GUARDRAIL CERTIFICATION TRAINING

GENERAL GUARDRAIL MATERIALS UNDERSTANDING

A quality control representative for a certified guardrail supplier generally deals with two types of materials, steel and wood. To perform materials evaluation the employee needs to understand basic materials concepts. The majority of this training program will focus on steel. Wood products, while part of this certification program, will be supplied under the Department's current certification program for wood posts and blocks.

The quality control representative, to evaluate whether materials meet specification requirements needs

1. A basic understanding of the material.

2. Copies of the applicable specifications

3. Reading, writing and mathematical skills

4. The authority to accept and reject materials delivered to a company no matter what the reason.

This training program does not attempt to provide the above knowledge, information and skills. This training program is to give a quality control representative a basic understanding of the applicable materials; the typical evaluation process; some basic concept guidelines.

Materials Definitions

Area	a measure of the size of a surface or region.
Brinnell Hardness	the relative hardness of a material as measured by the Brinell test
Carbon	very common nonmetallic element having the symbol C
depth	the perpendicular measurement downward from a surface
elongation	the stretching of a member by tensile stress, including plastic stretching.
force	any external agent that causes a change in the motion of a free body, or that causes stress in a fixed body
Galvanizing	a zinc-coating that resists corrosion.
hardness	the quality or degree of being resistant to penetration or wear.
length	the longer or longest dimension of an object
Magnesium	a silvery alkaline-earth metallic element having the symbol Mg
Manganese	a hard, brittle, grayish metallic element having the symbol Mn
Phosphorus	a widely occurring nonmetallic element having the symbol P
PI	for any circle, the constant irrational number that is the ratio of the circumference to the diameter; denoted by "pi", and approximately equal to 3.14159265
Pressure	the force that is exerted per unit area
PSI	pounds per square inch.
Rockwell hardness	a unit of metal hardness according to the Rockwell hardness test
Silicon	a nonmetallic element having the symbol Si
Strain	the manifestation of this change in an actual body; the deformation of a material under a stress; it may be **elastic strain** (deformation disappears when stress is removed) or **plastic strain** (deformation is permanent)
Stress	a force exerted when one body or body part presses on, pulls on, pushes against, or tends to compress or twist another body or body part; *especially* **:** the intensity of this mutual force commonly expressed in pounds per square inch
sulfur	a nonmetallic element having the symbol S
Tensile strength	the maximum tensile stress (stretching) that a material can withstand without failure
width	the horizontal measurement taken at right angles to the length
Yield	the stress point at which strain continues to increase without any further application of stress.

GENERAL BASIC MATERIALS CONCEPTS

Steel products are generally physically tested to determine the following materials values

1. Yield Point

2. Ultimate Tensile

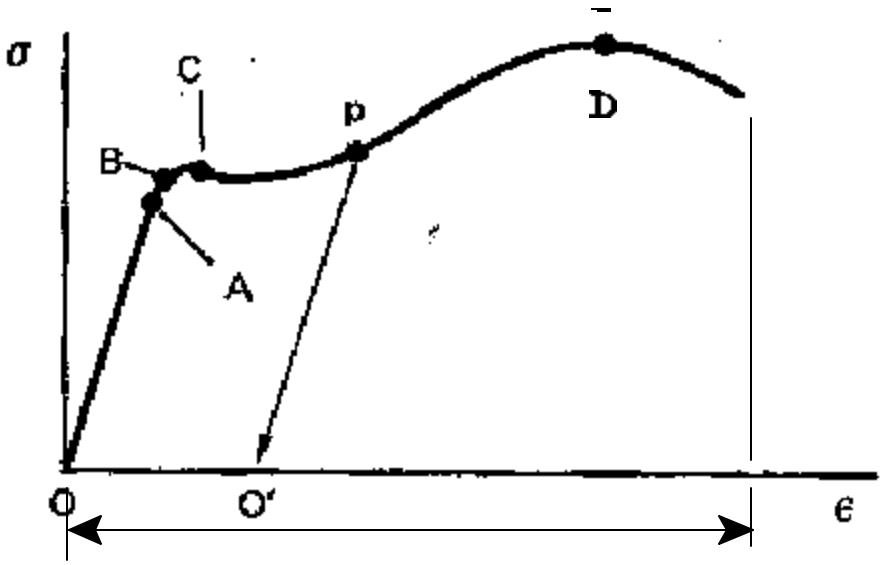
3. Elongation

4. Hardness

5. Chemical

These physical properties of a steel define enough information for a designer to develop structural requirements and for a materials engineer to assure the materials will perform as the designer expects.

<u>Yield Point - Ultimate Tensile and Elongation</u>



This graph above is a typical STRESS - STRAIN curve for a steel material.

The graph above shows points **A B** and **C**. All of these points are very close to each other and for this instruction will be defined as the **YIELD POINT** of the steel. The yield point of a material is the amount of force (or stress) required to cause a material to change from an elastic (returning

to its exact original shape if the load is released) to a plastic (when the load is released the material is permanently deformed)

On the previous page's graph there is a point **D**. This point is the highest vertical point on the graph and is known as the **ULTIMATE TENSILE**. The highest stress the material reaches before it fails.

The horizontal line with the arrow heads on the bottom of the graph measures the total amount of STRAIN the steel saw until it broke. Strain is measured in inches of movement/per inch and becomes dimension less.

ELONGATION is measured in percent of movement over a specific length. ELONGATION and STRAIN are similar measurements that can be calculated from the same information.

Example:

the ELONGATION of the steel was 22% in an 8 inch gage length.

8" x 22%/100 = 1.76" that the material stretched in the 8"

STRAIN (inch/inch) = (1.76/8)/(8/8) = .22/1 = .22

If you compare the numbers the total ELONGATION is also the total STRAIN.

HARDNESS

Hardness is a measurement of wear or penetration resistance to force. For steel materials it often can be compared to brittleness of the steel. An extremely hard steel will be very strong but will be brittle. The yield point and the ultimate tensile may be very close together and the steel will show very low strain.

Bolts and Nuts will be harder than guardrail or posts. Washers often will be the hardest of the steel components because they should not deform (change shape) when the bolt head or nut is tightened against them.

CHEMICAL

Steel is produced by a chemical reaction of different materials. In its simplest form, steel is the combining of Iron (FE) and Carbon (C) with Oxygen (O), Limestone and other components to develop a basic steel. Other chemicals are mixed into the basic steel to change the overall mechanical properties of the steel during the manufacture.

The chemical make up of a steel is another measure of the properties of the steel. An example is adding chromium (Cr) and nickel (Ni) to steel causes the steel to be stainless and rust resistant.

For the steels used in guardrail, bolts, nuts, washers, steel posts, rods the major controlled chemical components will be:
Carbon (C)
Manganese (Mn)
Phosphorus (P)
Sulfur (S)
Silicon (Si)

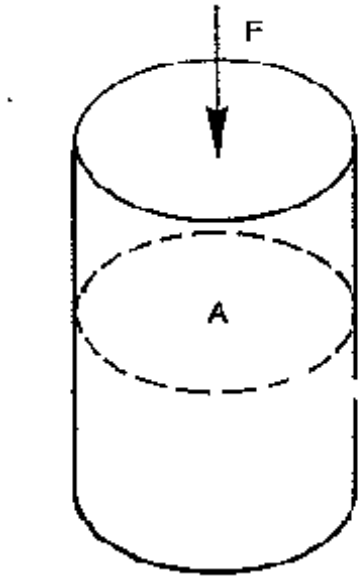
Test report measures are in percents and they are very small (Carbon might be .20 or less)

GENERAL MECHANICAL CALCULATIONS

In the above general discussion we have talked about yield point, ultimate tensile and elongation.

Generally yield point and ultimate tensile are reported in PSI (pounds per square inch) or STRESS.

Stress is the force applied over a specific area.



F = Force
A = Area

Example:
A Force of 600 lbs is applied to a 1/4" diameter rod what is the STRESS in Psi?

$A = \text{Area} = (D^2/4)\ \pi = ((.25)\ (.25))\ (\pi = 3.1416))/4 = .049\ in^2$

$\text{Stress} = F/A = 600\ lbs/.049\ in^2 = 12223\ Psi\ (lbs/in^2)$

APPLICABLE SPECIFICATIONS

The Ohio Department of Transportation specifies in each project the Construction and Materials Specifications for each project.

A quality control representative needs to not only be familiar with the specifications being used for each specific project but to have the correct and up-to-date specification that applies. Generally ODOT materials specifications will be defined in one of four methods.

1. National materials specifications - AASHTO (American Association of State Highway Transportation and Officials and ASTM (American Society of Testing and Materials)

2. Special plan note materials requirements - These are project specific requirements that the designer has required for a project specific reason. These may be modifications to item (1) type specifications or may be complete separate materials requirements.

3. ODOT standard drawings. - Some materials are only listed on standard drawings with specific requirements

4. Proprietary product materials requirements - Project plans may require a specific manufacturer's product. The materials requirements now become that manufacturer's materials specifications

Materials do not just include physical properties developed through tests but also include Dimensional and Coating properties. A material that has the correct strength but is the wrong size is NO GOOD.

The vast majority of materials for guardrail components will involve items 1 and 3.

National specifications (1) can be purchased from AASHTO and ASTM.

AASHTO's home page is: http://www.transportation.org/aashto/home.nsf/FrontPage

ASTM's home page is: http://www.astm.org/

Copies cannot be provided by ODOT and you need to assure your firm knows what the requirements are by having up-to-date specifications.

Standard Drawings can be purchased from ODOT by contacting the Office of Contracts. 614-466-3778

READING, WRITING AND MATHEMATICAL SKILLS

While this training manual shows examples of some mathematical skills to demonstrate acceptance concepts, this manual will not assure any quality control representative has the minimum skills necessary to perform the duties required of the guardrail certification program.

None of the needed skills are above a high school education but the skills may need brushing up on.

General mathematics skills include:

1. Calculation of Areas for rectangles and circles
2. Multiplication
3. Division
4. Understanding percentages
5. Addition
6. Subtraction

Reading

1. General reading skills are required but reading a specification is an acquired skill through experience. Terminology is different and understanding is built up by experience.

Writing

1. Standard high school level writing skills will fulfill any program requirements.