

# Field Testing and Standard Evaluation of Wheel Chocks Manufactured From Recycled High-Density Polyethylene



# Field Testing and Testing Standards Evaluation of Wheel Chocks Manufactured From Recycled, High-Density Polyethylene

Final

*Prepared for:*

CWC

A division of the Pacific NorthWest Economic Region (PNWER)  
2200 Alaskan Way, Suite 460  
Seattle, WA 98121

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*Prepared by:*

**Turtle Plastics**

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## 1.0 INTRODUCTION

Approximately 30 billion pounds of plastic is landfilled annually and most of it could be manufactured into usable products. Of this, approximately two million pounds of automobile trim is discarded in landfills. Cleveland Reclaim Industries, Inc., aka Turtle Plastics of Lorain, Ohio, has developed processes and products to manufacture a number of different products from recovered plastic; Turtle Plastics was founded over 15 years ago. Its corporate mission statement is to manufacture and market useful products from materials that would otherwise end up in the waste stream.

Turtle Plastics processes 200,000 pounds a month of auto trim, in addition to varying volumes of intravenous bags, rafts and pool liners, and post-consumer containers. Through their research and production trials, Turtle Plastics has modified their processes to remove or accommodate recycled plastics with some level of contamination.

Turtle's main product line includes modular flooring products manufactured from recycled PVC, such as post consumer swimming pool liners and automobile body side molding. They also manufacture a complete line of fire and rescue "cribbing" manufactured from recycled, high-density polyethylene (HDPE)<sup>1</sup>, and a carpet tile for commercial and hospitality banks, restaurants, hotels and other commercial or private buildings.

One of the newer product lines for Turtle Plastics is a wheel chock manufactured from 100% recycled HDPE, for large vehicles used in the fire and rescue industry. The chock is designed specifically for 44.5-inch diameter wheels, typical of large fire trucks.

Currently, many of the wheel chock products in this market are manufactured of aluminum. The styles of aluminum chocks include an aluminum triangular block and a fold-up chock. Other companies also manufacture chocks made from steel, wood, and virgin or recycled plastic.

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<sup>1</sup> Cribbing is a material used to shore up vehicles to allow rescue personnel to extricate the injured.

The CWC worked with Turtle Plastics and two consultants to evaluate Turtle's current wheel chock designs to:

- ?? compare field performance of Turtle's wheel chock to two different aluminum wheel chock designs, with respect to preventing movement of fire trucks on two different surfaces; and
- ?? meet an industry standard for chock breakage, as published by the Society of Automotive Engineer's (SAE)<sup>2</sup>.

CWC retained the services of an independent consultant in testing of Packaging, Pallet, & Material Handling systems, who also does extensive testing for the Virginia Polytechnic Institute in Virginia. The consultant designed and conducted a field test to compare the performance of the Turtle Plastics wheel chock with two of the common existing aluminum chock designs, on asphalt surfaces using an actual fire truck.

CWC also retained the services of Kettering University (formerly General Motors Institute) to evaluate Turtle's recycled plastic chock product with respect to meeting the SAE J348 standard.

Test results were expected to aid in design enhancement, if necessary, for Turtle's chock products.

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<sup>2</sup> SAE Standard J348 JUN 90, "Wheel Chocks".

## **2.0 FIELD TESTING PROCEDURES AND RESULTS**

### **2.1 Introduction**

At the beginning of this project, the original functionality test intended to compare Turtle's recycled plastic chocks and two competing aluminum products in a laboratory simulation. The test was to simulate field performance of the chocks supporting the two 44.5 inch front tires of a standard fire truck, with the following variables: three temperatures; three simulated road surfaces; and two slopes. After some experimental design and discussion, the test plan was changed to an actual field test using a Pierce Lance 2000 Ladder/Platform fire truck with 44.5 inch wheel diameter on the front tires.

Sample plastic wheel chocks from Turtle and two different designs of competing aluminum chocks were tested in the state of Virginia on January 27, 2000. The fire truck and driver were provided by the Blacksburg, Virginia fire department. The field test was conducted on asphalt with the following variables:

- ?? two slopes; 3 degrees and 30 degrees from horizontal; and
- ?? two starting positions; a static position with the chock up against the wheel, and a rolling start.

Subsequent to this field test, Turtle designed and produced a smaller plastic chock since to fit better in existing truck compartments designed for carrying chocks. Their previous chock was too large to fit in the standard truck compartments.

Turtle conducted a similar field test on their larger and (newer) smaller chock, as well as the competing aluminum chocks. They conducted the test on a less extreme slope. The plastic chocks performed well in both the static and dynamic tests, but not as well as the aluminum chocks.

## 2.2 Materials

The wheel chocks tested are described in Table 1.

**Table 1 - Description of Wheel Chocks Tested**

| <b>Feature</b>  | <b>Plastic</b>  | <b>Aluminum<br/>(Non-Folding)</b>   | <b>Aluminum<br/>(Folding)</b>   |
|---|---|---|---|
| Material  | 100% Recycled HDPE  | Aluminum  | Aluminum  |
| Height (inches)   | 11.1  | 12.0  | 12.0  |
| Width (inches)  | 14.5  | 11.3  | 10.7  |
| Length (inches)   | 15.0  | 21.0  | 20.9  |
| Average Weight (pounds)   | 18.2  | 17.0  | 21.8  |
| Tooth configuration<br><i>(Note: “Front” surface refers to the bottom surface that fits furthest under the tire).</i> | Bottom surface has three rows, running the lengthwise direction, with 5 teeth per row; teeth are consistent in size | Teeth around entire bottom surface perimeter; 22 small teeth in front, two large teeth on sides, and five large teeth on back | Bottom surface is comprised of two separate aluminum pieces. Front surface has 34 small teeth and back surface has five large teeth                   |
| Other features  | Four “handolds” (holes) are molded into the curved surface that contacts the tire                                   | One handhold on the back surface or non-contact surface for the tire  | Collapse to 5.8-inches in height; width and length. Two handholds, one on the front curved surface that contacts the tire and one in the back surface |

The fire truck used for these tests was a Pierce Lance 2000 model, designated as “Ladder 2.” This particular truck was manufactured in July 1999. The gross vehicle weight was 75,500 pounds. The truck (and firefighters), were loaned from the City of Blacksburg, Virginia Fire Department.

Ladder trucks use outriggers to lift the truck rear axles (and wheels) when the ladder is extended. Therefore, the front tires were the tires to be chocked. The front tires on this truck were 44.5 inches in diameter, and were labeled as 425/65R 22.5 XYZ Michelin X.

The recommended tire pressure for these tires is 125 pounds per square inch (psi). The actual tire pressure was not measured.

### **2.3 Test Methods**

The field test was conducted in Blacksburg, Virginia. The ambient temperature was recorded as 35 degrees Fahrenheit. Performance was evaluated on two asphalt road surfaces of differing slopes.

The first series of tests took place in the Blacksburg Fire Department parking lot located at the Prices Fork Station, on an asphalt lot that was 3 degrees from horizontal. The second series of tests were conducted on an asphalt side road adjoining Prices Fork Road and U.S. 460 East. The slope of this road was approximately 30 degrees from the horizontal.

Both static and dynamic tests were conducted. For static tests, a single chock at a time was placed in front of and touching the truck tires, and the brake was released. Wheel and chock movement was observed. This was repeated several times with each different chock types.

For the dynamic tests, a single chock was placed a set number of inches in front of the truck tire, and then the brake was released. The truck rolled toward the chock before contacting the chock. The chock was set four inches in front of the tire on the 3 degree slope and two inches in front of the tire on the steeper slope. This was repeated several times with each different chock types.

The findings of interest for both static and dynamic tests were the ability to stop truck movement, and the amount of chock movement after release of the truck brake and contact with the front tires.

## 2.4 Observations and Test Results

The test fire truck was equipped with aluminum fold-up chocks similar to the type evaluated. It is desirable to store chocks close to the tires to increase the likelihood of use. These fold-up chocks were stored near the front tires, under the truck body as shown in Figure 1. Maintaining ground clearance is critical, and the fold-up design is preferred for this type ladder truck due to minimal ground clearance and a long wheelbase.

**Figure 1**



When trucks offer more ground clearance, the block style aluminum chock is often used with a slide in holder (see Figure 2). The block style chocks offer a base lip that allows them to hang in the slide in holder. The plastic chocks do not offer this type lip to hang in holders, and by design do not fold up for use in low profile chock holders.

**Figure 2**



Initial observation showed that the plastic chock curvature matched the curve of the 44.5-inch wheel better than either of the aluminum chocks (see Figure 3).

**Figure 3**



The test results are presented below.

*Surface 1 (3 degrees from horizontal); Static Test*

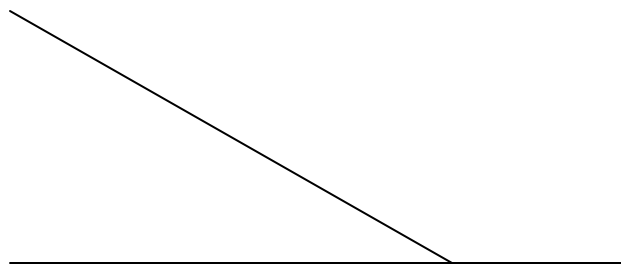
Several chocks of each of the three different styles were placed in front of and touching the truck tires. Upon release of the brake, no chock movement was observed in any of these cases. The truck did roll forward slightly on both of the aluminum chocks until full tire contact was made with the chock curvature.

*Surface 1 (3 degrees from horizontal); Dynamic Test*

Several chocks of each of the three different styles were placed four inches in front of the truck tires. Upon release of the brake, the truck rolled forward to meet the chock. No chock movement was observed in any of these cases.

*Surface 2 (30 degrees from horizontal); Static Test*

The approximate slope of test surface 2 is shown in Figure 4 below.



**Figure 4**

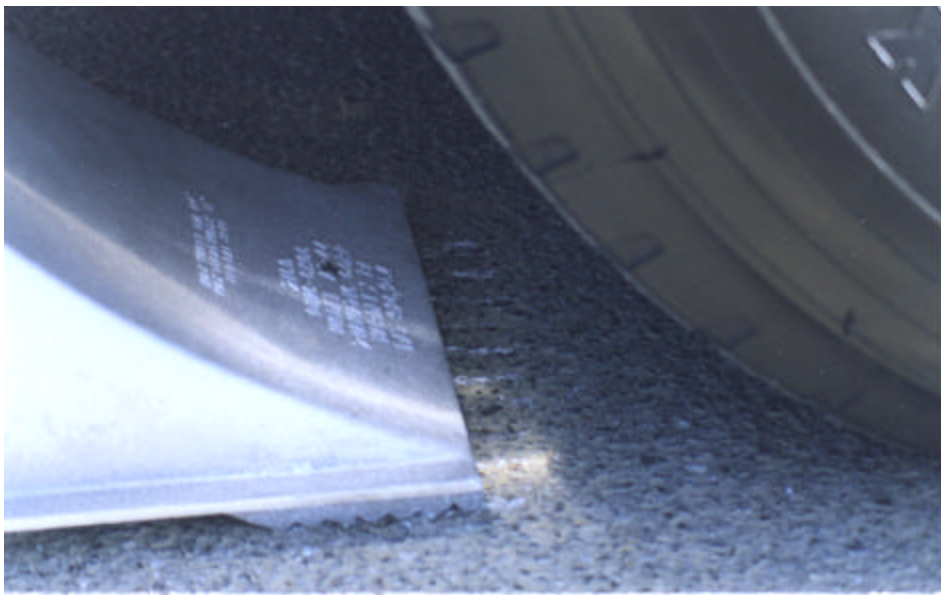
Again, chocks were placed in contact with the fire truck wheel and the truck brake was released. Both the aluminum block and aluminum fold-up chocks moved between one to three inches. It is likely that the movement was caused as the tire rolled forward to full contact with the chock curvature (see Figure 5). The aluminum chocks stopped the truck in these static tests when the bottom teeth dug into the asphalt surface and prevented

further chock movement. The indentations in the asphalt from the aluminum chocks is illustrated in Figure 6, a photo taken after the truck backed away from the chock.

**Figure 5**



**Figure 6**



The plastic chocks, when placed in contact with the front tires, were propelled from the tire as the brake was released and truck weight was applied to the chock. The plastic chock teeth had no apparent grip on the asphalt surface, and the driver was forced to apply brakes to stop truck movement in all static tests with the plastic chocks.

*Surface 2 (30 degrees from horizontal); Dynamic Test*

Due to the unsatisfactory results with the plastic chocks in the less extreme static tests, and to prevent the possibility of truck damage, plastic chocks were not tested for dynamic performance on this slope. For safety reasons, only a two-inch roll distance was used for dynamic testing on the aluminum chocks.

The aluminum chocks were placed two inches in front of the front tires. Aluminum chock movement was much more severe than on the 3 degree slope. The aluminum chocks slid between 10 and 15 inches before truck movement halted. In all tests, however, the truck was eventually stopped by the chock.

As in the testing on Surface 1, the aluminum chock teeth dug into the asphalt surface to stop truck movement. Table 2 summarizes the chock movement data.

**Table 2 – Chock Movement Measurements and Observations**

| Surface Slope<br>(Degrees from<br>Horizontal) | Dynamic<br>or Static | Chock Movement (Inches)                                     |                           |                       |
|---|----------------------|---|---------------------------|-----------------------|
|   |                      | Recycled Plastic<br>Chock                                   | Aluminum<br>(Non-Folding) | Aluminum<br>(Folding) |
| <i>3 degrees l</i>                            | Static               | 0   | 0                         | 0                     |
| <i>3 degrees l</i>                            | Dynamic              | 0   | 0                         | 0                     |
| <i>30 degrees</i>                             | Static               | Chocks ejected<br>away from tire<br>when brakes<br>released | 1 to 3 inches             | 1 to 3 inches         |
| <i>30 degrees</i>                             | Dynamic              | Not tested  | 10 to 15 inches           | 10 to 15 inches       |

## **2.5 Conclusions**

The performance of three wheel chock designs (aluminum block, aluminum fold-up, and plastic) supporting one front tire (44.5 inch diameter) of a fire truck was compared on asphalt surfaces. The plastic and both aluminum wheel chock designs prevented fire truck movement on a 3 degree slope asphalt surface during static and dynamic roll tests.

In the 30 degree slope test, both aluminum chock designs slid, but did stop, fire truck movement during static and dynamic tests. The plastic wheel chock did not stop truck movement during the static test on a 30 degree slope; therefore dynamic tests were not completed. The plastic teeth did not grip the asphalt surface as well as aluminum teeth.

In the current design of the plastic chock tested, the bottom plastic teeth did not offer adequate friction on asphalt at the steeper slope tested, and do not dig into the asphalt surface to prevent truck movement. Metal teeth may be one option to consider for future chock design.

As previously mentioned, the plastic chock curvature very closely matched the tire perimeter. It may be that the larger wheel contact curvature radius of the aluminum chocks is intentional, as it would force more of the truck weight onto the chock teeth and down into the pavement. A chock that “fits” the wheel curvature may have more horizontal force acting on the bottom surface, when more downward vertical force is needed to keep the chock stationary.

## **3.0 CHOCK BREAKAGE TESTING PER SAE STANDARD J348**

### **3.1 Introduction**

Turtle Plastics discovered a chock breakage standard, by the Society of Automotive Engineers (SAE), titled “SAE J348 Wheel Chocks”. This standard only tests for strength and breakage resistance, not for traction performance or other performance properties. Proving that Turtle’s chock product meets this requirement may enhance

the companies' product marketing development, so this test was added to the scope of work for the project.

It was difficult to locate a lab able to conduct this test. Competing chock manufacturers would not divulge who does this test for them, although their product is certified to the standard. The SAE was not aware of labs that conduct this test. Furthermore, the National Fire Protection Association, who refers to this standard in some of their codes, was unaware of any labs that conduct this standardized test. One competitor, Worden, on the east coast, is capable of conducting this test, but Turtle Plastics did not want to send their product to a competitor.

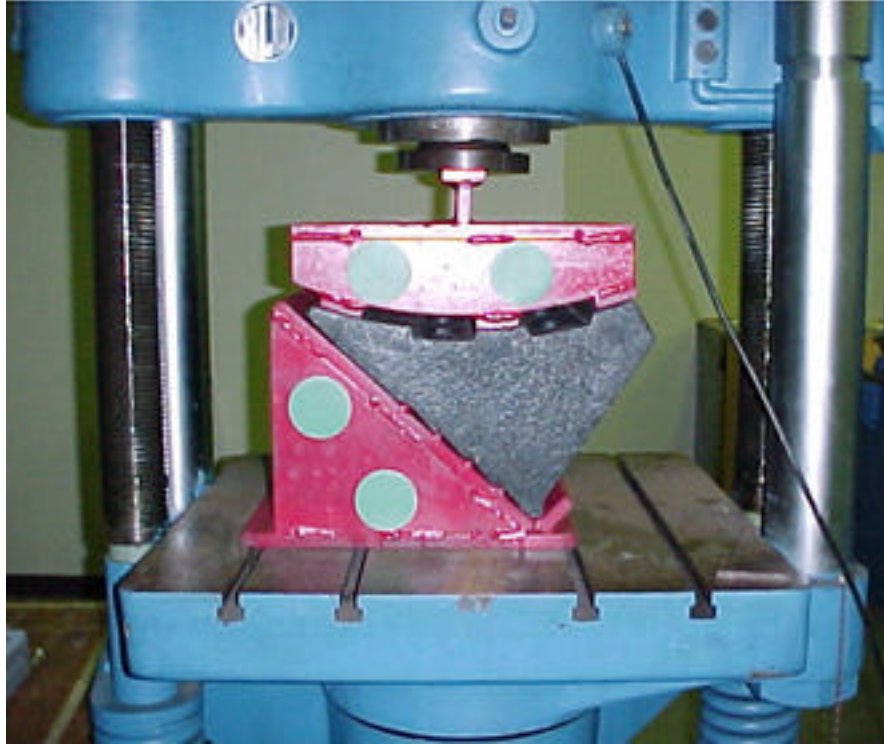
Finally, General Motors Institute at Kettering University agreed to conduct the test. They had not done this particular test before, and therefore had to manufacture test fixtures specifically for this test and for the specific chock design. They conducted testing to SAE J348 in June 1999, on Turtle's older and newer version of the chock.

### **3.2 Materials**

The sample chocks submitted for testing at Kettering University included one of the same design used in the Virginia field testing, and one sample of a more compact chock (but similar design). [The original chock design was too large to fit into the compartments built into standard fire trucks that are specifically designed to hold wheel chocks].

### **3.3 Methods**

Per the test standard, an ultimate test load of 35.5 tons was used on each of the two chocks, a 10% overload from the specified 32 tons as per SAE J348. Since the load indicator on the Baldwin is an analogue pressure sender operating on a pneumatic principle, as opposed to an electronic force transducer, a 10% error in indication of the load could be experienced. Consequently, by going to 35.5 tons, a load of at least 32 tons was assured. Figure 7 shows the chock in the test apparatus with no load on the chock.



**Figure 7: Front view (left side) of large chock in Baldwin load testing machine. Large circular targets identify the frontal view. No load on chocks in this position shown.**

### **3.4 Results**

Both chocks, large and small, withstood the applied load of 35.5 tons without any visual or permanent damage as prescribed in SAE Standard J348. The small chocks exhibited visual elastic deformation at the maximum load. At elevated temperatures and long time loading history, this elastic deformation could result in some permanent distortions since polymeric materials are prone to creep. Additional wall thickness in the small chock could alleviate this possibility.

The length to height ratio of both chocks is 1.50. SAE J348 suggests a ratio of 1.73. Based on the static load test results for the large and small chocks, this slight non-conformance does not appear to be a deterrent to the structural integrity of the chocks. Possible design alternatives were suggested to address the length to height ratio.