Engineering Standards and Product Liability

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Abstract

Engineering standards are developed and promulgated by various agencies and technical associations such as the American Society of Mechanical Engineers (ASME), the Society of Automotive Engineers (SAE), Southern Building Code Congress International (SBCCI), etc. In the legal environment published standards constitute the minimum requirements in performance criteria. Standards can even take the effect of law if they appear, for example, in building codes. Cities and municipalities in the south adopt the building codes developed and published by SBCCI almost universally.

Many engineering students receive the B. S. degree with little or no exposure to engineering standards. This deficiency can easily be corrected by introducing standards (or portions) during appropriate sections of conventional technical courses or laboratories. For example, the author has required laboratory students to perform portions of the performance tests for audible back up alarms used on some construction equipment (SAE standard). Note that OSHA requires these alarms on certain equipment. As a minimum, students should be made aware of the existence of standards and the importance they have in the workplace.

The purpose of this paper is to demonstrate the application of standards in the product liability arena. The example cited is for Industrial Rotary Mower and the associated blades. The standards for the mower and blades are SAE J232 Apr94 and ANSI/ASAE S483 Jul93.

Background

In 1998 Camilla Haynes was killed when a 13-pound blade (Fig. 1) broke loose from an industrial rotary mower and flew through the windshield (Fig. 2) hitting Haynes in the chin and throat area, crushing her jugular vein and spine. Driving along I-55 in Jackson, Mississippi, Mrs. Haynes, the driver of the vehicle, was traveling from her home in Arkansas with her children and mother to a family vacation in Florida when the accident occurred. Two years later a Mississippi jury, in federal court, returned the largest known damage award ($12 million) in the state's history to the Estate of Camilla Haynes. The defendants named in the lawsuit were the blade manufacturer, the manufacturer of the industrial mower, and the company that the Mississippi Department of Transportation had contracted to mow the grass. In the informal investigative phase of the matter, the expert witnesses determined that the blade and mower manufacturers had not complied with the appropriate published standards. Furthermore, the expert witnesses stated that the mower manufacturer had not followed sound engineering practices.

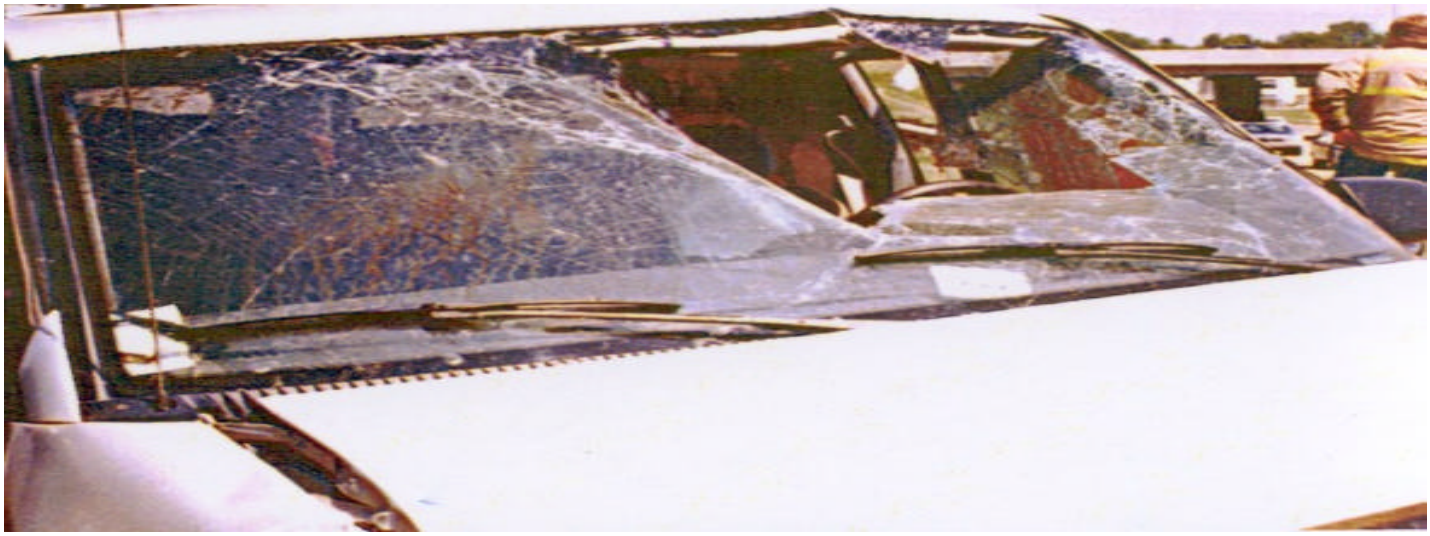
During formal depositions in the discovery phase of the suit, expert witnesses for both plaintiff and defendants testified that proper procedure, prescribed in the standards and in the

contract drawings, had not been followed by the blade manufacturer and the mowing machine manufacturer. Proper procedures were not utilized during manufacture, testing, and inspection of incoming blades.

In the federal lawsuit of the Estate of Camilla Haynes vs. the blade and mower manufacturers compliance with two standards, ANSI/ASAE S483 Jul93, Rotary Mower Blade Ductility Test and SAE J232 Apr94, Industrial Rotary Mowers, came under close scrutiny during the trial. The cited standard ANSI/ASAE S483 Jul 93,Rotary Mower Blade Ductility Test, is published jointly by the American National Standards Institute and the American Society of Agricultural Engineers, and the other cited standard SAE J232 Apr94, Industrial Rotary Mowers, is published by the Society of Automotive Engineers. While these two standards did not take the effect of law in this case, they did constitute the minimum requirements in the design/manufacturing processes that came into question for these two manufacturers. In the legal arena, any Standard utilized must obviously have a publication date preceding the manufacture of the equipment under examination. Due to the constraints limiting the length of the paper, the standards referenced in the paper are not included. Complete copies of the standards may be obtained from the appropriate Standards setting agency (ANSI, ASAE, or SAE) or from Global Engineering (www.global.ihs.com).

Figure 1. Example of Blade that Struck Mrs. Haynes

Figure 2. Front Windshield of Mrs. Haynes' Van



Engineering Standards

Standard ANSI/ASAE S483 Jul93, Rotary Mower Blade Ductility Test

The mower manufacturer references the standard, ANSI/ASAE S483 Jul93, Rotary Mower Blade Ductility Test (a destructive test), on the drawings. The blade manufacturer (through their contract with the mower manufacturer) must adhere to the requirements of the blade hardness and bend test specified for blades used on industrial and agricultural rotary mowers. In this case the standard does not take the effect of law but the blade manufacturer is bound to the standard in terms of its contract with the mower manufacturer. Furthermore, the cost of the blade to the mower manufacturer includes the cost to bend test blades based on the standard.

During the discovery phase of the trial, the expert witness found that the blade manufacturer was not manufacturing and testing blades in accordance with the Standard ANSI/ASAE S483 Jul93. The sampling procedure as defined in the Standard is to pull random samples from each lot at the minimum rate of one for each 200 blades, but not less than two blades from any lot. A change in mill heat run shall start a new lot. The samples are then to be bent on the blade bend test fixture to a permanent set angle (25 degrees for this blade). The test renders the tested blades unusable. If any blade from a lot breaks or incurs a crack visible to the naked eye before reaching the permanent set angle, then the entire lot shall be totally rejected and no blades from that lot may be used without corrective measures. The corrective measure procedure is to reheat treat the entire lot. The lot is then to be retested, but the sample size must be doubled. If all sample blades pass the retest, then the lot may be accepted and shipped to the customer. However, in initial testing of heat-treated samples, the blades were showing cracks to the visible eye after being bent. The blade manufacturer was aware that tested samples from lots were showing cracks. However, the lots were not reheat treated and retested using the increased sample size. Instead, the lots along with cracked samples were shipped to the mower manufacturer. The mower manufacturer received the lots along with cracked samples, and the lots of blades were installed in mowers. The expert witnesses cited in the written deposition that the mower manufacturer was aware that samples from lots they had received had visible cracks, but no corrective action was taken.

Furthermore, it was documented in discovery that the testing fixture to bend the samples to a permanent set angle was not built to conform to the Standard. The Standard (See Fig. 3) specifies that stops may be used on the ram that will stop against the roller areas of the bottom die, but they shall not make contact in the area of the bend in the blade. Note that the blade manufacturer placed a stop (steel rod stock) in the lower apex (19 mm radius area) of the bend test fixture as shown in Fig. 4. The stop assisted the machine operator in knowing where to terminate the bending of the blade. Any visible cracks that are produced in the blade during the bend test are most likely to be produced in the area where the lower surface of the blade contacts the prohibited stop; and for this reason the stop should not have been added to the test fixture. Blade contact with the stop would likely obscure any cracks produced during the test. ANSI/SAE considered this factor during the development of the standard although this is not explicitly mentioned in the standard.

Figure 3. (Fig.2 from ANSI/SAE S483 JUL93 Blade Bend Test Fixture)

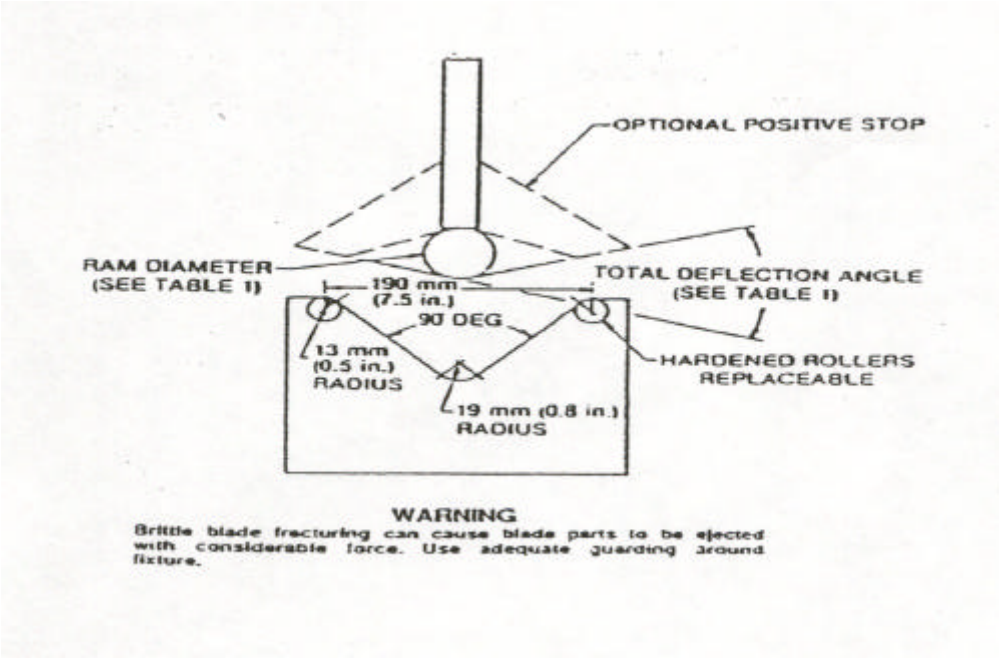
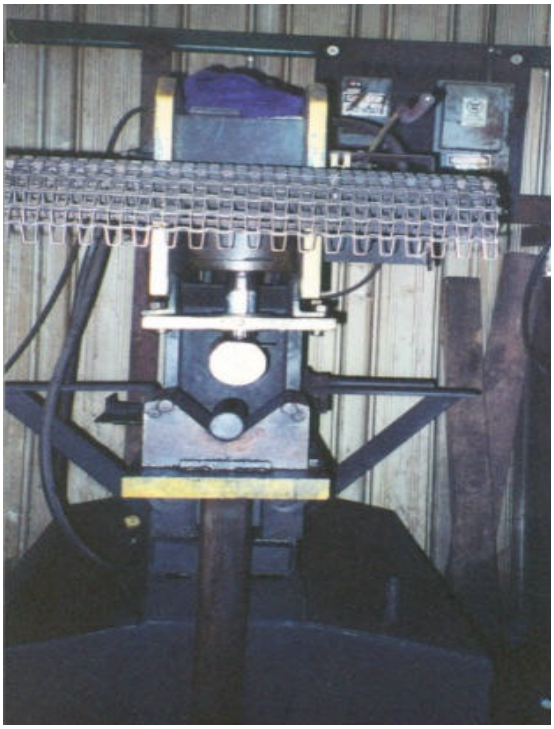


Figure 4. (Blade Bend Test Fixture of Blade Manufacturer)



Standard SAE J232 Apr94, Industrial Rotary Mowers

The mower manufacturer presented evidence that the mower was designed and manufactured to be in compliance with Standard SAE J232 Apr94. Two of the tests required by this Standard were critical to presentation of the plaintiff's case. The two tests were the Blade Impact Test and the Blade Unbalance Test.

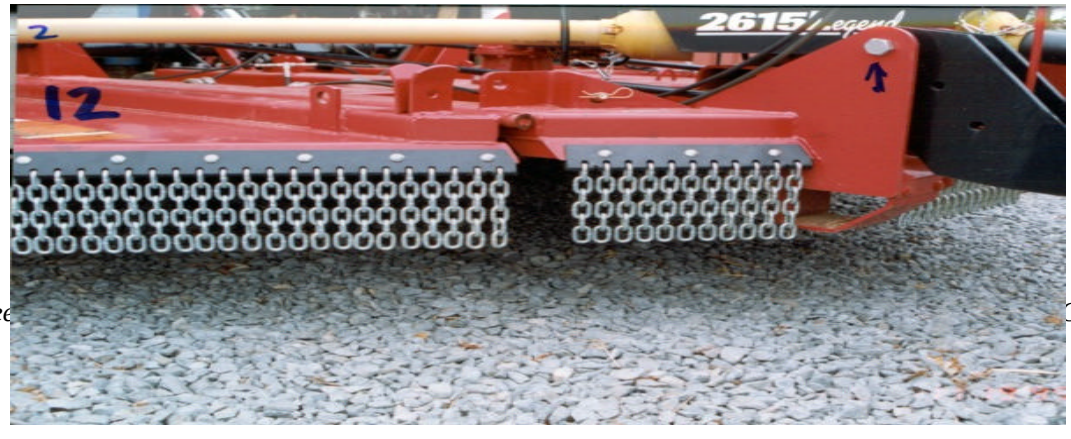
The Blade Unbalance Test requires that the mower be operated for two minutes at full speed with one of two blades removed and that "the test shall be completed without loss of any part of the unit or failure of any component in a manner that could be hazardous to the operator or bystanders." This test clearly indicates that mowers can be expected to lose blades during operation and that the machine must be designed to operate safely after a blade separation.

Defense experts testified that the failed blade had been abused during its approximately two-day lifetime. The required Blade Impact Test is performed by suddenly dropping a mower operating at full speed so that a blade impacts a two inch diameter steel rod which is held vertically in a prescribed rigid fixture. The blade must contact the steel rod approximately 25 mm (1 inch) from the outer tip of the blade. The test is satisfactory only if no parts are lost from the mower during the test (i.e. the blade cannot break on contact with the steel rod). Videotapes of a blade impact test performed by the mower manufacturer clearly showed that blade damage from these tests was much more severe than the normal wear in evidence on the blade which struck Mrs. Haynes. This gave credibility to plaintiff's argument that the blade had not been abused.

Violation of Sound Engineering Practices

Part of the responsibilities of the expert witness in this case was to determine if the mower manufacturer had implemented sound engineering practices promoting safety. To insure a safe product good engineering practices will design out unsafe conditions if it is cost effective. If the safety design is cost prohibitive then a feasible guard should be provided. If guarding is not feasible then a warning label should be applied. The mower shown in Fig. 5 is built with a guard (a skirt made of chains) to impede small objects as they come in contact with the blade during mowing. But, will the design of the chain guard as shown in the figure impede a blade that breaks away? Can the mower manufacturer improve the existing guard to impede larger objects?

Figure 5. A Mower with a Chain Guard



Alternate Guard Design

During discovery, it was determined that it was desirable to modify the conventional six link chain guard used on the deck of the mowing machine in Fig. 5. The idea was to reduce the incidence of thrown object damage (typically broken auto glass) produced when using the mower on right of way of roads.

Several states were determined to have a requirement that a length of 3/16-inch diameter aircraft cable be woven through the second chain link from the bottom of the six-link section. The idea was to cause the individual chain sections to act as an integrated skirt (barrier). The courtroom analogy was the lacing used in the fingers of baseball gloves to cause the fingers to act as a unit.

The defendant claimed that this modification would significantly alter the utility of the mower, and that no states actually enforced the requirement and that they sold no mowers equipped with cable. The Plaintiff produced evidence that defendant had been asked to quote prices on mowers with the aircraft cable laced through the chain guard.

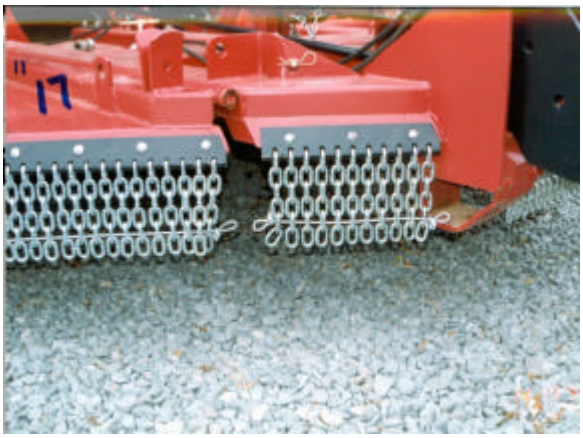
A mower was purchased and tested following addition of the aircraft cable to only half of the mower. The cable and associated clamps seen in Fig. 6 were purchased at a local building supply for approximately $30. Figures 7 (a), (b), and (c) show how the cable was added to the chain curtain. A one-day testing of the mower (video tape produced for evidence) clearly showed that there was no discernable difference in operation between the modified and unmodified halves of the mower.

Figure 6. Cable and Clamps

Figure 7 (a). A Close-up View of a Cable and Clamp Threaded through Chain Guard

Figure 7 (b). A Wider View of Cable and Clamp Threaded on One Side of the Guard

Figure 7 (C). Cable and Clamps Threaded on Both sides of the Mower's Guard



Recently adopted Federal Court rules require that any alternate design be tested to be credible. Plaintiff determined that extensive tests had been performed at the University of Texas concerning the thrown object protection provided by various guarding alternatives. Mowers

were tested with: no chain guard, conventional one row chain guard, and chain guards with the interlaced aircraft cable. The test clearly showed that the chain guard with aircraft cable interlaced was the most effective method of reducing the incidence of thrown objects from rotary mowers. Plaintiff's argument was that had the aircraft cable been placed on the chain guard, then the blade, after separation, would not have struck Mrs. Haynes.

Additional Accident

One of the authors is currently studying a second accident involving separation of a blade from rotary mower. The blade separated and penetrated the metal deck and deflected off an adjacent tree. The blade then struck and injured a bystander before landing a considerable distance from the point of impact with the injured party.

Figure 8 shows the tractor and mower, as it was located at the time of the accident. Each of the two blades is attached to the rotary member ("stump jumper") using a single bolt and is allowed to pivot freely about the bolt. In this instance, the blade broke through the bolt hole (as in Haynes) and penetrated the steel deck prior to hitting the tree.

Figure 8. Tractor and Mower before the Accident

Figure 9 shows the rotary element with attached single blade and the blade bolt that attached the thrown blade.

Figure 9. The Rotary Element Underneath the Mower after the Accident

Figure 10 shows the gash in the steel mower deck that allowed the blade to leave the housing.

Figure 10. The Gash in the Mower Housing Where the Blade Exited

The relevant standard issues for the second accident are the blade ductility (as in Haynes) and those portions of the rotary mower standard (SAE J232), which deal with the integrity of the steel deck (Structural Integrity Tests).

This matter may (or may not) result in litigation.

Standards – "Reveille til Taps"

Engineering students have, in general, little or no knowledge of how frequently they encounter in everyday life a plethora of products for which engineering standards apply. For example, they shower or bathe using water heated by a heater that conforms to an ANSI standard. The relief valve on the water heater is ASME approved by an appropriate standard. Their automobile contains standard nuts and bolts (SAE), operates on standard gasoline (ASTM), and standard oil (SAE) is used (hopefully) to protect the engine during operation. As educators, we have an obligation to introduce our students to engineering standards. Laboratory courses are ideal settings for teaching and demonstrating standards; however opportunity exists during lecture courses as well. An example involving the first law of thermodynamics could contain a reference to the ANSI approved residential water heater. In litigation matters, the first step upon receiving questions about a product is to check for any applicable standards and whether or not the product conforms to the standards. XYZ Nut and Bolt Company is not legally required to manufacture products that conform to the SAE standard; however they will not stay in business long if their products are not "standard".

Liabilities

The Haynes trial lasted two weeks with two hours of deliberation in which the jury returned a verdict against the blade and rotary mower manufacturers. In the $12 million settlement the jury found that these two manufacturers produced unreasonably dangerous products and held them willfully liable for damages to be shared equally. In a second damage-only trial the award was reduced to approximately one half of the original settlement. The rotary mower manufacturer had inadequate control over its product and ignored information that the blade would break. In addition, the mower manufacturer failed to exercise reasonable quality control in that it sold an agricultural rotary mower for non-agricultural use without equipping it with a device to keep items from flying out from beneath it. The blade manufacturer acknowledged that the blade sold to the mower manufacturer had a small crack in it that couldn't be seen with the naked eye. The blade broke off at the hairline crack that was not detected during manufacture. The crack was caused by improper heat treatment.

References

Standard ANSI/ASAE S483 Jul93, Rotary Mower Blade Ductility Test.

Standard SAE J232 Apr94, Industrial Rotary Mowers.

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