to be bombproof. (Mythbusters Bedliner Episode Season 11 Episode 19) We also talked to Subject Matter Experts from Texas Tech University specializing in debris testing for tornado shelters and structural engineers. We realized that the FEMA certified tornado

shelters are more wind resistant and are built from concrete and steel. However it made more sense to use shock absorbent material to reinforce the innermost room because they would be cheaper, easier to find, and could be layered for strength. We then focused on materials like foam, plywood, chicken wire and a spray-on bedliner. All these materials come in dimensions that would easily fit a standard room. We did learn from our research that the most vulnerable part of a room is the door and there are standardized steel doors that have been well researched and available that can withstand tornado winds.

For our educational intervention we used information from the American Red Cross, the NOAA and The Weather Channel to collect key facts on tornado safety and preparedness to develop an educational powerpoint. We also selected some relevant videos that were brief but informative to be included in the educational intervention.

Hypothesis

(4) State your hypothesis. Describe how your hypothesis could help solve your problem.

Hypothesis PHASE 1: If the inside of a previously built room is layered with durable but low cost materials then the room would be safer in the event of a tornado.

Hypothesis PHASE II: If people are educated about tornado preparedness then they will have increased knowledge of tornado safety and are more likely to make tornado safety plans for the future.

(5) Identify the independent variables and the dependent variables in your hypothesis.

PHASE I: DIY SHELTER

Independent: The materials that are used to reinforce the walls and the different methods used in testing the target materials.

Dependent: The extent of damage done to the testing materials.

PHASE II: SURVEY & EDUCATIONAL INTERVENTION

Independent: The tornado safety educational intervention which includes a power point and several videos.

Dependent: The overall change in knowledge which will be measured through the difference in the pre- and post- survey.

(6) How did you measure the validity of your hypothesis?

PHASE I: DIY SHELTER

In order to measure the validity of our hypothesis we selected five different materials for testing. These included drywall, plywood, chicken wire, Foil Backed Poly Styrene, and LineX spray in bedliner We layered these to make five different targets. We then proceeded to test these targets using 2 different tests. Refer to Attachment C: TESTING PROTOCOL). The pitching test shot a baseball at the target from a distance of 50 ft at the speed of about 100 mph. The second test was the drop test where a 20 lb and 30 lb weight was dropped on the target from a height of 50 ft. The velocity of the weights was 38.58 mph. However the momentum for the 30 lb weight reached 77.16mph. (Refer to Attachment D: Computation of Velocity and Momentum)

We then scored extent of damage to the target.

PHASE II: SURVEY & EDUCATIONAL INTERVENTION:

In order to test for increase in knowledge about tornado safety and preparedness we gave a sample of middle school students a pre-survey that measured tornado preparedness and knowledge about safety planning. These students then received an educational intervention including a PowerPoint and videos about tornado safety planning. A post-survey was then administered to assess for growth in knowledge and to measure the likelihood that these students would discuss and make tornado safety plans with their family.

Experimental Design

(7) List the materials you used in your experiment. Include technologies you used (e.g., scientific equipment, internet resources, computer programs, multimedia, etc.).

Survey Monkey
Internet for research
Calculators for computation of final velocity and momentum of missiles
PowerPoint
Links to educational videos
Google drive to share information
Power tools for assembling test materials
Baseball pitching machine
Access to a crane for drop test
Video camera and camera to record experimental procedures and results
All materials for target

(8) Identify the control group and the constants in your experiment.

PHASE I: DIY SHELTER: The control group in this phase was the singular drywall target mounted with carriage bolts to a 2x4 stud wall in order to represent the wall of a standard interior room. Because this is the standard construction of an interior room we assumed that the damage done to this testing layer would be consistent with the expected damage caused by a tornado so we used it for our control group. We used the drywall, the

carriage bolts and the 2x4 frame in every test to insure consistency in our tests. Our targets were also the same distance from the starting place of the projectile, 50ft. The same projectile was used for the pitching test (baseball) and the drop test (20-30lb weights). The same method of propulsion was also used in each test. In the pitching test it was the pitching machine. In the drop test it was the weight being dropped from the same height of 50ft.

PHASE II: SURVEY and EDUCATIONAL INTERVENTION: The Control Group in this phase was the Pre-Survey data collected reflecting baseline knowledge of tornado safety and preparedness. Students selected to participate in this study were one team at each grade level that had convenient access to computers in the classroom. They represented about 10% of the enrollment at each grade level.
The constants in our experiment was the standardized survey and educational interventions. The same students who completed the pre-survey were asked to complete the post-survey.

(9) What was your experimental process? Include each of the steps in your experiment.

PHASE I: DIY SHELTER
We developed five different test targets. Each target consisted of different combinations of our layering materials and we were then able to assess the effectiveness of adding these layers. These layers included plain drywall to replicate a standard wall, Foil Backed Poly Styrene because it would compress without breaking, chicken wire to act as a net, plywood for stability, and Line-X to act as another shock absorbing layer. After assembling these materials into five different testing targets we tested them in two different ways. The first way was by using the Jenks High School batting cages and launching a baseball at the targets from 50ft. The second way was by going to Belger Cartage Service and using a crane fit with a man basket to go up to a height of 50ft and dropping our projectiles onto the targets. We then created a method of rating the damage. The data collected was then put into a tabular format and analyzed.

PHASE II: SURVEY and EDUCATIONAL INTERVENTION:
We developed a pre-survey and post-survey to measure tornado safety knowledge and level of preparedness. This was done on Survey Monkey. (Attachment E1-PRESURVEY TORNADO SAFETY)
The surveys asked questions about tornado preparedness and safety plans at home. Questions were created to measure knowledge about when to go into your safe room or what to do if you are in a car when a tornado is in the area. There were also questions about common injuries that could occur during and after a tornado and what you should bring with you into your safe place in the event of a tornado.
We also planned an educational intervention including a PowerPoint that covered key elements of tornado safety and selected brief videos that also addressed tornado preparedness. (Attachment-F POWERPOINT)
Administered pre-survey to a sample of 6th, 7th and 8th grade students at Jenks Public Schools. (334 students- approximately 10% of each classes enrollment.)
These students completed the educational intervention.
The post-survey was then administered. This measured change of knowledge as well as likelihood that the student would discuss tornado safety and preparedness planning with their family.
Data analysis was then completed.

Data Collection and Analysis

(10) Describe the data you collected and observed in your experiment. The use of data tables, charts, and/or graphs are encouraged.

PHASE I: DIY SHELTER
The data we collected was how well the different DIY shelter materials and targets withstood different missile types, under two different testing conditions. We coded the data according to extent of damage done by the missile to the target. The data collected is represented in a tabular format (refer attachment....). The magnitude of damage was scored as None, Mild, Moderate and Severe. (Refer Attachment Test PROTOCOL).
PHASE II: SURVEY and EDUCATIONAL INTERVENTION
We collected Pre and post survey responses via Survey Monkey. These were then scored and compared using percentages of correct response. (Refer Attachment .....)
These included a comparison of 6th to 7th and 8th grade and pre survey responses combined at all three grade levels. The Post survey comparison was only done for 6th grade responses.

(11) Analyze the data you collected and observed in your experiment. Does your data support or refute your hypothesis? Do not answer with a yes or no. Explain your answer using one of the following prompts: 'Our data supports/refutes the hypothesis because...'

PHASE 1- We hypothesized that if the inside of a previously built room is layered with durable but low cost materials then the room would be safer in the event of a tornado. The data we collected supported our hypothesis under conditions where all five selected layers were used in the target tested. The single drywall layer was perforated in both the pitching test and the drop test. However as we added layers to the target the damage inflicted on the target became less severe and the missile did not perforate the target (see attachment….). It would appear that the foam, chicken wire, and Line-X when combined made the strongest protective agent.

PHASE II: Overall the data we obtained does support our hypothesis that if individuals are provided with information about tornado safety and preparedness they will show increased knowledge about tornado safety and are more likely to discuss issues of tornado preparedness with their family. However we can't measure if this would actually translate into action.
We also found that Pre-survey data showed relatively high levels of baseline knowledge.

In the pre-survey the initial questions that dealt with Tornado preparedness showed that
less than 25% of respondents have a FEMA certified shelters at home. While 66% of students reported that they had a tornado safety plan only about 30% reported having an emergency kit put together that they can grab as necessary. More than 70% are able to hear weather updates in their safe place and or have access to a severe weather app on their phone. We found that most students were relatively knowledgeable about tornado safety and preparedness in general. The large majority of students knew what to do if they are in a car and when to use a tornado shelter/safe room. Over 70% knew that the most common injury during a tornado is caused from being hit by flying debris. However, only about 55% knew that the most common injury which occurs after a tornado is from stepping on nails. More than 90% of respondents knew that they needed canned food, flashlights and blankets in a tornado shelter. In comparison about 75% knew that boots, sturdy clothes and important documents would be needed after a tornado. Unfortunately only about 50% recognized the importance of having an axe or sledgehammer in the shelter. These would be useful in the event that they are trapped and need something to help them get out of the shelter after the tornado has passed. Over 20% of the respondents told us that one of the reasons they don't have a shelter at home is because it costs too much money.
On the pre and post survey comparison we found an increase in knowledge on all questions. However the greatest change of about 20% was observed on the question that dealt with what to do when you are in a car and hear a tornado warning. On items that dealt with what you should have in your emergency kit knowledge over all was increased. The largest change was seen on including a sledgehammer and axe. There was was also an increase in knowledge about the need for sturdy boots, helmet and gloves. It should be noted that since baseline knowledge on most items was already fairly high it is not surprising that we did not see large changes in knowledge.

(12) Explain any sources of error and how these could have affected your results.

PHASE 1- DIY SHELTER:
We tested targets made of durable, cost effective, and easily accessible materials for the DIY shelter. There were some sources of error in procuring our results these include that our tests were not to scale. Our target size was not the size of a standard wall, but only a 2 foot by 4 foot section. We also did not use actual debris such as the standard 2x4 fired from an air cannon which would have simulated a tornado better. Other sources of error in assessing our results are that we did not factor in the impact of wind on our missiles during the drop test. Human judgement was used to estimate the damage the targets had sustained which could also lead to a small margin of error.

PHASE II-SURVEY AND EDUCATIONAL INTERVENTION
Sources of error in this phase may include the following.
We were unable to get all pre-survey participants to complete the post-survey due to state testing and scheduling conflicts. Hence our pre post comparisons are only based on the 6th grade participants. which is a smaller sample size than we would have liked to have.
By the time student reach middle school in Oklahoma they appear to have been well educated on on tornado safety and preparedness. However we were not able to survey adults in the community to assess for their level of knowledge. Given that most safety planning is done by adults this would be an important population to reach.
We also do not know how students would act upon their change in knowledge.

Drawing Conclusions

(13) Interpret and evaluate your results and write a conclusion statement that includes the following: Describe what you would do if you wanted to retest or further test your hypothesis. Evaluate the usefulness of the data your team collected. What changes would you make to your hypothesis and/or experimental design in the future, if any?

PHASE I DIY SHELTER
Overall our test results showed that adding the layers used in the targets increased the safety over that of standard drywall. The multiple layers of Target 5 were particularly protective with the protective properties decreasing as we took away layers from the target. If we were to re-test this hypothesis we would like to conduct further testing to include sharp projectiles as well as using an air cannon to launch the projectile which would better simulate how projectiles are propelled during an actual tornado. We would also like to test how well chicken wire would do in containing missiles that were launched at it. Since our test showed that adding the cheapest layer of foam was very effective in preventing perforation we would like to see further testing where we use different types of foam as a protective layering agent. This study showed how layering different materials can have the same effect as a single heavier duty layer such as the steel that is recommended in the FEMA guidelines. This data is relevant in many ways including showing that it is possible to redesign tornado shelters to be more cost effective.
The data collected with these tests is useful in that it shows that there are other more cost effective options for installing a tornado shelter. With this data lower income families can add these layers to an interior closet and have a better chance of surviving in the event of a tornado. The materials when added together cost $484.62 for three walls that are 6.4ft by 4ft. Though the additions do not put a room up to FEMA standard the do make a safer less expensive option than simple drywall walls.
PHASE II

Uploaded Files:

- [**View** **Attachment- B BIBLIOGRAPHY** (By: rktwister, 03/04/2014, .docx)]

Bibliography of tornado safety and preparedness websites.

- [**View** **Attachment- C TEST PROTOCOL DIY SHELTER** (By: rktwister, 03/04/2014, .docx)

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Phase 1 testing protocol.

- [View] **Attachment- D COMPUTATION OF VELOCITY AND MOMENTUM** (By: rktwister, 03/04/2014, .docx)

The calculation of velocity and momentum for drop test

- [View] **Attachment E1 - PRE SURVEY TORNADO SAFETY** (By: rktwister, 03/04/2014, .pdf)

Pre-Survey administered through Survey Monkey

- [View] **Attachment- E2 POST SURVEY** (By: rktwister, 03/04/2014, .pdf)

Post survey for tornado safety awarness

- [View] **Attachment- F POWERPOINT** (By: rktwister, 03/04/2014, .pptx)

Tornado safety powerpoint for the educational intervention

- [View] **Attachment- G DIY SHELTER TEST RESULTS** (By: rktwister, 03/04/2014, .docx)

Results for material testing

- [View] **Attachment- H1 TORNADO SAFETY DEMOGRAPHICS** (By: rktwister, 03/04/2014, .docx)

Pre-survey

- [View] **Attachment- H2 SAFETY KNOWLEDGE ITEMS** (By: rktwister, 03/04/2014, .docx)

Pre- Survey

- [View] **Attachment- H3 TORNADO SAFETY ITEMS** (By: rktwister, 03/04/2014, .docx)

Pre- survey

- [View] **Attachment- H4 TORNADO SAFETY ITEMS** (By: rktwister, 03/04/2014, .docx)

Pre- survey

- [View] **Attachment- H5 SHELTER DURING A TORNADO** (By: rktwister, 03/04/2014, .docx)

Pre and Post comparison

- [View] **Attachment- H6 SAFETY DURING A TORNADO** (By: rktwister, 03/04/2014, .docx)

Pre and Post survey

- [View] **Attachment- J1 DROP TEST PICTURES** (By: lhilst, 03/04/2014, .JPG)

Photograph of drop test targets

- [View] **Attachment- J2 DROP TEST PICTURES** (By: lhilst, 03/04/2014, .JPG)

Photograph of drop test targets

- [View] **Attachment- J3 DROP TEST PICTURES** (By: lhilst, 03/04/2014, .JPG)

Photograph of drop test targets

- [View] **Attachment- J4 DROP TEST PICTURES** (By: lhilst, 03/04/2014, .JPG)

Photograph of drop test targets

- [View] **Attachment- J5 DROP TEST PICTURES** (By: lhilst, 03/04/2014, .JPG)

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Photograph of drop test targets

- [View **Attachment- J6 DROP TEST PICTURES** (By: lhilst, 03/04/2014, .JPG)]

Photograph of drop test targets

- [View **Attachment- J7 DROP TEST PICTURES** (By: lhilst, 03/04/2014, .JPG)]

Photograph of drop test targets

- [View **Attachment- J8 DROP TEST PICTURES** (By: lhilst, 03/04/2014, .JPG)]

Photograph of drop test targets

- [View **Attachment- J9 DROP TEST PICTURES** (By: lhilst, 03/04/2014, .JPG)]

Photograph of drop test targets

- [View **Attachment- J10 DROP TEST PICTURES** (By: lhilst, 03/04/2014, .JPG)]

Photograph of drop test targets

Community Benefit

(1) How could your experiments and data help solve your problem and benefit your community? Describe next steps for further research/experimentation and how you have or how you could implement your solution in the future.

Our experiment suggests that applying a layering of five specific materials to the existing dry wall and studs in an existing interior room would provide additional safety. This would be an easy cost effective option for those who can not afford a FEMA standard tornado shelter. While this may not meet FEMA standards it would certainly provide greater protection than a regular room.
The data we obtained on our surveys tells us that many people are aware of basic tornado safety, however surprisingly enough a large number do not have an emergency kit.
Steps for further research:
DIY SHELTER: We would want to test these materials further to better assess how well they would do under higher wind speeds and with different kinds of missiles which imitate flying debris. Since the foam held up well we would like to test different types of foam and insulation materials that might be more shock absorbent and still affordable. We will be forwarding this information to the Wind Science and Engineering Research Center at Texas Tech University so that they can test layered materials.
EDUCATIONAL INTERVENTION: We would have liked to put our survey and educational interventions on Facebook or any other social media site to get greater participation and be able to educate more people about tornado preparedness. We have found no one central source for tornado safety education and information. We had to search many different sites to get educational information. We think that creating one centralised Tornaod Safety and Preparedness web page would be useful. It could have useful videos, powerpoints, safety planning games for kids. Important tips on how to make an emergency planning kit would be very beneficial. Schools and classrooms could access this information to educate their students. Adults could also access this for tips and for complete family safety planning. This web page could provide links for "geotagging" of shelters people already have. This would allow for tornado shelters to be located easily following a tornado. It could also be the advocate for community shelters and the implementation of monolithic domes in our communities around us. This is a problem that is particularly close to our hearts in Oklahoma. Every person who is better prepared for a tornado is potentially a life saved in case of such a natural disaster.

ATTACHMENT A

TIME LINE – TORNADO SAFETY & PREPAREDNESS PROJECT

Sept 2013 – *Explored several different topics and decided Tornado safety and preparedness would be the project we would work on.*

October 2013 – *Researched Tornado Alley, Tornado Safety, Tornado shelters, Alternative Materials for Tornado Shelter. Viewed Myth Buster Videos*
Oct 7,2013 – *Meeting with Rama Challa, Structural Engineer, Director of Engineering; Environmental and Chemical Plants at Mitsubishi Heavy Industries America*

Nov 5th 2013 – *Meeting with Ed Calianese, Warning Coordination Meteorologist National Weather Service Tulsa OK*
Nov 18th 2013 – *Called Mr. Babcock at Boeing discussed materials in airplanes that withstand tremendous air pressure and possible materials to explore further.*
Conference call with Mr. Tanner,Research Associate and Instructor. Texas tech University.
Nov 19th 2013 – *Conference call with Dr. Kiesling, Research Professor and Executive Director, National Storm Shelter Association (NSSA). Texas Tech University*
Nov 29, 2013 – *Met with Mr. Babcock to establish test protocol options*

Dec 2013 – *Survey preparation, Educational Intervention planning, Selection of Materials to be used for testing.*

Jan 2014 – *Assembling Materials for Targets and it's frame*
Jan 14th, 2014 – *Met with Heather Duncan the Director of Donor Relations in Community Action Project Tulsa. Discussed how to reach out to others in the community. Possibility of designing a Facebook page.*
Jan 31st 2014- *Meeting with Mr. Andrew Connors to assess for possibility of Air Cannon test with SCFM- Air Compression Systems.*

Feb 12th, 2014 – *Pitching Machine Test Jenks Indoor Baseball training area.*
Feb 14th and Feb 17th – *Pre- Survey 7th and 8th grade*
Feb 20th 2014 – *Pre-survey 6th grade*
Feb 24th 2014 – *Post survey 6th Grade*
Feb 25th 2014 – *Drop Test Belger*
Feb – March 3rd - *Complete write up Data analysis and submit mission folder.*

ATTACHMENT B
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ACKNOWLEDGEMENTS:

1. Belger Cartage Services - Crane services and Turnkey solutions.– Use of their crane for the drop test.
2. Jenks Athletic Department- For use of their Pitching Machine, indoor baseball facilities and radar gun.
3. Jenks Middle School and Jenks East Intermediate- for allowing student participation in Pre and Post Survey accompanied by educational interventions.
4. LINE-X TULSA Truck Accessories & Van Upfitter - for donation of LineX coating on Plywood for testing.
5. Sutherlands Store – Donations of some materials for assembling Targets.

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6.

TABLE I – PHASE I - TEST PROTOCOL FOR DIY TORNADO SHELTER

Target **Test and Missile type**	**Target 1** Drywall	**Target 2** Drywall Plywood	**Target 3** Drywall Chicken wire Plywood	**Target 4** Drywall Chicken wire Line-X Plywood	**Target 5** Drywall Foam Chicken wire Line-X Plywood
Pitching Test Baseball 100 mph					
Drop Test 1 20lb weight Final Velocity Momentum					
Drop test 2 30lb weight Final Velocity Momentum					

MAGNITUDE OF DAMAGE SCORING KEY

SEVERE: Perforation, where the missile passed through the target and could be seen from the non-impact side.

MODERATE: Penetration, where the missile leaves an indentation and almost perforates the target.

MILD: Dented, only slight damage to the front of the target material but the non-impact side is not affected.

NONE: Repercussed, where the missile is repelled and creates minimal damage to the target.

TABLE 2- PHASE 1- TEST RESULTS OF PITCHING TEST

Target **Test and Missile type**	**Target 1** Drywall	**Target 2** Drywall Plywood	**Target 3** Drywall Chicken wire Plywood	**Target 4** Drywall Chicken wire Line-X Plywood	**Target 5** Drywall Foam Chicken wire Line-X Plywood
Pitching Test Baseball	Severe Drywall perforated	Moderate Drywall perforated Plywood dented	Moderate Drywall perforated Chicken Wire slightly dented Plywood slightly dented	Mild Drywall perforated Chicken wire slightly dented Line-X slightly dented Plywood repercussed	None Drywall perforated Foam dented Chicken wire slightly dented Line-X repercussed Plywood repercussed

TABLE 3-PHASE 1- TEST RESULTS OF DROP TEST

Target **Test and Missile type**	**Target 1** Drywall	**Target 2** Drywall Plywood	**Target 3** Drywall Chicken wire Plywood	**Target 4** Drywall Chicken wire Foam Plywood	**Target 5** Drywall Foam Chicken wire Line-X Plywood
Drop Test 1 20lb weight	Severe Drywall perforated	Severe Drywall perforated Plywood severely dented	Severe Drywall perforated Chicken wire perforated Plywood perforated	Moderate Drywall perforated Foam perforated Foam dented Plywood dented	Mild Drywall perforated Foam severely dented Chicken wire repercussed Line-X repercussed Plywood repercussed
Drop test 2 30lb weight	Not tested	Not tested	Severe Drywall perforated Chicken wire perforated Plywood perforated	Severe Drywall perforated Chicken wire perforated Foam perforated Plywood perforated	Mild Drywall perforated Foam severely dented Chicken wire repercussed Line-X repercussed Plywood repercussed

ATTACHMENT D

COMPUTATION OF VELOCITY & MOMENTUM FOR DROP TEST

$V^2 - U^2 = 2as$

Where

V is the Final Velocity

U is the starting velocity which in a drop test is Zero

a is the acceleration which due to gravity in the drop test is 32.2 ft/sec²

s is the height from which the drop will occur. In this case 50 ft.

V^2 =sq rt of 2x32.2x50 = 3220

Sq rt of 3220 = 56.75 ft/sec

To convert this to mph

56.75 x 3660 (no. of secs. in an hour)

This is then divided by 5280 which is the number of feet per mile

This is a fudge factor or a conversion factor of .68

So 56.75 x .68= 38.58 mph

We believe that the velocity achieved at 50 ft drop test was 38.58 mph

MOMENTUM:

Since we were unable to get the height we wanted in the drop test we chose to use a weight that was heavier and double the weight of a 15lb 2x4

Based on Mass that was dropped we then computed Momentum.

Momentum p= m.v

m is mass

v is velocity

The 30 lb missile would have a momentum that is double that of the 15 lb. We believe that this would have the same impact as a 15lb weight being propelled at twice the speed at about 77.16 mph.

Tornado Safety Awareness Survey 1-5

Survey

1. Do you have a FEMA certified tornado shelter at home?

- Yes
- No

2. Does your family have a tornado safety plan?

- Yes
- No

3. Do you have an emergency kit for tornados?

- Yes
- No

4. Do you have access to a severe weather app on your phone?

- Yes
- No

5. Can you hear weather updates in your safe place at home?

- Yes
- No

6. When should you go into your tornado shelter or safe room?

- When a tornado watch is issued
- When a tornado warning is issued
- When the tornado enters your state
- When you see the tornado

7. If you are in your car and you hear a tornado warning you should...

- try to out run it
- stay in the car
- get out of the car and go into a ditch on the side of the road

Tornado Safety Awareness Survey 1-5

8. What is the most common injury that occurs *during* a tornado?

- Stepping on nails
- Getting hit by flying debris
- Being crushed by falling buildings
- Being blown away

9. What is the most common injury that occurs *after* a tornado?

- Stepping on nails
- Getting hit by flying debris
- Being crushed by falling buildings
- Being blown away

10. Should the following items be included in your tornado safety kit?

	Yes	No
Canned food, can opener and water		
Boots, helmet and work gloves		
Pen, paper and duct tape		
Mirror, lipstick and lotion		
Blankets		
Flashlight, batteries, radio and phone		
Copies of important documents and medications		
Sledgehammer and axe		

11. Which best describes why you don't have a FEMA certified tornado shelter at home?

- Because it is too expensive
- Because they are hard to install
- Because one would take up too much space
- Other (please specify)

Tornado Safety Awareness Survey 2-6

1. Based on the tornado safety information you have received, how likely are you to discuss the following with your family?

	Very Likely	Somewhat Likely	Not Very Likely	Not Likely	N/A I already have one
Getting an in home shelter					
Developing a tornado safety plan					
Preparing a tornado emergency kit					
Downloading a severe weather app					
Setting up a weather update system in your safe place					

2. When should you go into your tornado shelter or safe room?

- When a tornado watch is issued
- When a warning is issued
- When the tornado enters your state
- When you see the tornado

3. If you are in your car and you hear a tornado warning you should...

- Try to out run it
- Stay in the car
- Get out of the car and go into a ditch on the side of the road

4. What is the most common injury that occurs *during* a tornado?

- Stepping on nails
- Getting hit by flying debris
- Being crushed by falling buildings
- Being blown away

5. What is the most common injury that occurs *after* a tornado?

- Stepping on nails
- Getting hit by flying debris
- Being crushed by falling buildings
- Being blown away

Tornado Safety Awareness Survey 2-6

6. Should the following items be included in your tornado safety kit?

	Yes	No
Canned food, can opener and water		
Boots, helmet and work gloves		
Pen, paper and duct tape		
Mirror, lipstick and lotion		
Blankets		
Flashlight, batteries, radio and phone		
Copies of important documents and medications		
Sledgehammer and axe		

Tornado Safety and Preparedness

By: The Knightettes of the Twisters

Living in the Tornado Alley

- Do you have a Tornado Plan?
- Are you prepared?
- Do you have an emergency kit?

Know the Difference

- ***Tornado Watch-*** Tornadoes are possible in the area. Be prepared to go to a shelter.

  BE ALERT!!!

- ***Tornado Warning-*** A tornado has been sighted. Go to a safe room or tornado shelter.

  TAKE ACTION NOW!!!

Do you have a plan?

- If you have a shelter, go there.
- A basement or underground cellar are good options.
- If you do not have a shelter go to an interior room that does not have windows and is located on the lowest floor of your house.
- Practice tornado drills so that you know exactly what to do if a tornado hits.
- Let neighbors and other family members know your safety plans.

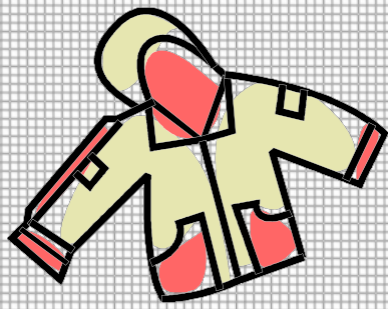
Mobile Home or Car

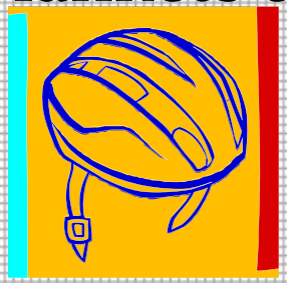
- If you are in a Mobile Home, leave as soon as possible and find a sturdy building or shelter.
- If you are in a car and there is a ditch nearby, lay low in the ditch and cover yourself.
- If there is no ditch close by, keep yourself belted and cover yourself with either your hands, a blanket or both.

What to Wear

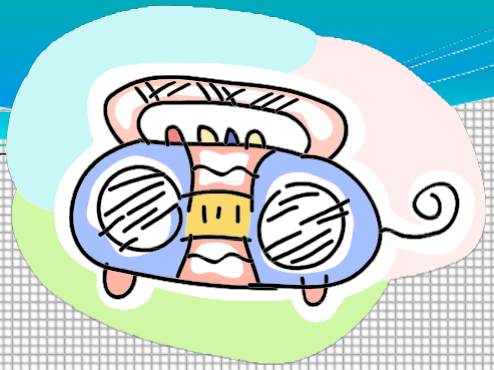
Because you never know how much debris will be created from a tornado:

- Wear sturdy shoes
- Wear a long-sleeved shirt and long pants
- Use a helmet
- Bring a jacket and gloves
- Have extra clothes and blankets on hand





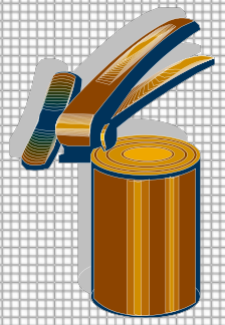
Electronics



- Make sure to have a radio because you need to know what is happening with the tornado or if it is heading your way.
- Stay tuned to the NOAA (National Oceanic Atmospheric Administration) or other local weather stations for news on the tornado.
- Bring a phone(try to keep as charged as possible).
- Bring a flashlight with extra batteries in case of a black out.

Food and Water

- You will need easy access to food and water.
- Bring packaged non-perishable foods that are easy to consume such as cheese crackers and peanut butter.
- If you take canned goods make sure to have a can opener or that they have flip tops.



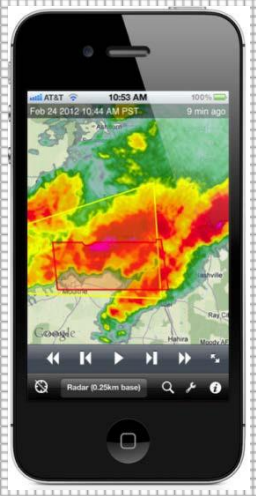
Extras For Your Tornado Safety Kit

- Important documents or copies of them.
- Extra money
- Any medications that you or a family member will need.
- A sledge hammer if debris traps you in the safe room.

Severe Weather Apps

To get severe weather alerts, download a weather app from:

- NOAA
- Red Cross
- Or your local T.V. stations.



Tornado Safety

- ***Be prepared!***
- ***Have a plan!***
- ***Have an emergency kit ready!***

TABLE 2- PHASE 1- TEST RESULTS OF PITCHING TEST

Target **Test and Missile type**	**Target 1** Drywall	**Target 2** Drywall Plywood	**Target 3** Drywall Chicken wire Plywood	**Target 4** Drywall Chicken wire Line-X Plywood	**Target 5** Drywall Foam Chicken wire Line-X Plywood
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TABLE 3-PHASE 1- TEST RESULTS OF DROP TEST

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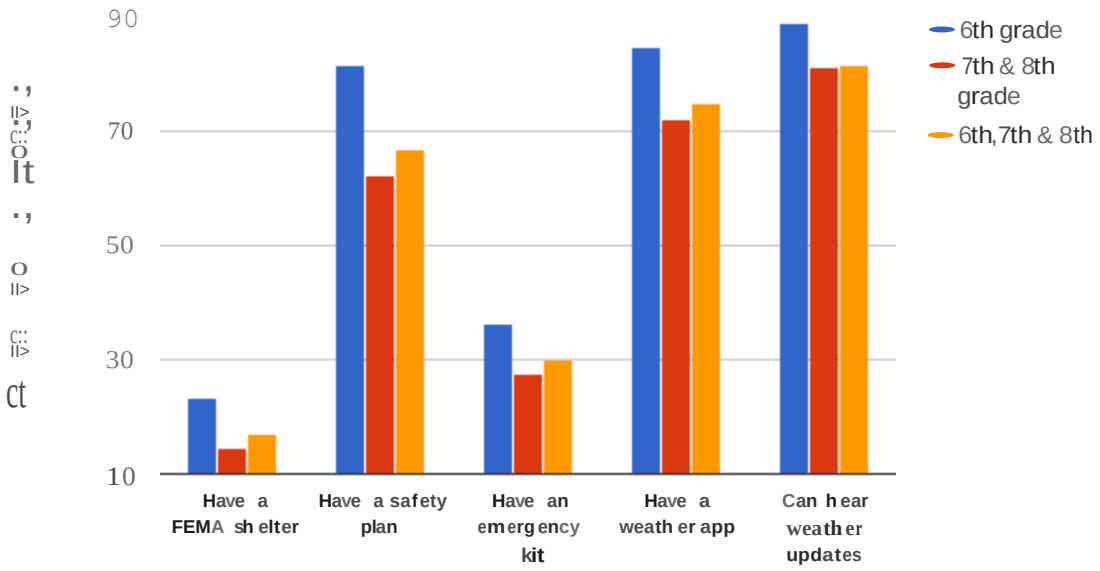
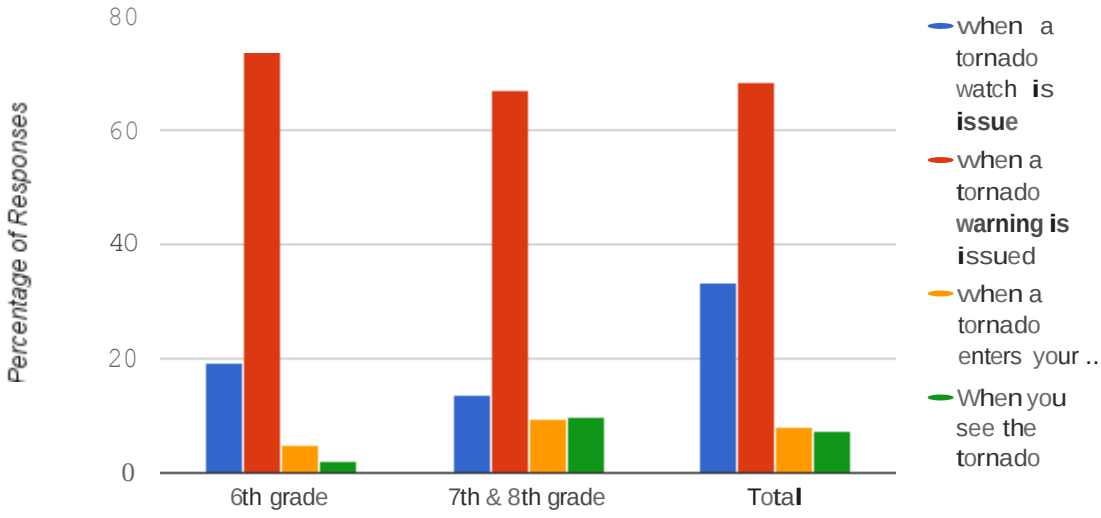
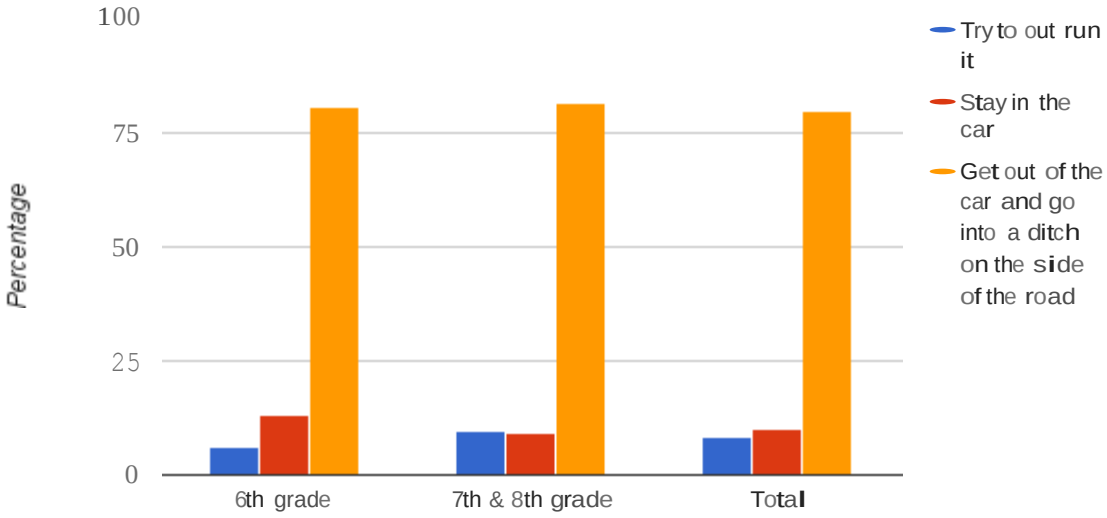
Phase II Chart 1: Pre-Survey Tornado Safety Demographics



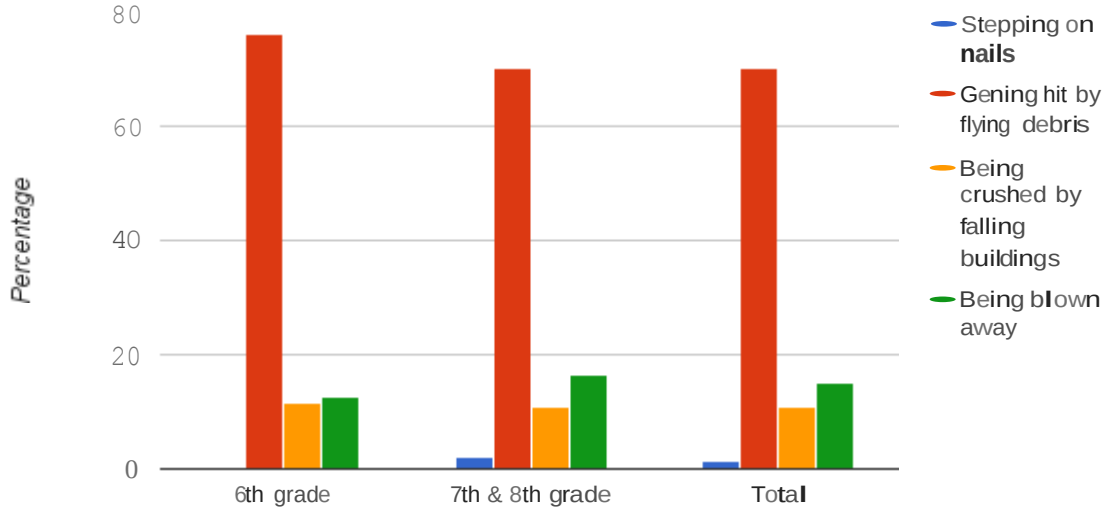
Phase II Chart 2 Pre-Survey: When should you go into your tornado shelter?



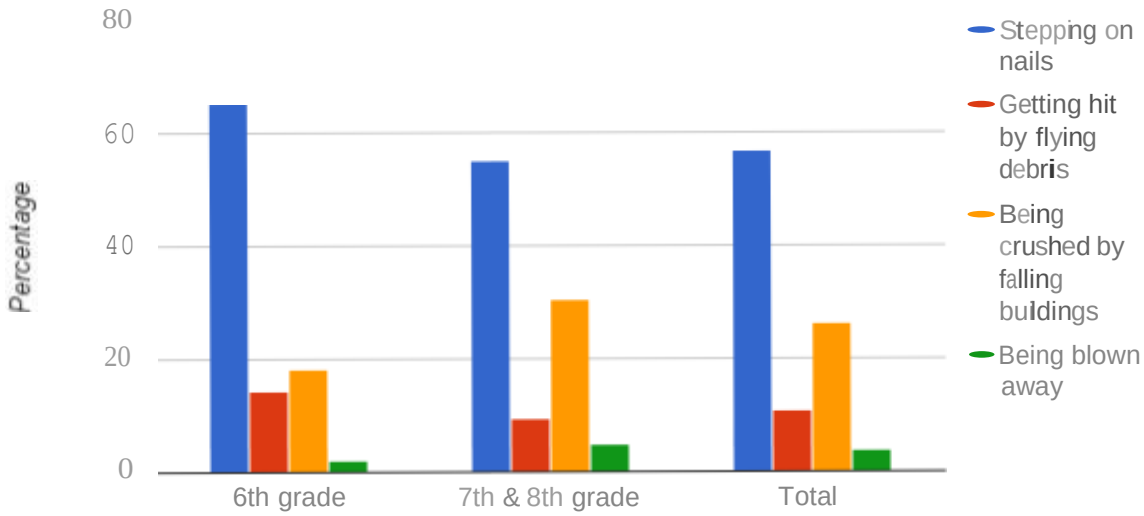
Phase II Chart 3 Pre-Survey: If you are in a car and you hear a tornado warning you should...



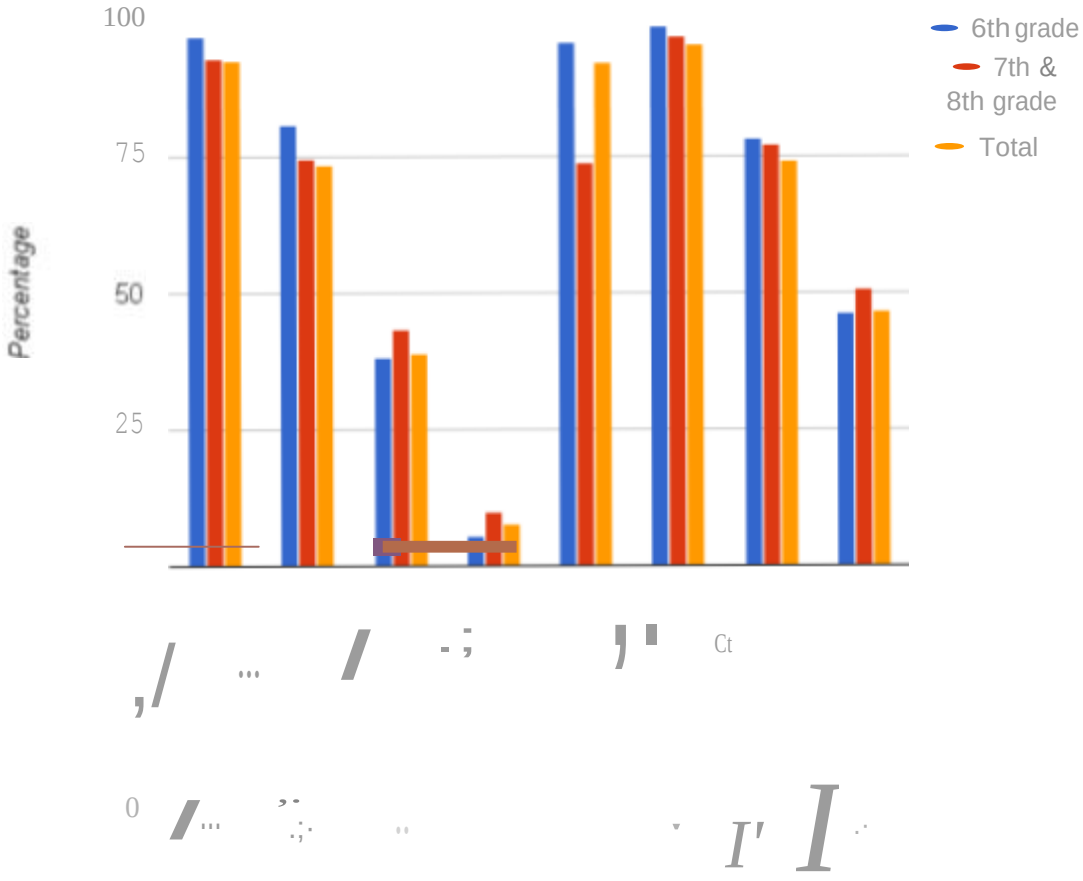
Phase II Chart 4 Pre-Survey: What is the most common injury that occurs during a tornado?



Phase II Chart 5 Pre-Survey: What is the most common injury that occurs after a tornado?



Phase II Chart 6 Pre-Survey: Should the following items be Included in your emergency kit?



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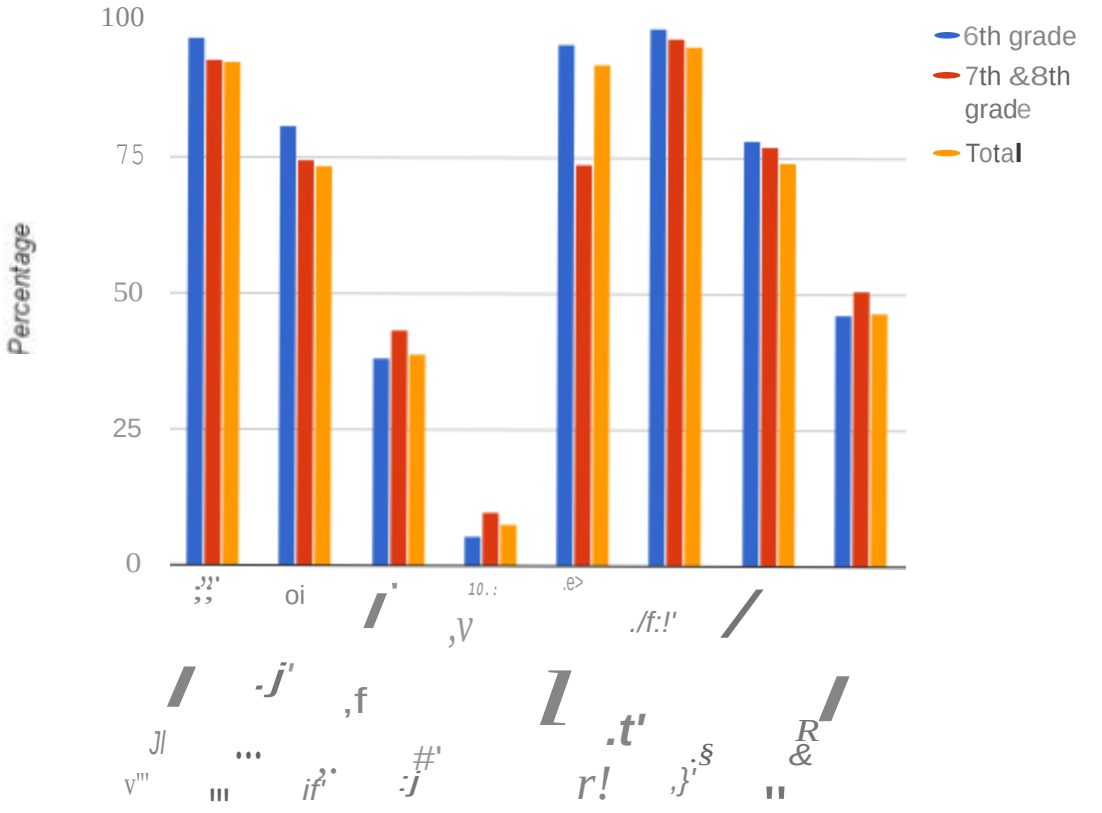
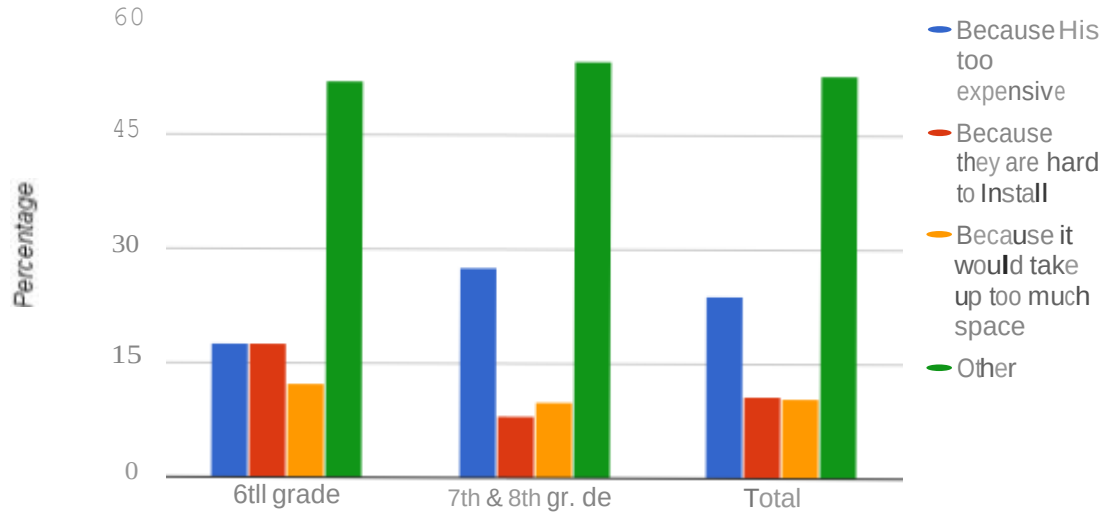
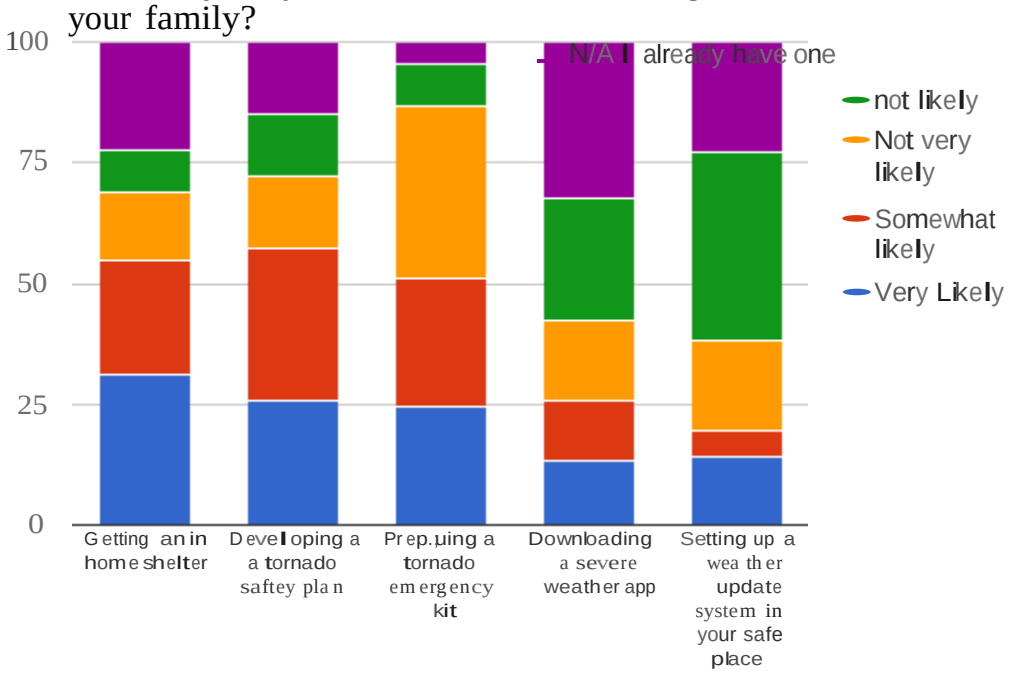
Phase II Chart 6 Pre-Survey: Should the following items be included in your emergency kit?



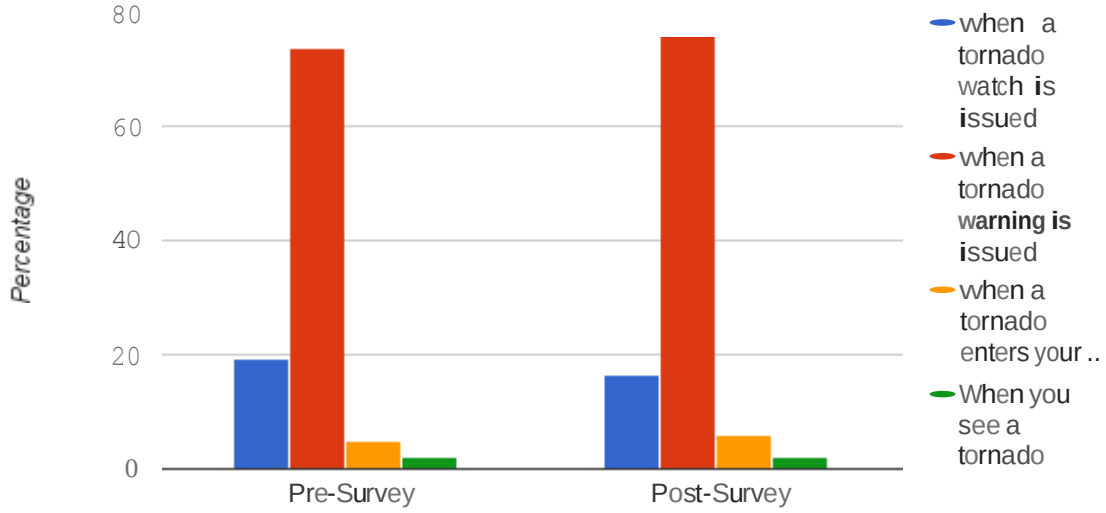
Phase II Chart 7 Pre-Survey: Which best describes why you don't have a FEMA certified tornado shelter at home?



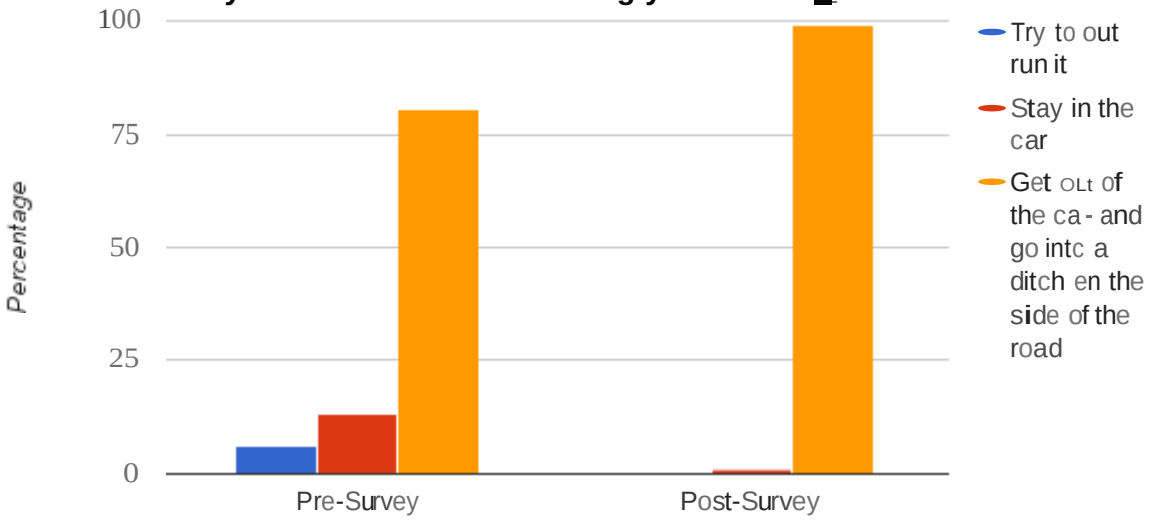
Phase II Chart 8 Post-Survey: Based on the tornado safety information you have received, how likely are you to discuss the following with your family?



Phase II Chart 9 Comparison of Pre and Post-Surveys for 6th Grade: When should you go into you tornado shelter?



Phase II Chart 10 Comparison of Pre and Post-Surveys for 6th Grade: If you are in your car and you hear a tornado warning you should_



LIGHTROC FOR [illegible]GS AND [illegible]LS

Severe

20 Lbs

Test 2

HD WALLS

Severe

30 lbs

20 lbs

Test2

Severe

BACK OF TARGET

Test 3

Severe

20 lbs

zoL!li

30 lbs

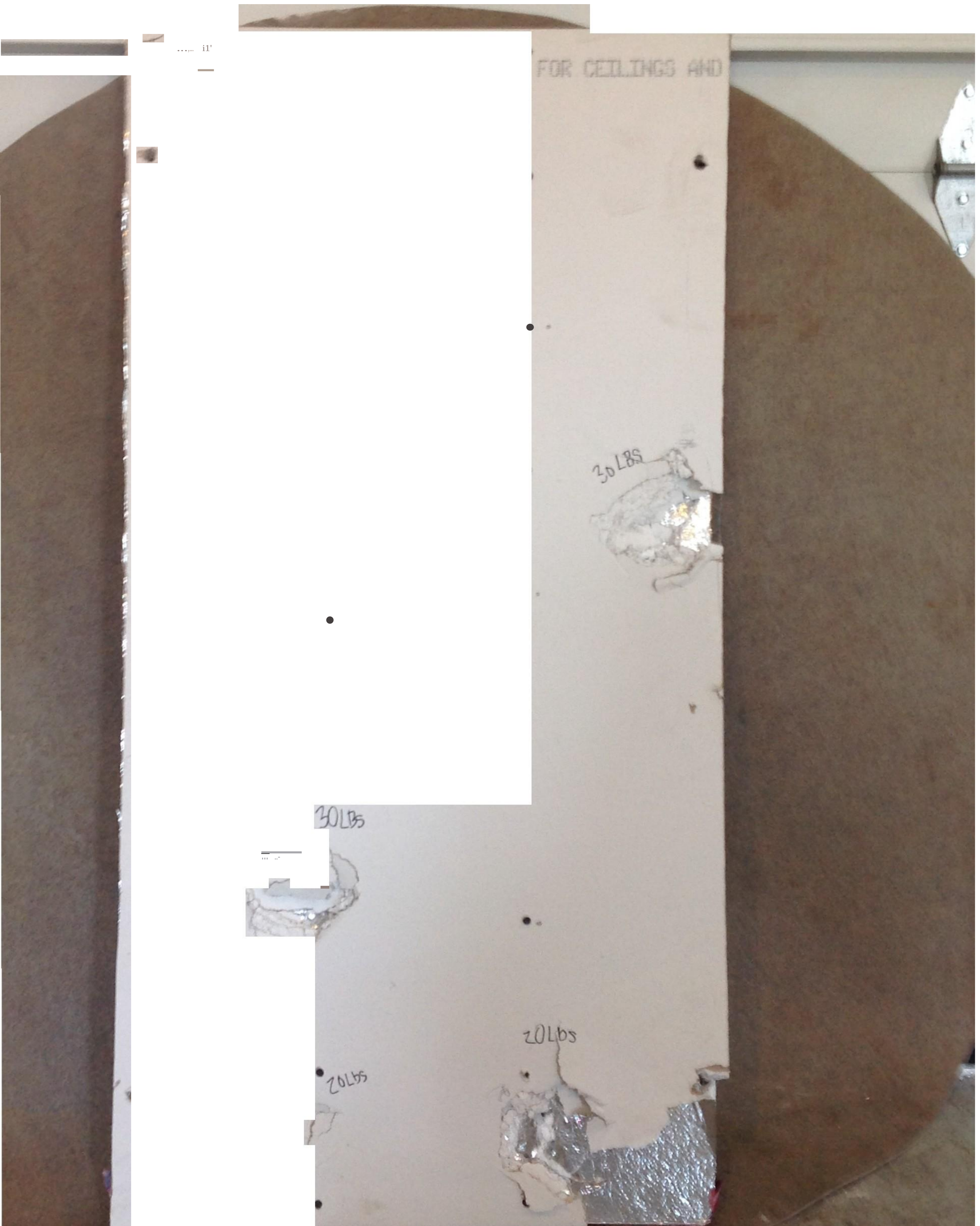
Back of Target

20 Lbs

30 Lbs

Moderate

Back of Target


FOR CEILINGS AND
30 LBS
30LBS
20LBS
20LBS

Test 5

Back of Target

Mild