D-Calc™ Version 4.0 Software Manual

July 2015

SOFTWARE DESCRIPTION

Introduction

D-Calc 4 is an easy to use, user-friendly program for assessing the effects of damage on the strength of wood poles. This version includes screen touch capability and incorporates an embedded database (Microsoft SQL Compact Edition 3.5) to store D-Calc 4 data. Multiple databases may be defined (project specific) and multiple D-Calc 4 analyses may be saved in each database. D-Calc 4 data is fully compatible with previous versions of D-Calc. Data from previous versions may be imported into D-Calc V4 and stored in a SQL Compact Edition database.

Description

The user enters the pole dimensions along with the location and description of the damage. The strength loss calculations are performed and the results may be printed. Up to three (3) layers of pole damage may be entered. Each damage layer may include up to four (4) damage types.

Platform Requirements

D-Calc 4 requires Windows 8.1, Windows 8, Windows 7 SP1, Windows Vista SP2, Windows XP P3 or Windows XP Tablet PC SP3 running on a minimum 2-GHz Pentium 4 processor (or equivalent) with 2 GB of RAM. A minimum of 2 GB of free hard drive space is also required, as is a display with 1024x768 pixel resolution.

CONTENTS

LIST OF FIGURES

1
INSTALLING THE APPLICATION

If you experience difficulties accessing the application
Administrator privileges are required to install and run D-Calc 4. If you experience difficulties accessing the application after standard installation on Windows XP, Windows Vista, Windows 7, Windows 8 or Windows 8.1, please consult your IT department personnel to have proper access permissions setup for your use. If the problem cannot be resolved, please call EDM International at 1-970-204-4001 (or email info@edmlink.com).

Installation Procedure

To install D-Calc 4, perform the following steps:

NOTE: .NET Framework Version 4.0 or higher must be installed prior to installing D-Calc 4. Also, Administrator privileges are required to install the application.

1. Install .NET Framework 4.0 or higher that you downloaded from the Microsoft website.
2. Install Microsoft SQL Server Compact 4.0 (SSCERuntime_x64-ENU.exe (64bit) or SSCERuntime_x86-ENU.exe (32bit) from the installation CD if not currently installed.
3. Install Microsoft ReportViewer 2012 Runtime (ReportViewer.msi on the installation CD. This may you require you to first install SQLSysClrTypes.msi on the installation CD.
4. Insert the D-Calc 4 installation CD in your computer's CD drive or DVD drive.
5. If the installer does not launch automatically, run Setup.exe from the installation CD.
6. The initial installation dialog ("Preparing to Install…") is shown in Figure 1-1. While the dialog is open, the D-Calc files are extracted and the dialog closes upon completion.

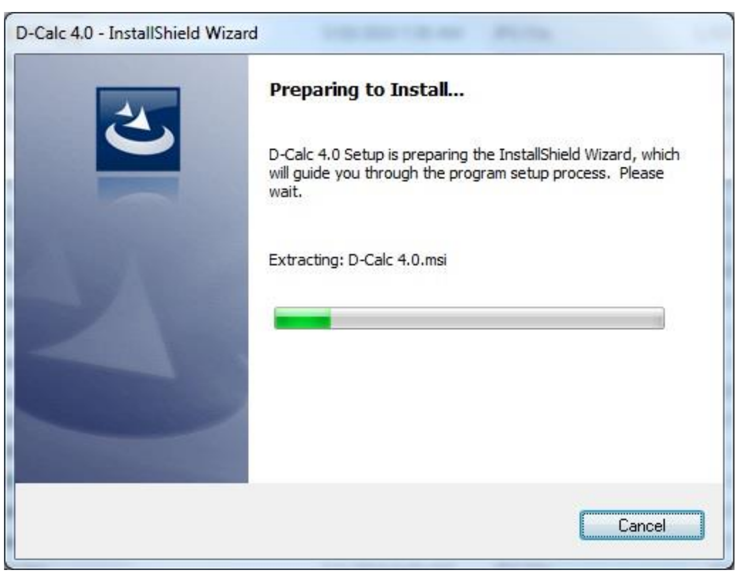


Figure 1-1. Preparing to Install

7. Next, the “Welcome” dialog is displayed – Figure 1.2. Click the **Next** button.

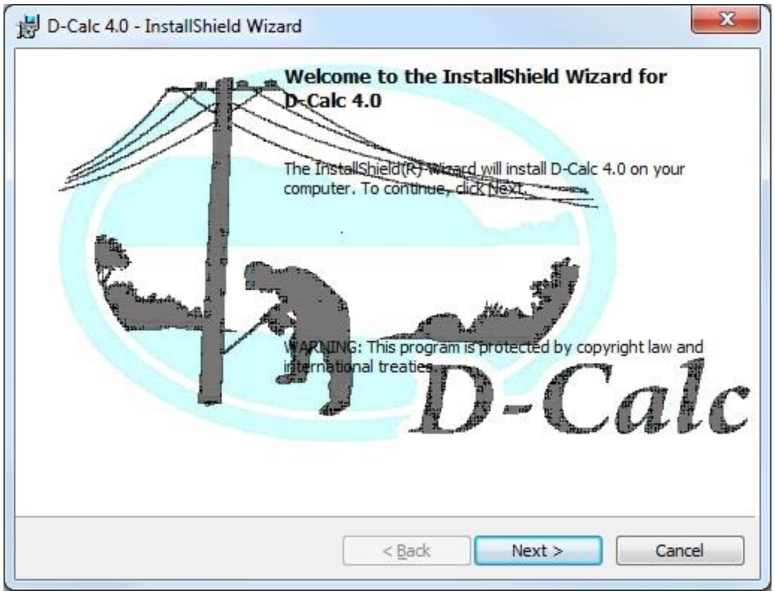


Figure 1-2. Welcome Dialog

8. The License Agreement dialog appears next as shown in Figure 1.3. After reading the agreement, click “**I** to accept the terms of the license agreement”. The “**Next**” button will now be activated. Click the “**Next**” button.

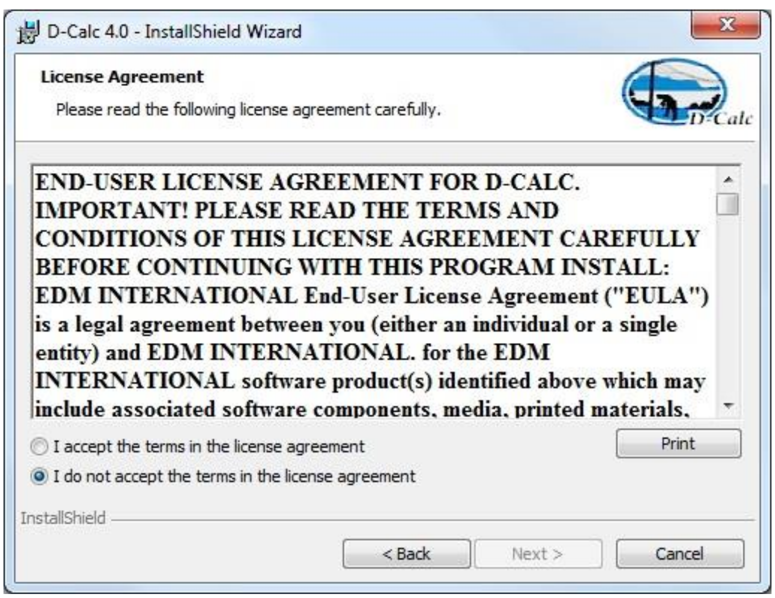


Figure 1-3. License Agreement Dialog

9. The “Destination Folder” dialog as shown in Figure 1.4 is now displayed. The default location is strongly recommended as the installation folder. Click the “**Next**” button to continue.

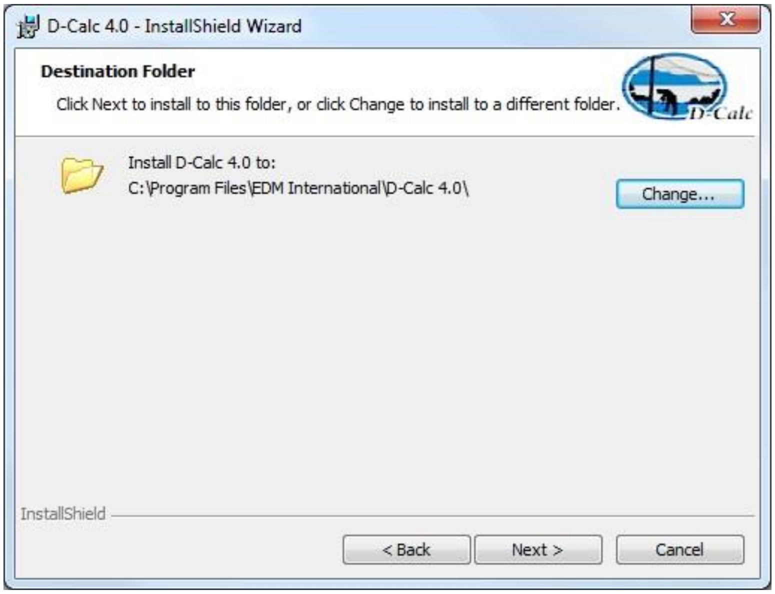


Figure 1-4. Destination Folder Dialog

10. The “Installing D-Calc 4.0” dialog next appears as shown in Figure 1-5. When finished installing the files, the “**Next**” button is enabled. Click the “**Next**” button.

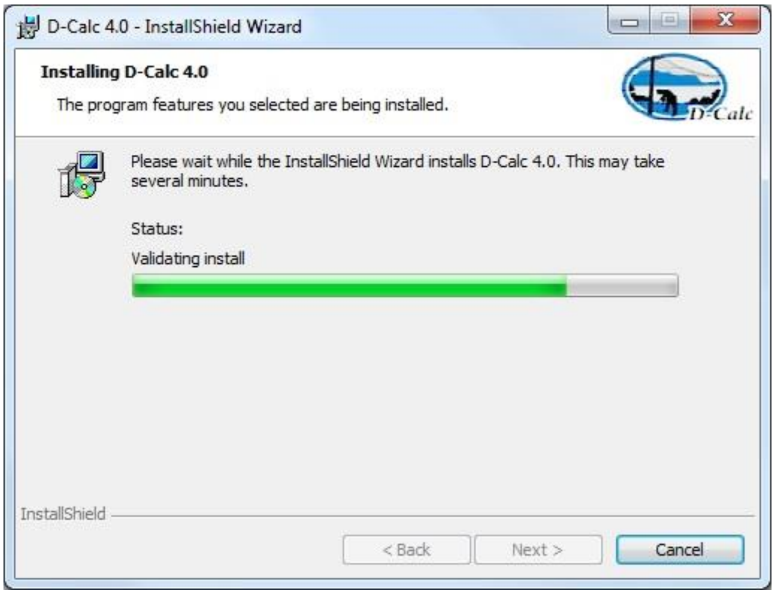


Figure 1-5. Installing D-Calc 4 Dialog

11. Finally, the “Completion” dialog as shown in Figure 1-6 is displayed. Click the “**Finish**” button to conclude the installation of D-Calc 4.

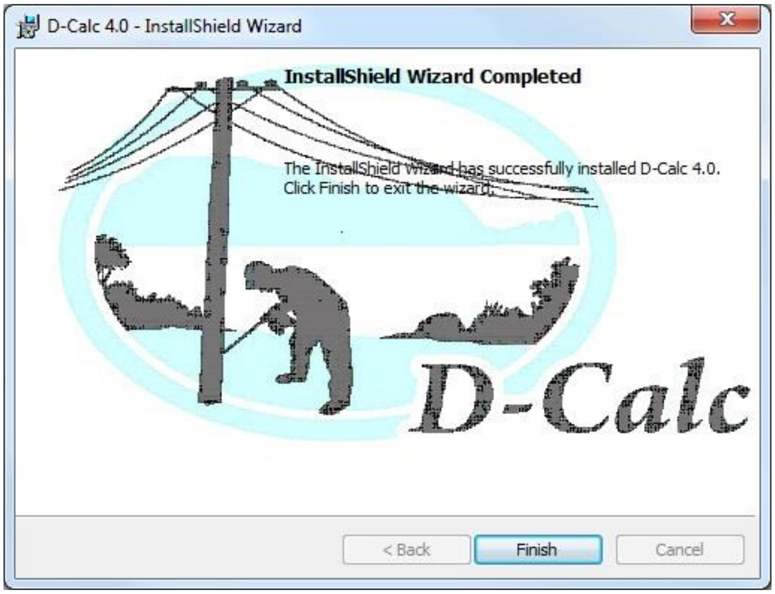


Figure 1-6 "Completion Dialog

The installation will add a shortcut on the desktop and an item in the Start → All Programs list.

Uninstalling and Re-Installing the Application

To Uninstall D-Calc 4.0, use “Programs and Features” found on the Control Panel. The application must be uninstalled before re-installing the application.

2
QUICK START GUIDE / EXAMPLES

Example 1: A 45', class 3, southern pine distribution pole has been hit by a passing vehicle resulting in a 3.0" deep gouge 2½' above the ground (see Figure 2-1). The pole measures 14" in diameter directly above the damaged area. To assess the damage, proceed as follows:

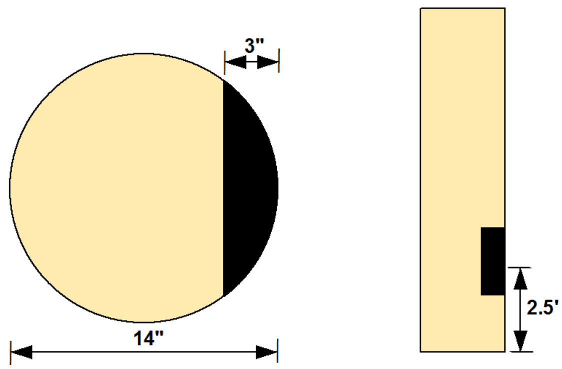


Figure 2-1. Schematic Diagram of Example 1

1. Click the **DB Options** button to create a D-Calc database using English units and Diameter measurement. The **Project Database Options** dialog appears (Figure 2-2). Enter a name for the Project Database - ExampleDB. The database name will be entered using a popup keyboard. Click the **Save It** button to <u>save</u> the database. Click the **Close** button to <u>select</u> that database as the Current Project Database.

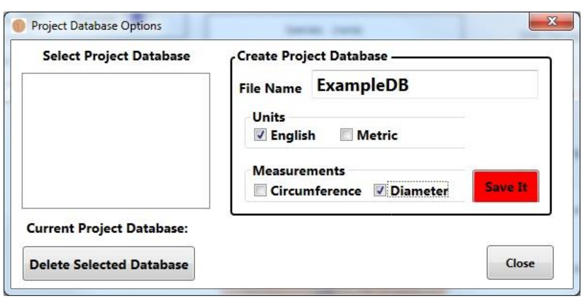


Figure 2-2. Project Database Options

2. Click the **ANSI** button to enter the ANSI specifications for the pole. Select Species (**Southern Pine)**, Class (**3)**, and Length (**45)**. Then click **OK** to return to the main screen. See Figure 2-3.

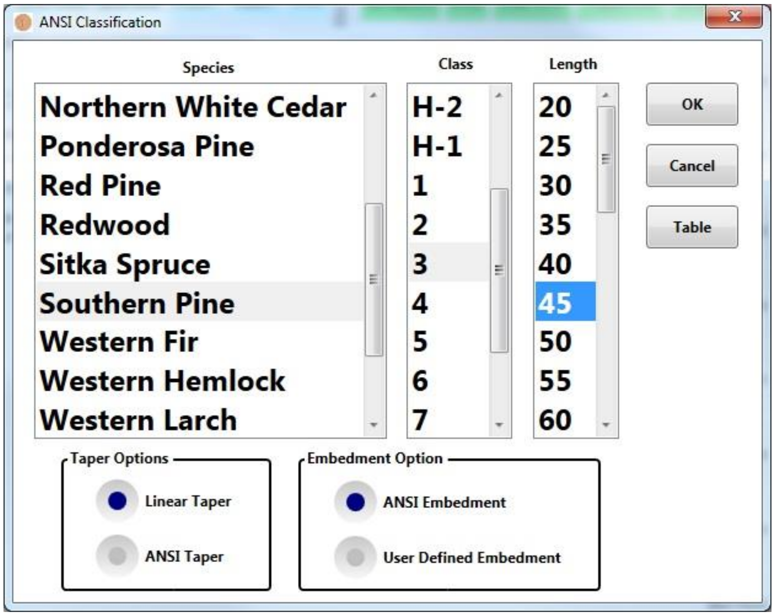


Figure 2-3. ANSI Classification for Example 1

3. On the main screen, enter the actual dimensions of the pole and the location of the damage. Since you measured the diameter, select the **Diameter** radio button (if not already selected), and input **14** as the "Pole Diameter (in)" in the corresponding input box. Then, enter **2.5** as "Distance From Groundline (ft)" to show that the damage is 2½' above the ground (Figure 2-4).

Figure 2-4. Pole Diameter and Distance from GroundLine for Example 1

4. Click on the icon for “**Misc. Damage – Slice**” in order to enter a damage description (Figure 2-).

Figure 2-5. Damage Description for Example 1

5. The damage can then be described in the boxes which appear in the middle of the screen as follows: **90** for Angle to Damage (deg.), **Depth Missing (in)** for the dimension, and **3** for the depth missing value (Figure 2-). (You can repeat Step 4 with different values to see how the damage can be increased or decreased and moved around the pole).

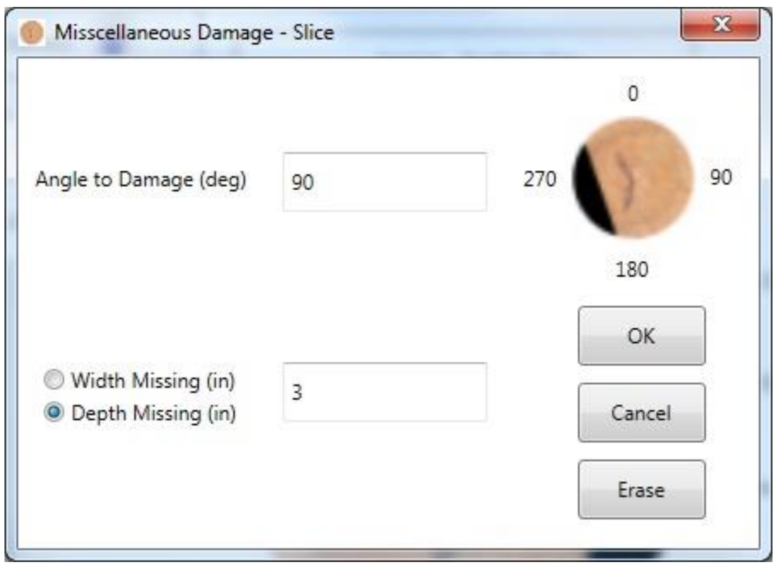


Figure 2-6. Damage Parameters for Example 1

6. Now, click the **Analyze** button and the results (Figure 2-7) indicate that the pole has 91% remaining section modulus in-line and 68% remaining transverse, based upon the actual pole size. The ANSI COMPARISON results show that the pole was oversized to begin with and retains 161% of its in-line section modulus and 120% transverse. This pole, which would be rejected by most evaluations, has a larger section modulus than required by ANSI minimums for an undamaged pole of the same class.

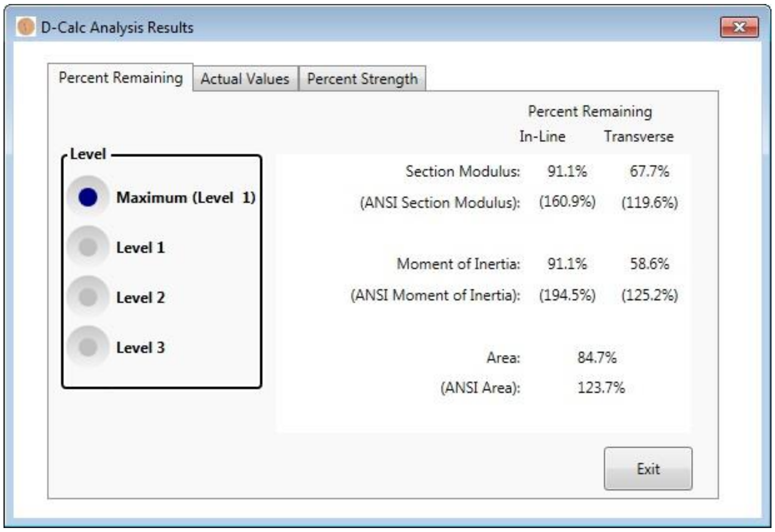


Figure 2-7. Results of Analysis on Example 1

Example 2: A 70', class 1, Douglas-fir transmission pole has a woodpecker nest 35' up the pole. The nest is 6" in diameter, has a 2" entry hole and a 2" outside shell remaining as shown in Figure 2- below. The entry hole opens in the line direction. A tape measure was used to measure the circumference directly above the nest at 40". To assess the damage, proceed as follows:

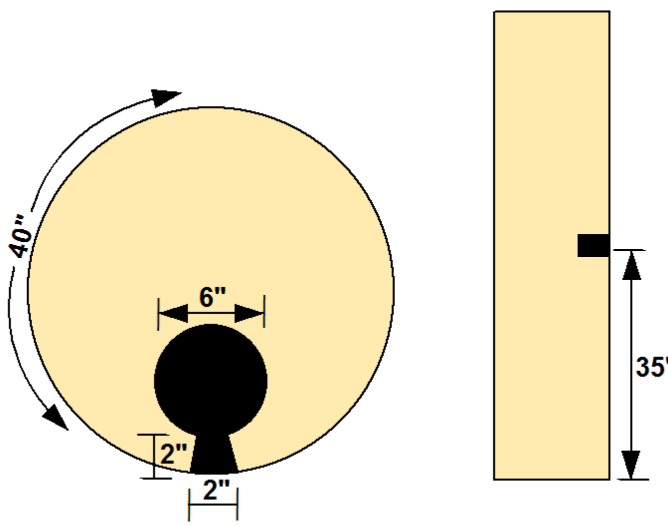


Figure 2-8. Schematic Diagram of Example 2

1. Click on the **ANSI** button to enter the ANSI specifications for the pole. The ANSI Classification dialog (Figure 2-9) appears. Enter Species (**Douglas-fir),** Class (**1**), and Length (**70)**. Then click **OK** to return to the main screen.

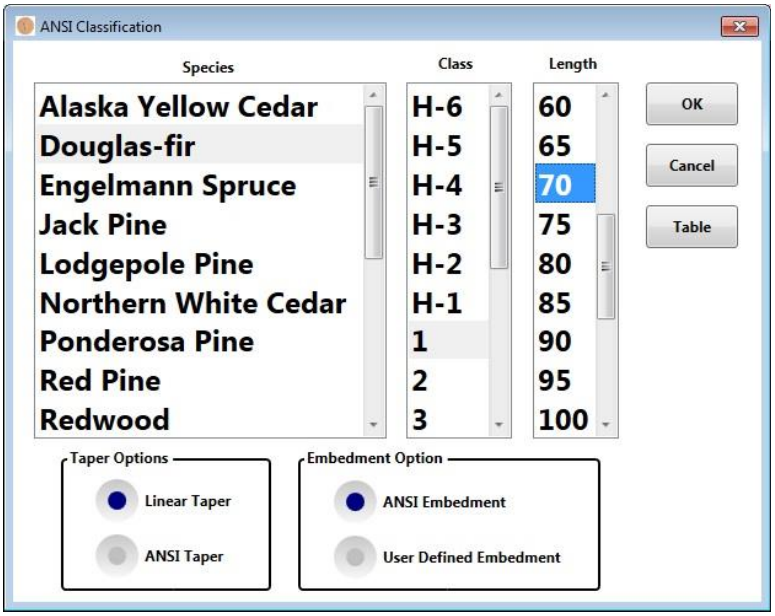


Figure 2-9. ANSI Classification for Example 2

2. On the main screen, enter the actual dimensions of the pole and the location of the damage. Since you measured the circumference, select the **Circumference** radio button (if not already selected), and input **40** as the Pole Circumference (in) in the corresponding input box. Then, enter **35** as "Distance From Groundline (ft)" to show that the damage is 35' above the ground (Figure 2-).

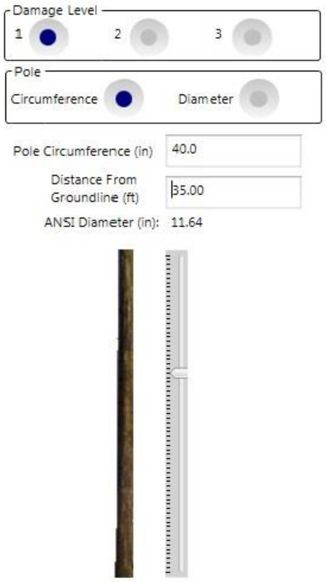


Figure 2-10. Pole Diameter and Distance from GroundLine for Example 2

3. Click on the icon for "**Woodpecker Cavity**" in order to enter a damage description (Figure 2-).

Figure 2-11. Damage Description for Example 2

4. Enter **180** for "Angle to Opening (deg)" (or click on the corresponding location on the graphic), **2** for "Circumference Missing (in)", **2** for "Shell Thickness at Opening (in)", and **6** for "Nest Diameter (in)" (Figure 2-12).

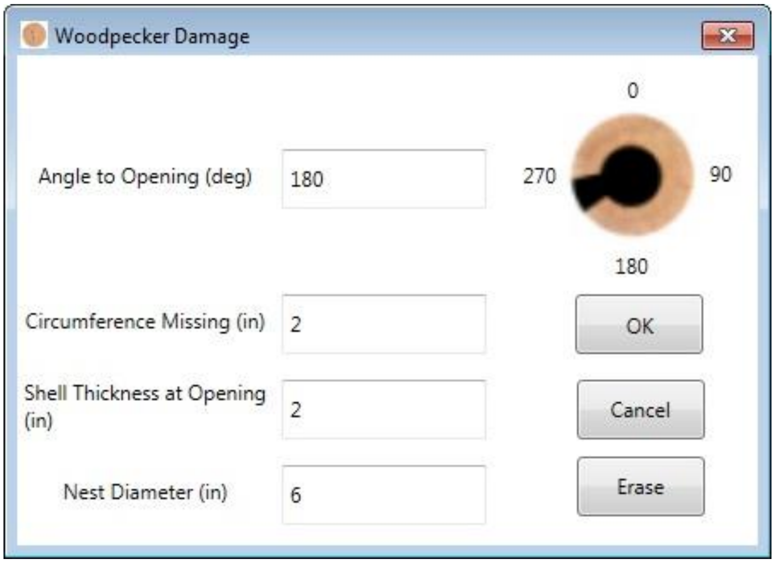


Figure 2-12. Damage Parameters for Example 2

5. Now, click the **Analyze** button and the results (Figure 2-13) indicate that the pole has 76% remaining section modulus in-line and 95% remaining transverse, based upon the actual pole size. The ANSI COMPARISON results show that the pole was oversized to begin with and retains 100% of its in-line section modulus and 124% transverse.

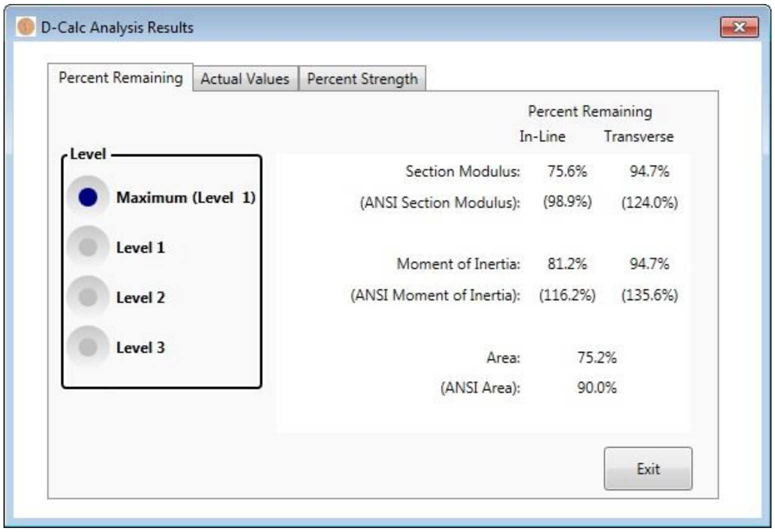


Figure 2-13. Results of Analysis on Example 2

Detailed instruction for all D-Calc 4 functions are provided in the following pages.

3
THE USER INTERFACE

Note: The installation of D-Calc 4 will provide required supporting files.

The **main form** of D-Calc 4 is shown in Figure 3-1. The interface has ten (10) major components:

- File Options
- Database
- ANSI Data
- Damage Level
- Pole Size
- Inspection Properties
- Damage Height
- Damage Types
- Pole Cross Section/Defect Editor
- Analyzer

Each of these components is shown in Figure 3-1, and explained below.

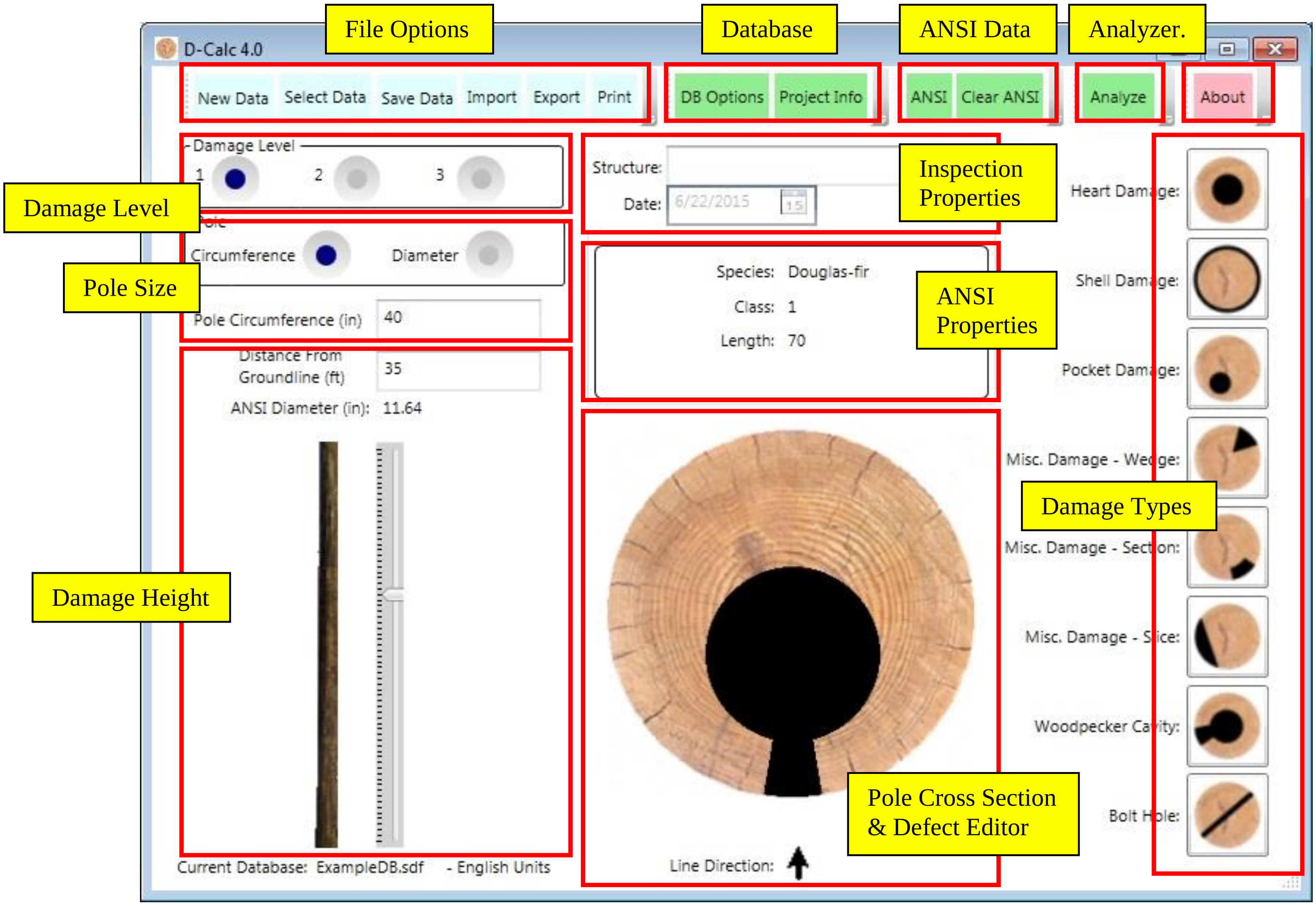


Figure 3-1. D-Calc 4 Main Form.

File Options

The File Options toolbar (Figure 3-2) consists of six items:

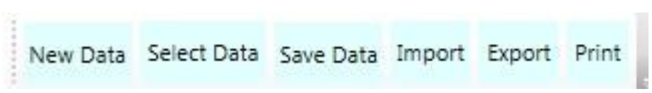
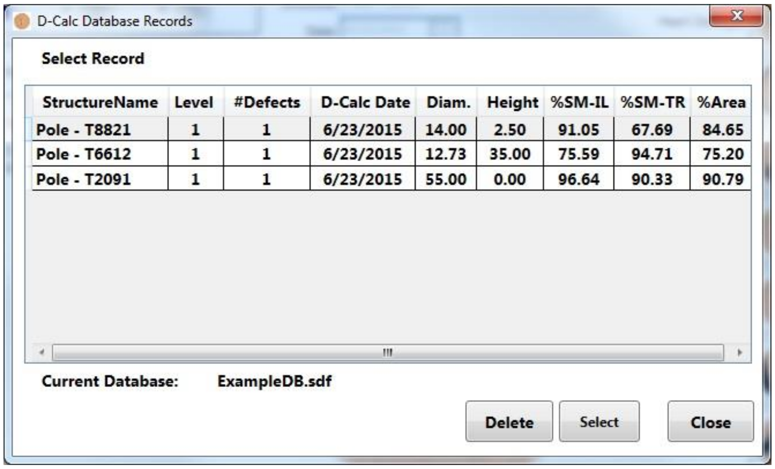


Figure 3-2. File Options Toolbar

- *New Data* – Add a new pole and enter data for up to three (3) damage levels with each level having up to four (4) defects. If current data has not been saved when the **New Data** button is pressed, the user will be prompted to save any unsaved current data prior to entering data for a new pole.

- *Select Data* – Click the **Select Data** button to select damage data for a level of a pole that currently exists in the selected D-Calc 4 (.sdf) database. Figure 3-3 summarizes the defect data and analysis results for the three poles in the sample database: ExampleDB.sdf.



StructureName	Level	#Defects	D-Calc Date	Diam.	Height	%SM-IL	%SM-TR	%Area
Pole - T8821	1	1	6/23/2015	14.00	2.50	91.05	67.69	84.65
Pole - T6612	1	1	6/23/2015	12.73	35.00	75.59	94.71	75.20
Pole - T2091	1	1	6/23/2015	55.00	0.00	96.64	90.33	90.79

Figure 3-3. Data Selection Table

Note that each pole in the above Database Records list has a single defect on level 1. Although three defect level records are always stored in the database for each Pole, only those associated with damage are shown in the Database Records list. A selection is made by clicking on a row then clicking the **Select** button. The main form is populated and the graphic, representing the damage on the selected level is displayed. A row (damage level for a pole) may be deleted from the grid (and database) by highlighting the row and clicking the **Delete** button. If the data for a row is deleted and the other levels for that pole have no data, then all data (database records) associated with that pole will be deleted from the current database.

- *Save Data* – When the **Save Data** button is pressed, the defect data for all three levels of the current pole is saved in the currently selected D-Calc 4 (.sdf) database. Damage level records for all three levels are saved even if one or more layers have no defects. A database must have been selected in order to save data.

- *Import* – Damage data from precious versions of D-Calc may be imported into the currently selected D-Calc 4 database. Data for previous versions of D-Calc was stored in flat files – one file per pole. Either a single file or a batch file containing multiple file names listed sequentially may be imported. The Import dialog is shown in Figure 3-4.

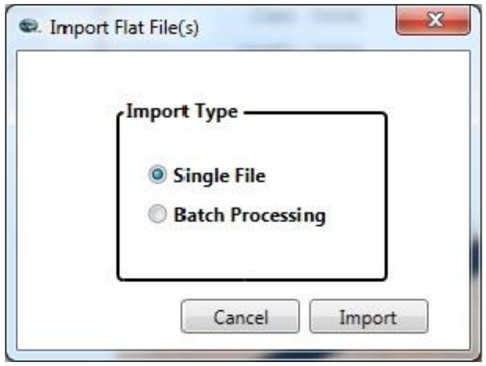


Figure 3-4. Import Flat File(s)

- *Export* – Data for a pole selected from the currently selected D-Calc 4 database may be exported to a single file. The export dialog is shown in Figure 3-5.

Figure 3-5. Export Flat File

- *Print* – Formats and prints the input data and analysis results for some or all poles in the currently selected database. There are five (5) print options.

  <u>Pole Selection Options</u>

  - *Current Pole* - To use the first option, the user must first **Select Data**. Otherwise, the **Print What** group buttons and **Print** button will be disabled. Data for one or all levels (if damage data exists) may be printed. The print dialog is shown in Figure 3-6.

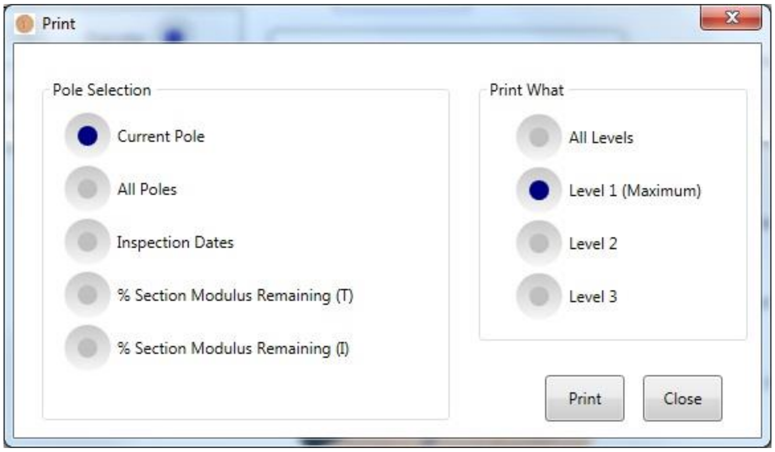


Figure 3-6. Current Pole

- *All Poles* – All damage data for all poles in the currently selected database will be printed. The print dialog is shown in Figure 3-7

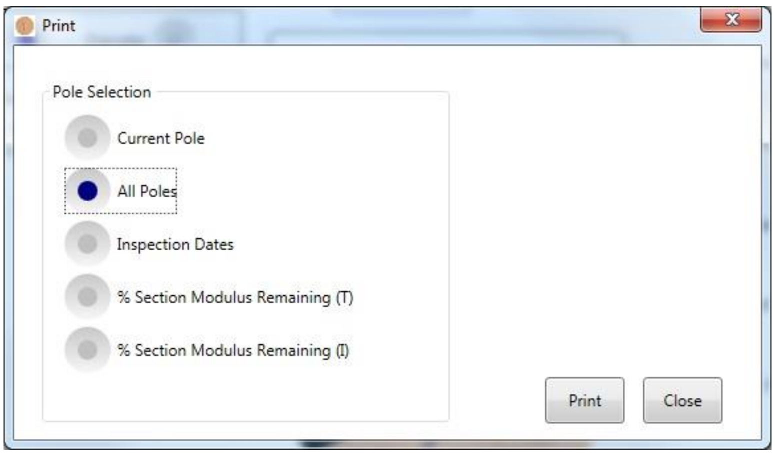


Figure 3-7. All Poles

- *Inspection Dates* – All damage data for all poles in the currently selected database with inspection dates lying within a given date interval will be printed. The print dialog is shown in Figure 3-8.

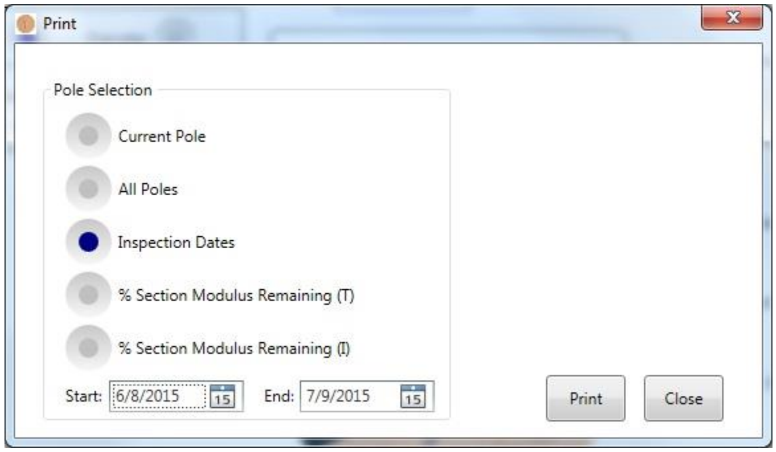


Figure 3-8. Inspection Dates

- *% Section Modulus Remaining (T)* – All damage data for all poles having a remaining Transverse Section Modulus below a given percentage threshold will be printed. The print dialog is shown in Figure 3-9.

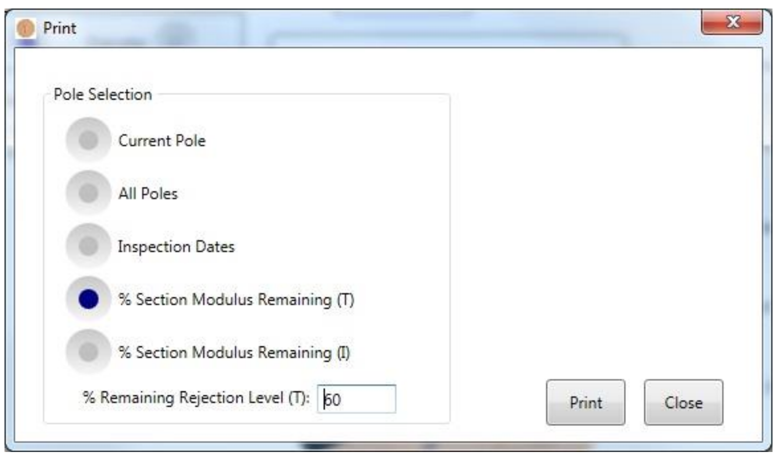


Figure 3-9. % Section Modulus Remaining (T)

- *% Section Modulus Remaining (I)* – All damage data for all poles having a remaining In Line Section Modulus below a given percentage threshold will be printed. The print dialog is shown in Figure 3-10.

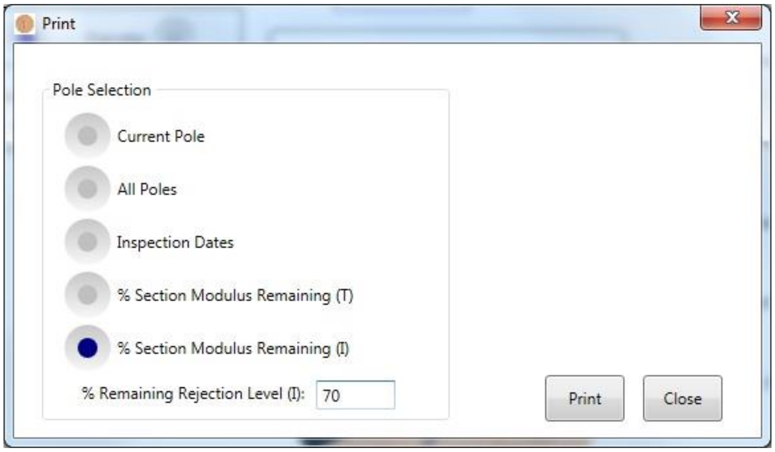


Figure 3-10. % Section Modulus Remaining (I)

- User can select the damage level(s) to be printed. The report will automatically be printed on your default (or selected) printer, and will function regardless of the printer type you are using.

Database

The Database toolbar consists of two items (Figure 3-2):

Figure 3-11. Database Toolbar

- *DB Options* – When the **Database** button is clicked, the Database Options dialog is displayed as shown in Figure 3-12. The dialog shows that three D-Calc databases that were created by the current user. "Sinclair Ltd – West Rd" was selected as the current project database. Databases can also be deleted by clicking the **Delete Selected Database** button. If the user attempts to delete a database, the prompt "Are you sure you want to delete this database? If you do, all project data will be lost" is displayed.

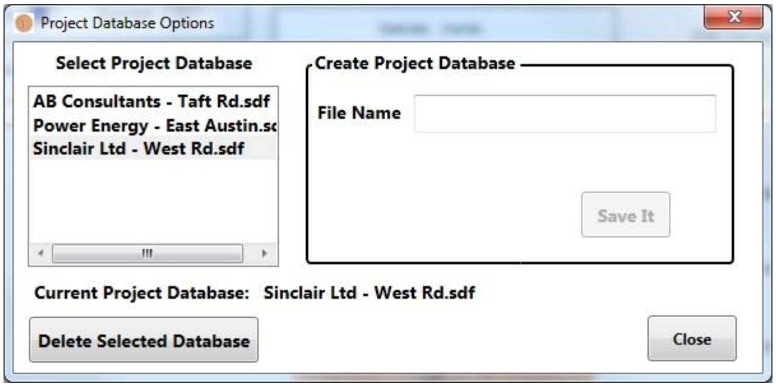


Figure 3-12. Database Options

- *Project Info* – When the **Project Info** button is clicked, the Project Information dialog is displayed as shown in Figure 3-13. All data in this dialog is associated with the currently selected database. The Project Start Date corresponds to the date when the currently selected database was created. Job, Project, Owner and Inspection Company information may also be entered and saved. The current system of units is also shown.

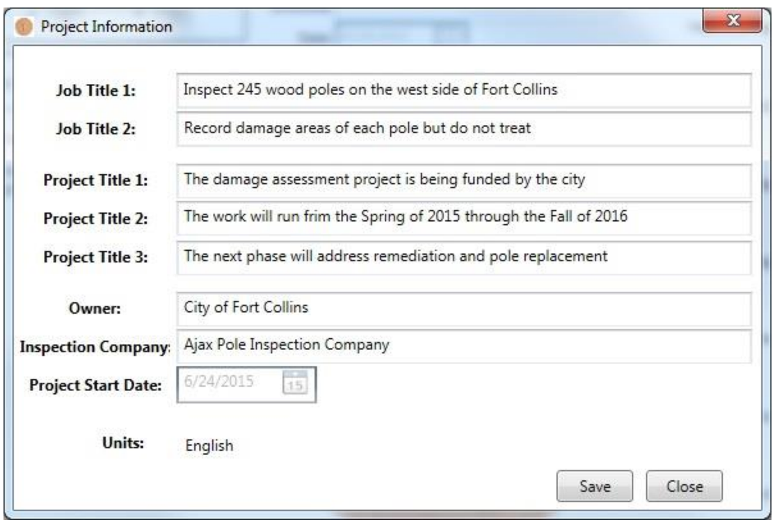


Figure 3-13. Project Information

ANSI Data

The user may choose to base their analysis on the "minimum" pole dimensions specified in the American National Standards Institute for Wood Poles – Specifications and Dimensions (ANSI O5.1). This information can be automatically accessed by selecting the pole species, class, and length.

In addition, entering ANSI information enables D-Calc 4 to compare the results of analyses based on actual field-measured dimensions of pole size and damage to the properties of an ANSI O5.1 "minimum" dimension pole.

The ANSI Data toolbar consists of two (2) items as shown in Figure 3-14

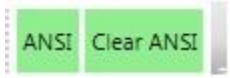


Figure 3-14. ANSI Data Toolbar

- *ANSI* - When the **ANSI** button is pressed, the ANSI Classification dialog appears as shown in Figure 3-15. The ANSI Classification data is

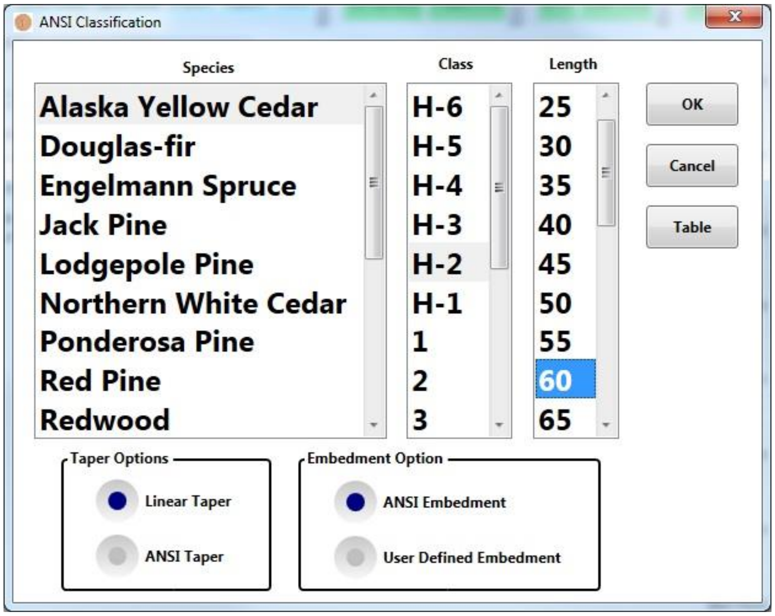
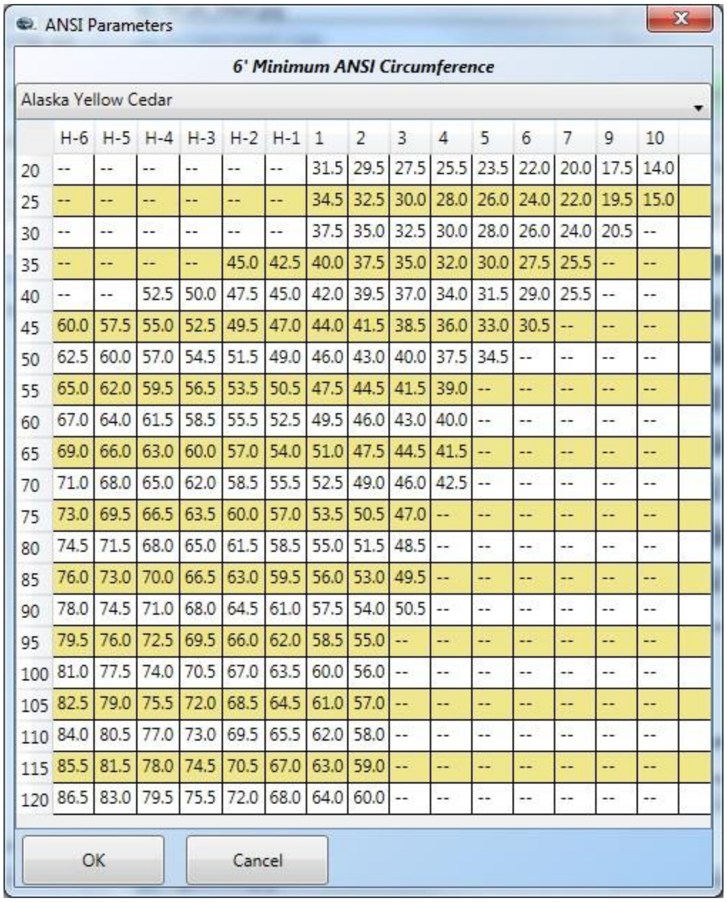


Figure 3-15. ANSI Classification

- **Species**: Allows you to select or change the species of the pole to be analyzed.
- **Class**: Used to select the ANSI O5.1 pole class.
- **Length**: Gives you the capability to choose pole length.
- **Taper Option**: Allows you to select the method used to calculate the pole taper. This function is used by D-Calc 4 to calculate the equivalent ANSI O5.1 minimum diameter at a location along a pole's length other than 6' from its butt. User can choose either a Linear Taper or an ANSI Taper.
- **Embedment Option**: Allows you to choose either ANSI Embedment or User Defined Embedment. ANSI Embedment is computed as 10% of pole length (feet) + 2 feet.
- **Table**: Give you access to a table of the ANSI O5.1 minimum circumferences at 6' from the butt of a given species of pole.

- *"This material is reproduced with permission from American National Standard for Wood Poles – Specifications & Dimensions (ANSI O5.1), copyright 1992, by the American National Standards Institute. Copies of this standard may be purchased from the American National Standards Institute at 11 West 42nd Street, New York, NY 10036, or http://www.webstore.ansi.com"*

The table of the ANSI O5.1 minimum circumferences is shown in Figure 3-16.



	H-6	H-5	H-4	H-3	H-2	H-1	1	2	3	4	5	6	7	9	10
20	--	--	--	--	--	--	31.5	29.5	27.5	25.5	23.5	22.0	20.0	17.5	14.0
25	--	--	--	--	--	--	34.5	32.5	30.0	28.0	26.0	24.0	22.0	19.5	15.0
30	--	--	--	--	--	--	37.5	35.0	32.5	30.0	28.0	26.0	24.0	20.5	--
35	--	--	--	--	45.0	42.5	40.0	37.5	35.0	32.0	30.0	27.5	25.5	--	--
40	--	--	52.5	50.0	47.5	45.0	42.0	39.5	37.0	34.0	31.5	29.0	25.5	--	--
45	60.0	57.5	55.0	52.5	49.5	47.0	44.0	41.5	38.5	36.0	33.0	30.5	--	--	--
50	62.5	60.0	57.0	54.5	51.5	49.0	46.0	43.0	40.0	37.5	34.5	--	--	--	--
55	65.0	62.0	59.5	56.5	53.5	50.5	47.5	44.5	41.5	39.0	--	--	--	--	--
60	67.0	64.0	61.5	58.5	55.5	52.5	49.5	46.0	43.0	40.0	--	--	--	--	--
65	69.0	66.0	63.0	60.0	57.0	54.0	51.0	47.5	44.5	41.5	--	--	--	--	--
70	71.0	68.0	65.0	62.0	58.5	55.5	52.5	49.0	46.0	42.5	--	--	--	--	--
75	73.0	69.5	66.5	63.5	60.0	57.0	53.5	50.5	47.0	--	--	--	--	--	--
80	74.5	71.5	68.0	65.0	61.5	58.5	55.0	51.5	48.5	--	--	--	--	--	--
85	76.0	73.0	70.0	66.5	63.0	59.5	56.0	53.0	49.5	--	--	--	--	--	--
90	78.0	74.5	71.0	68.0	64.5	61.0	57.5	54.0	50.5	--	--	--	--	--	--
95	79.5	76.0	72.5	69.5	66.0	62.0	58.5	55.0	--	--	--	--	--	--	--
100	81.0	77.5	74.0	70.5	67.0	63.5	60.0	56.0	--	--	--	--	--	--	--
105	82.5	79.0	75.5	72.0	68.5	64.5	61.0	57.0	--	--	--	--	--	--	--
110	84.0	80.5	77.0	73.0	69.5	65.5	62.0	58.0	--	--	--	--	--	--	--
115	85.5	81.5	78.0	74.5	70.5	67.0	63.0	59.0	--	--	--	--	--	--	--
120	86.5	83.0	79.5	75.5	72.0	68.0	64.0	60.0	--	--	--	--	--	--	--

Figure 3-16. ANSI O5.1 Minimum Circumferences

Clicking on an invalid cell of the table (--) results in an invalid set of ANSI parameters. For example, if the user chooses Species: Alaska Yellow Cedar, Class: 7; Length: 55, the dialog in Figure 3-17 is displayed.

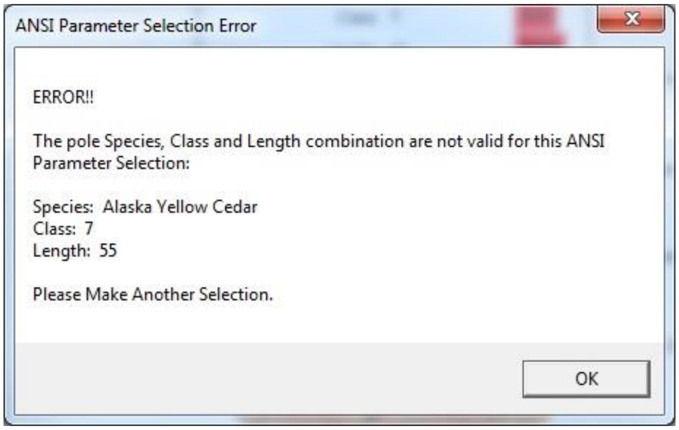


Figure 3-17. ANSI Parameter Selection Error

The main form now appears with a highlighted message as shown in Figure 3-18

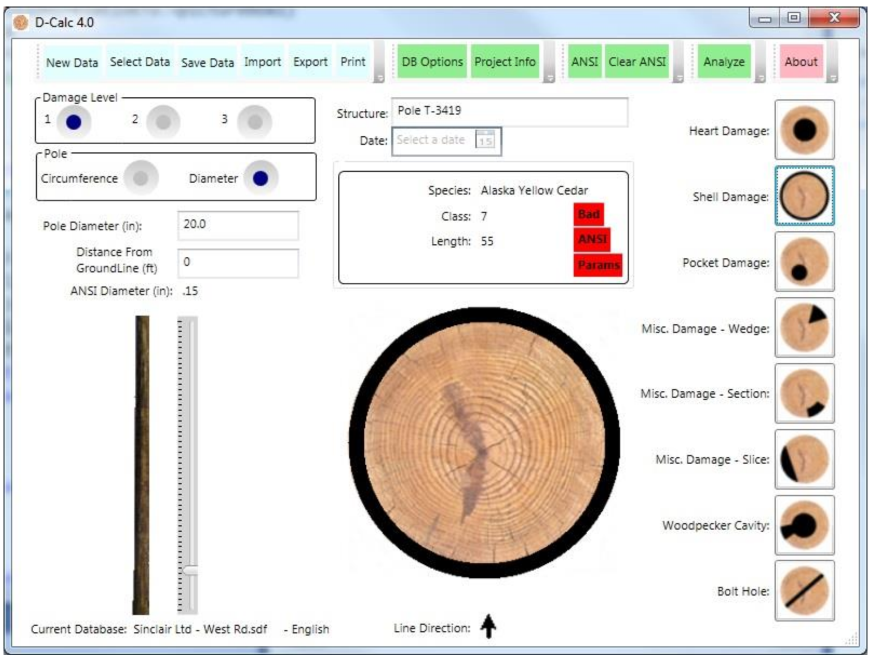


Figure 3-18. Bad ANSI Parameters

After entering valid ANSI classification data, the "ANSI Properties" window, located in the center of the main screen, will be populated with the summary information and the highlighted message will disappear. The calculated ANSI diameter for the given Distance from GroundLine will also appear on the left of the screen. The actual pole size will remain blank until a value is entered in the Pole Size text box.

You do not need to use the ANSI menu if you want to base your analysis solely on the dimensions of the pole and damage as measured in the field.

- *Clear ANSI* - When the **CLEAR ANSI** button is pressed, the ANSI data for the selected pole is cleared in the ANSI Properties window and the database values are saved.

Damage Level

The user can select up to three levels of damage/defects (Figure 3-19). “Level” refers to height above ground. For example, the user could define a wedge at 2.5’ above groundline, a bolt hole at 5’ above groundline, and a woodpecker cavity at 25’ above groundline.

Figure 3-19. Damage Level

For each level, up to four defects can be specified. Thus, D-Calc 4 can model a pole with up to 12 total defects (four defects on three different levels).

In many cases, the user will need to report only one defect on one level. In such cases, the Damage Level Selection will not need to be changed, and can stay at the default level of “1”.

Pole Size

The user can choose to report pole size in terms of either circumference or diameter (the default option is circumference) as shown in Figure 3-20.

Click on either the “Diameter” or the “Circumference” radio button. The title of textbox below will update itself accordingly. Type the appropriate value in the textbox (Figure 3-21).

Figure 3-20. Pole Size Radio Button

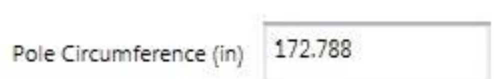


Figure 3-21. Pole Size Text Box

If the user toggles the Circumference/Diameter radio button *after* typing in a value to the text box, the value in the text box will update itself to the appropriate metric.

Inspection Properties

The user can enter a name for the Structure (Pole). The date represents the date when the database record for this pole was created. See Figure 3-22

Figure 3-22. Inspection Properties

Damage Height

Distance from Groundline for each damage level may be entered. When ANSI Properties are specified, the slide bar (shown in Figure 3-23) sets the Distance from Groundline and computes ANSI diameter at that height.

Figure 3-23. Damage Height

Damage Types

To select a damage type and to analyze the damage, D-Calc 4 requires you to input either the ANSI classification and/or the measured pole size.

If the measured diameter or circumference is not entered before **Damage Description** is entered, and if the ANSI Classification is also not entered, a message will instruct you to input a Pole Diameter before proceeding. If the ANSI Classification is entered, but a measured pole diameter or circumference is **not** entered, D-Calc 4 will automatically input the ANSI-calculated diameter for the analysis.

Once a pole size has been input, you may select a Damage Description. Damage can be assigned by using any combination of the eight damage types shown on the right hand side of the main screen (Figure 3-1). You may enter up to four defects per Damage Level.

To begin entering damage, click on one of the eight damage types (shown in Figure 3-24). A parameter box will appear in the middle of the screen to allow entry of the data required for the respective type of damage. *Damage types and parameters will be discussed in detail in Section 4.*

Figure 3-24. Damage Types

When you have completed the description for the damage type, click “OK”. The Pole Cross Section/Defect Editor in the middle of the main screen (Figure 3-25) will graphically depict the damage as you had configurated it. Repeat the process as needed, up to four damage types per level (location), in order to completely describe the damage at this location. Each damage type will appear on the cross section as a different-colored graphic.

Pole Cross Section/Defect Editor

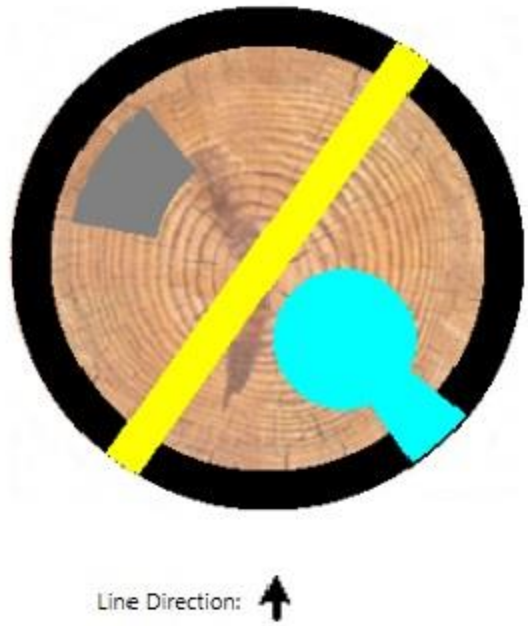


Figure 3-25. Example Cross Section, Depicting Four Types of Damage at One Level

The orientation of the damage relative to the line direction is important for bending strength calculations, as the effect of eccentric damage on bending strength is different in the In-Line (parallel to line) and Transverse (perpendicular-to-line) directions.

If you wish to change the size or orientation of any of the four defects, simply click on any of the defect graphics shown on the cross section and make appropriate modifications. If you need to change damage types or remove damage, click on the respective defect graphic, and select "Erase".

Analyzer

When all defects have been defined, at all levels/locations, click the "Analyze" button to analyze and report the damage to the pole (Figure 3-26).

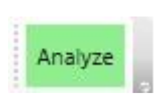
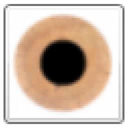


Figure 3-26. Analyze Button

The Analyze command and Results viewing will be discussed in detail in Section 5.

4
DAMAGE TYPES AND PARAMETERS



Heart Damage/Rot

The minimum shell thickness (inches) must be input to describe the degree of Heart Rot. D-Calc 4 assumes that the Heart Rot concentric and, therefore, that this thickness applies to the entire circumference (Figure 4-1).

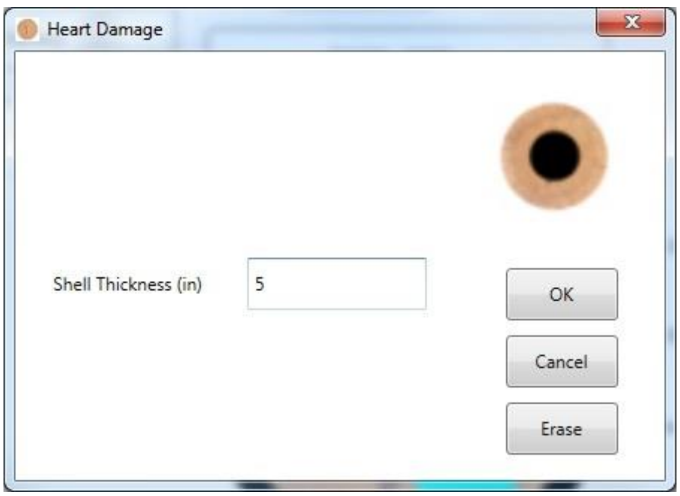
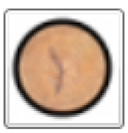


Figure 4-1. Heart Damage Parameters



Shell Damage/Rot

To describe the extent of Shell Rot, enter the radial depth (inches) of the damage relative to the original surface of the undamaged pole (Figure 4-2).

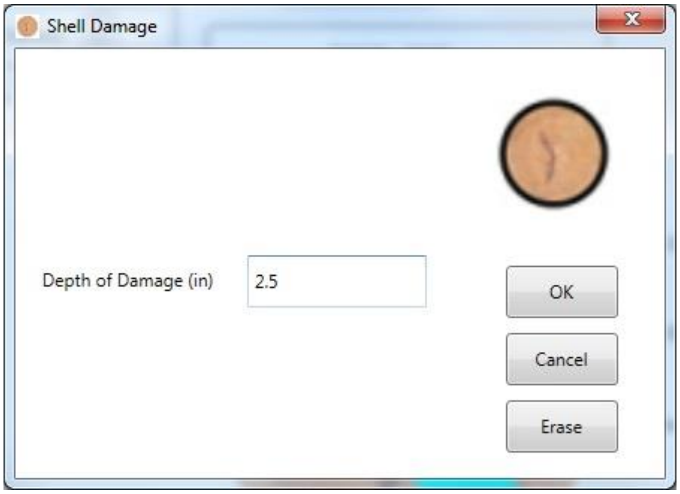
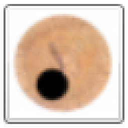


Figure 4-2. Shell Damage Parameters

**Pocket Damage/Rot**

Three input items are required to describe Pocket Rot: the angle (degrees) of the pocket relative to the line direction; the diameter (inches) of the pocket; and the minimum thickness (inches) of the wood at the point where the pocket comes closest to the pole's surface (Figure 4-3).

Note: You can input the angle through the text box <u>*or*</u> *by clicking on the graphic in the upper-right of the parameters window. This applies to Pocket Damage, Wedge, Section, Slice, Woodpecker Cavity, and Bolt Hole.*

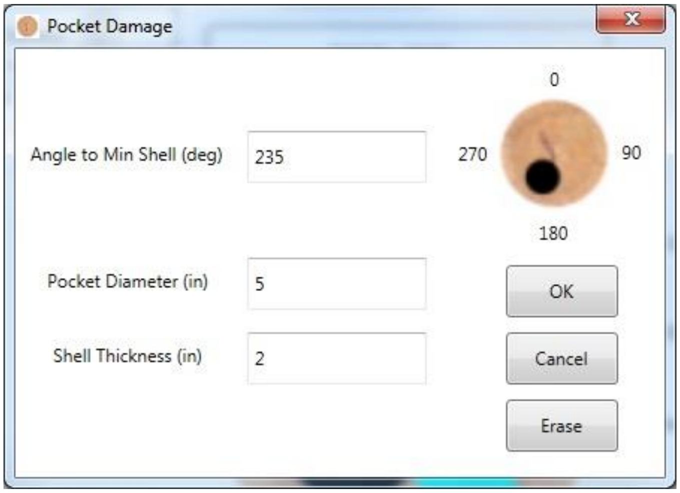
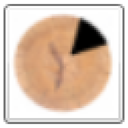


Figure 4-3. Pocket Damage Parameters



Misc. Damage – Wedge

To describe “Wedge” damage, input the angle (degrees) of the damage relative to the line direction, as well as the circumferential extent (inches) or radial depth (inches) of the damage (Figure 4-4).

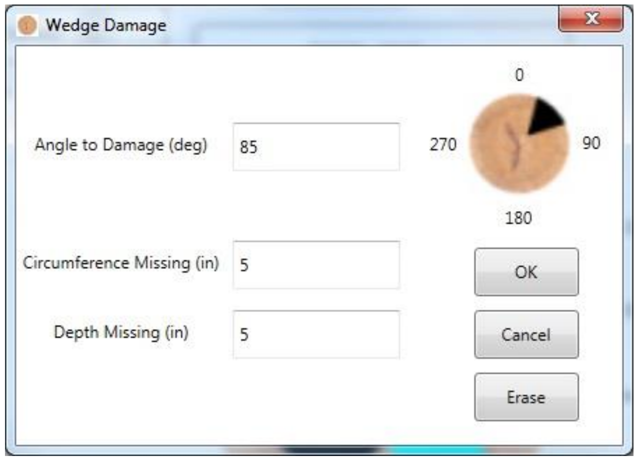
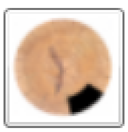


Figure 4-4. Misc. Damage - Wedge Parameters



Misc. Damage – Section

Three items must be input to describe “Section” damage: the angle (degrees) of damage relative to the line direction; the radial depth (inches) of the damage; and the circumferential extent (inches) of the damage (Figure 4-5).

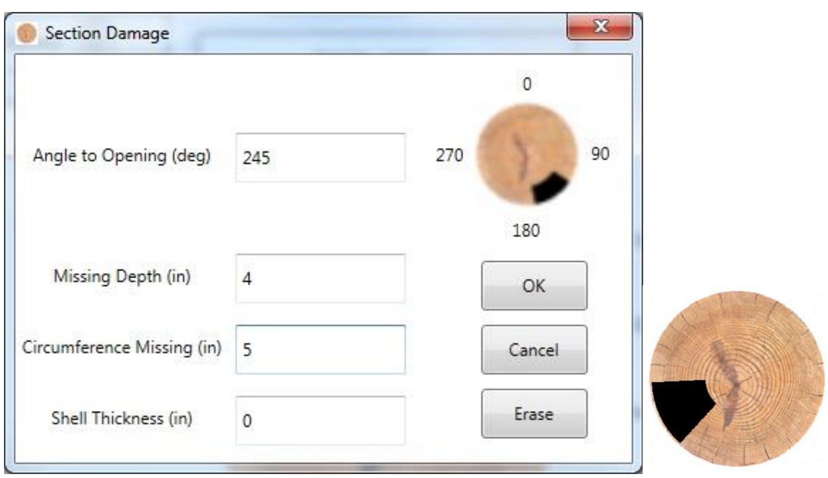


Figure 4-5. Misc. Damage - Section Parameters

Note: The *Misc. Damage – Section* damage type can be used with a non-zero shell thickness, in other words, a wedge under the surface. This could be used to model the effects of a wedge-shaped interior rot, or something similar, where the Pocket Damage type does not sufficiently describe the shape. Do do this, input a non-zero Shell Thickness, a Missing Depth greater than the Shell Thickness, and any Circumference. See Figure 4-6 below.

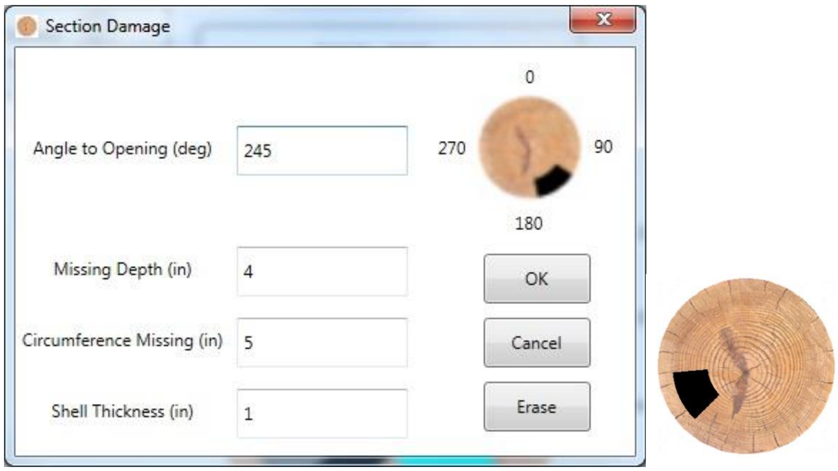
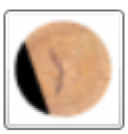


Figure 4-6. Example of Non-Zero Shell Thickness for Misc. Damage - Section



Misc. Damage – Slice

To describe "Slice" damage, the angle (degrees) of the damage relative to the line direction and the width *or* maximum radial depth (inches) of the damage must be input (Figure 4-7).

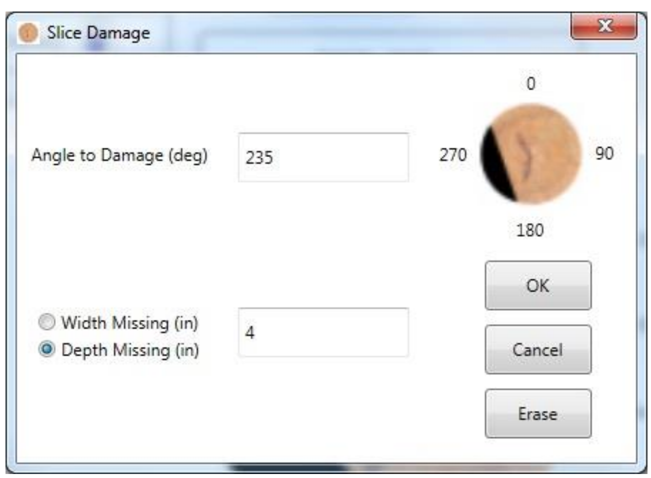
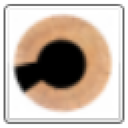


Figure 4-7. Misc. Damage - Slice Parameters



Woodpecker Cavity

To describe a woodpecker cavity, the angle (degrees) of the opening relative to the line direction; the circumference (inches) missing at the opening; the shell thickness (inches) at the opening; and the inner nest diameter (inches) must be input (Figure 4-8).

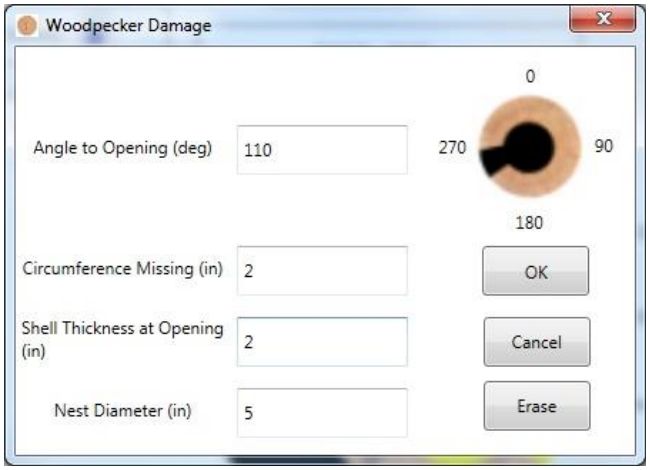
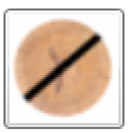


Figure 4-8. Woodpecker Nest Parameters



Bolt Hole

To describe a bolt hole, the angle (degrees) of the hole relative to the line direction and the diameter of the hole (inches) must be input (Figure 4-9).

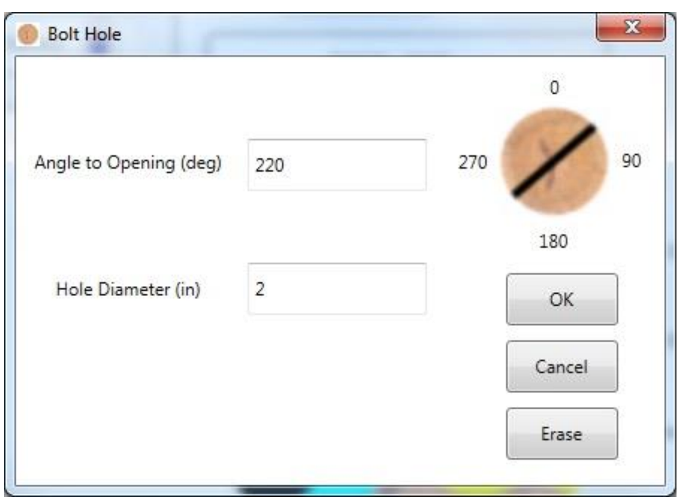


Figure 4-9. Bolt Hole Parameters

5
ANALYZE & RESULTS

The “Analyze” button enables you to evaluate the loss of section modulus due to the pole damage and to select similar analyses to determine cross-sectional area and moment of inertia reductions.

After entering the pole measurements, ANSI classification and damage type(s) for one or more levels, click the **Analyze** button to evaluate the damage and view results. If, in addition to entering the actual field-measured dimensions of the pole, you entered a description of the pole using ANSI O5.1 dimensions, the results of a comparison of the damaged pole to an undamaged ANSI O5.1 minimum dimension pole will also be displayed.

Note: Shell Damage and Heart Damage are evaluated with 100% accuracy using closed form solutions. The other types of damage are evaluated using numerical integration techniques that are typically accurate to within ±3% of the true value. The accuracy of these techniques will decrease slightly when severe pole damage causes a reduction of 70% or more in the section modulus, moment of inertia, or area

The analytical formulae for the in-line and transverse Moments of Inertia and Section Moduli are:

$I_i, I_t = \pi d^4/64$

$S_i, S_t = \pi d^3/32$

When viewing the Results window, you can click through three different tabs and view results for each level of damage:

- **Percent Remaining** of Section Modulus, Moment of Inertia, and Area (Figure 5-1)
- **Actual Values** of Section Modulus, Moment of Inertia, and Area (Figure 5-2)
- **Percent Strength** remaining for Section Modulus, and remaining strength in psi (Figure 5-3)

The strength equivalency function allows D-Calc 4 to calculate an equivalent material strength for the damaged pole based on an input strength. D-Calc™ estimates the reduced strength values by multiplying the strength you input by the percentage of remaining section modulus or area of the damaged pole, whichever you select. Results are displayed based on both the field-measured dimensions of the pole and damage, and a comparison of the damaged pole to an undamaged ANSI O5.1 minimum dimension pole (if the ANSI O5.1 information was entered).

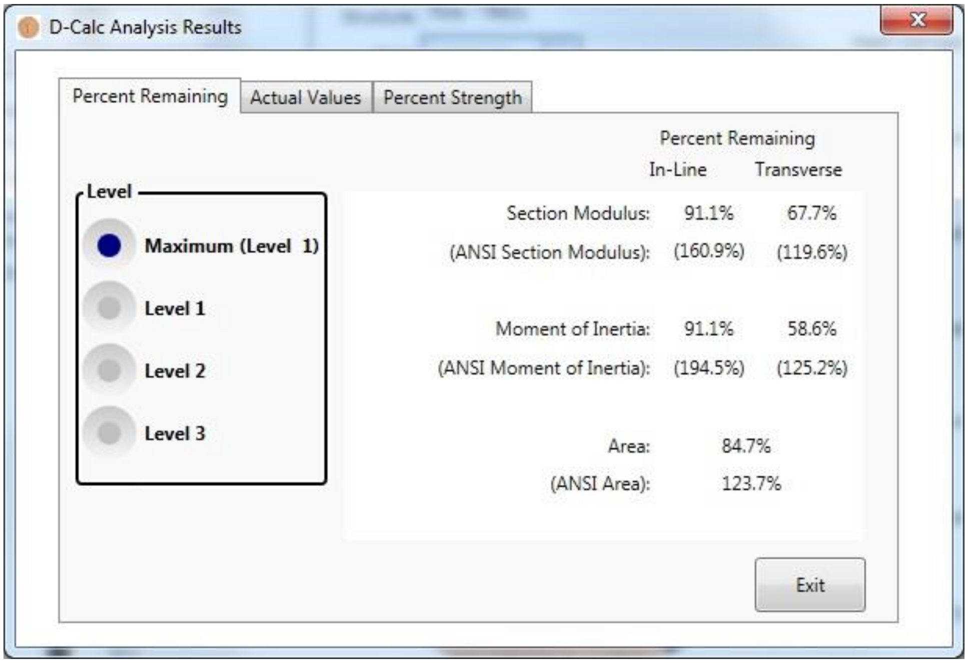


Figure 5-1. Example of "Percent Remaining" Tab in Results Window

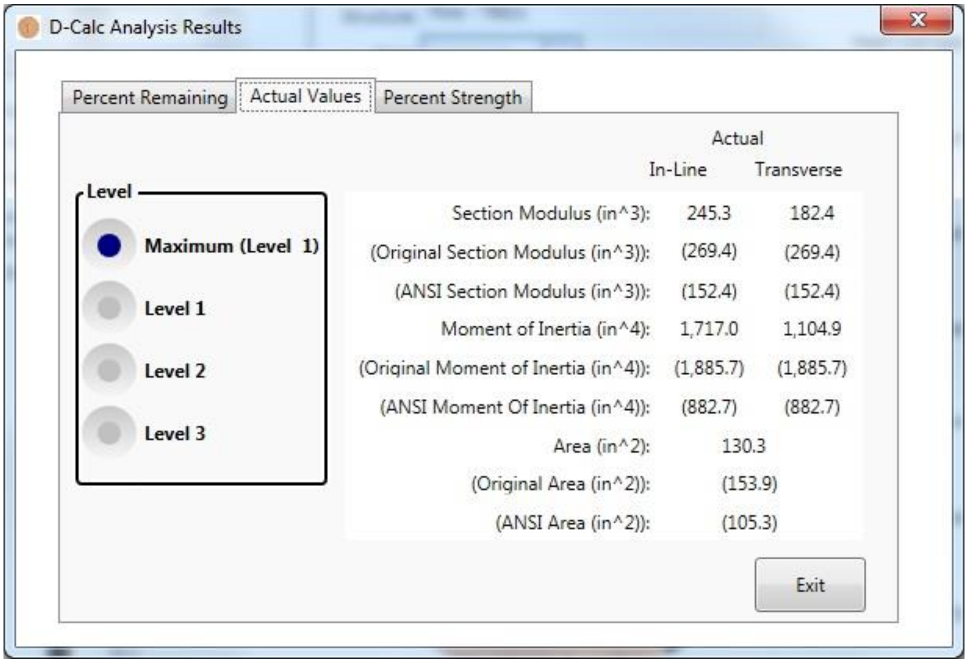


Figure 5-2. Example of "Actual Values" Tab in Results Window

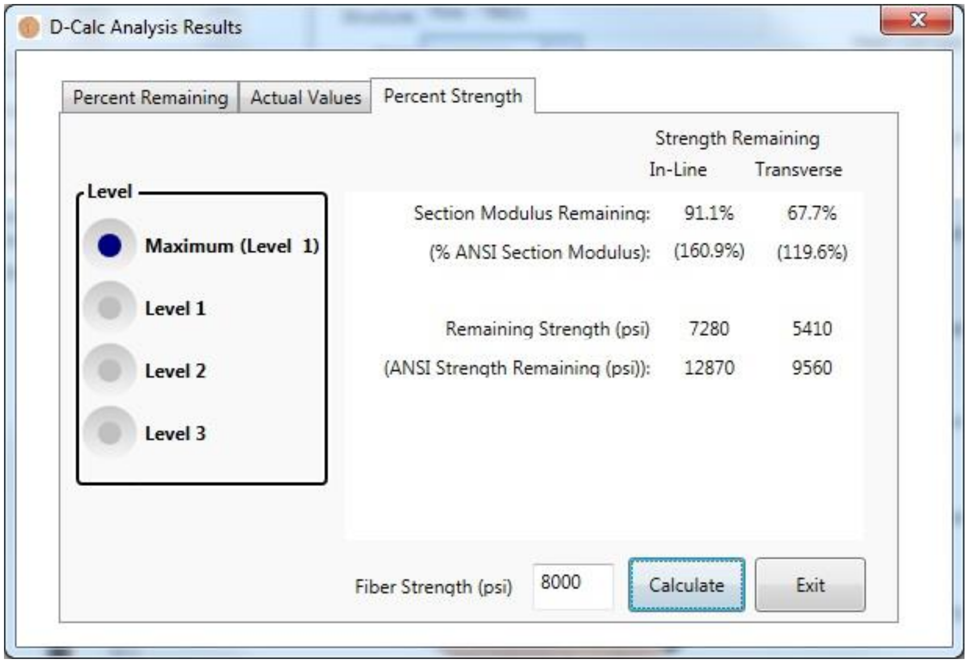


Figure 5-3. Example of "Percent Strength" Tab in Results Window

Note that D-Calc 4 allows you to calculate an equivalent material strength (in psi) for the damaged pole based on an input strength.

After analyzing the results, the results may be printed. The print dialog is shown in Figure 5-4.

D-Calc V4.0 (TM)

EDM International, Inc.

Pole: Pole - T6612

Job: Inspect 235 wood poles on the west side of Fort Collins

Record damage areas of each pole - no treatment

Level: 1

Date: 6/26/2015

Project: The damage assessment project is being funded by the city

The work will run from the Spring of 2015 through the Fall of 2016

The next phase will address remediation and pole replacement

ANSI

Species: Douglas - Fir

Class: 1

Length: 70

Selected Diameter: 12.73237

Selected Circumference: 40.00

Distance from Groundline: 35

ANSI Diameter: 11.64

Selected Bending Strength: 0

Damage Information

Damage 1
- Woodpecker Cavity
- Angle to Damage = 180 degrees
- Opening Diameter = 2.0 in.
- Nest Diameter = 4.0 in.
- Shell Thickness = 1.0 in.

Damage 2
- Pocket Damage
- Angle to Damage = 250 degrees
- Pocket Diameter = 4.0 in.
- Shell Thickness = 1.0 in.

Damage 3
- Miscellaneous Damage - Section
- Angle to Damage = 15 degrees
- Depth Missing = 3.0 in.
- Circumference Missing = 4.0 in.
- Shell Thickness = 1.0 in.

Damage 4
- Miscellaneous Damage - Wedge
- Angle to Damage = 118 degrees
- Width Missing = 5.0 in.
- Depth Missing = 6.0 in.

Results for Level 1

	In-Line	Transverse
Selected Section Modulus (in^3)	202.6	202.6
Remaining Section Modulus (in^3)	112.3	133.4
Percent Remaining	55%	66%
Equivalent Binding Strength (psi)	0	0
Selected Moment of Inertia (in^4)	1,290.1	1,290.05
Remaining Moment of Inertia (in^4)	807.8	885.7
Percent Remaining	62.62%	68.66%
Selected Area (in^2)	127.32	127.32
Remaining Area (in^2)	80.29	80.29
PercentRemaining	63.06%	63.06%

ANSI Results

	In-Line	Transverse
ANSI Section Modulus (in^3)	154.8	154.8
Percent of ANSI Remaining	72.53%	86.14%
ANSI Moment of Inertia (in^4)	901.1	901.1
Percent of ANSI Remaining	12.46%	98.29%
ANSI Area (in^2)	0.01	0.01
Percent of ANSI Remaining	51.86%	51.86%

Figure 5-4. Example of "Sample Print Page"

6
DATABASE STRUCTURE

D-Calc uses Microsoft SQL Server Compact Edition (CE) databases. A D-Calc 4 database contains the following tables:

- ANSI Class
- ANSI Length
- ANSI Species
- Defect Record
- LevelData
- Defect Data

The D-Calc databases may be viewed with CompactView - the installer may be found on the D-Calc installation CD. The latest version of CompactView may also be downloaded from the SourceForge website: http://sourceforge.net/projects/compactview/.

The ANSI Class data is shown in Figure 6-1.

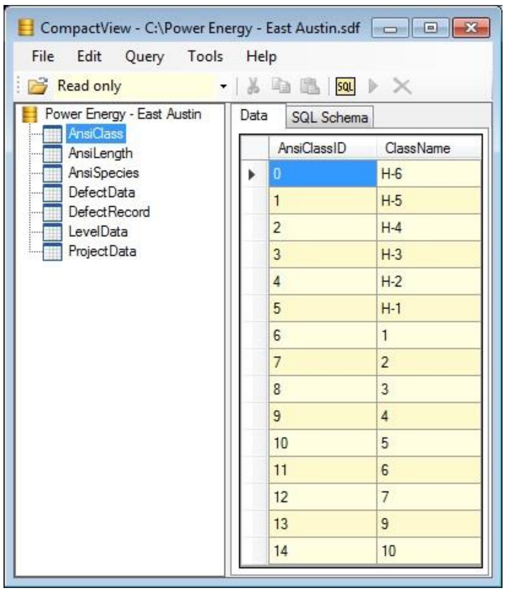
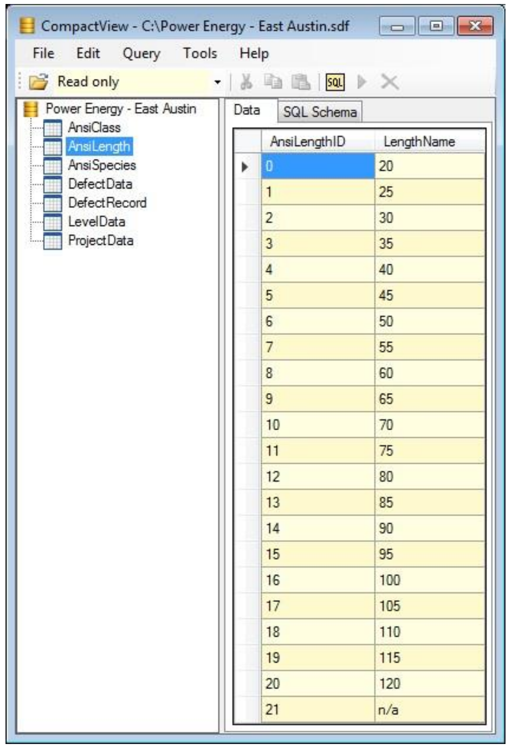


Figure 6-1. ANSI Class Data

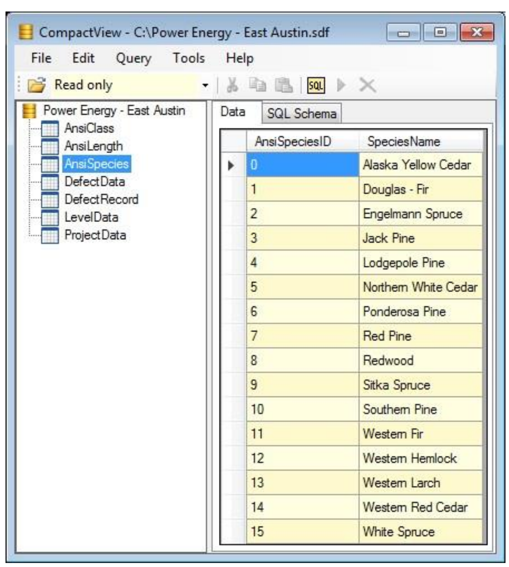
The ANSI Length data is shown in Figure 6.2



AnsiLengthID	LengthName
0	20
1	25
2	30
3	35
4	40
5	45
6	50
7	55
8	60
9	65
10	70
11	75
12	80
13	85
14	90
15	95
16	100
17	105
18	110
19	115
20	120
21	n/a

Figure 6-2. ANSI Length Data

The ANSI Length data is shown in Figure 6-3



AnsiSpeciesID	SpeciesName
0	Alaska Yellow Cedar
1	Douglas - Fir
2	Engelmann Spruce
3	Jack Pine
4	Lodgepole Pine
5	Northern White Cedar
6	Ponderosa Pine
7	Red Pine
8	Redwood
9	Sitka Spruce
10	Southern Pine
11	Western Fir
12	Western Hemlock
13	Western Larch
14	Western Red Cedar
15	White Spruce

Figure 6-3. ANSI Species Data

A PoleData record exists for each Pole. The contents of the PoleData record is shown in Figure 6-4.

Column	Data Type
PoleDataID	**GUID – Primary Key**
AnsiSpeciesID	INT - AnsiSpeciesTable
AnsiClassID	INT – AnsiClassTable
AnsiLengthID	INT - AnsiLengthTable
IsAnsiTaper	BIT
IsAnsiEmbedment	BIT
UserEmbedValue	FLOAT
FiberStrength	FLOAT
StructureName	NVARCHAR(25)
DcalcDate	DATETIME

Figure 6-4. Contents of PoleData Record

For each PoleData record, there exists three (3) LevelData records. Each LevelData record corresponds to a damage level. The contents of the LevelData record is shown in Figure 6-5

Column	Data Type
LevelDataID	GUID – Primary Key
PoleDiameter	FLOAT
AnsiDiameter	FLOAT
DamageHeight	FLOAT
SectionModulusX	FLOAT
SectionModuludY	FLOAT
MomentInertiaX	FLOAT
MomentInertiaY	FLOAT
Area	FLOAT
PctSectionModulusX	FLOAT
PctSectionModulusY	FLOAT
PctMomentInertiaX	FLOAT
PctMomentInertiaY	FLOAT
PctArea	FLOAT
DefectLevel	INT
NumberDefects	INT
ImagePath	NVARCHAR(200)
PoleDataID	GUID – Foreign Key

Figure 6-5. Contents of LevelData Record

For each LevelData record, there exists sixty (60) DefectData records describing the graphics data for all three (3) levels of a pole. Each DefectData record corresponds to a damage level. K (0-2) represents the defect level. I (0-3) represents the defect. J (0-4) represents a graphics parameter (see appendix 2). The contents of the DefectData record is shown in Figure 6-6.

Column	Data Type
DefectDataID	GUID – Primary Key
i	INT
J	INT
k	INT
Value	FLOAT
LevelDataID	GUID – Foreign Key
UserEmbedValue	FLOAT
FiberStrength	FLOAT
StructureName	NVARCHAR(25)
DcalcDate	DATETIME

Figure 6-6. Contents of DefectData Record

The ProjectData record contains project data information for all poles in the database. See Figure 6-7.

Column	Data Type
Version	NVARCHAR(25)
ProjectTitle1	NVARCHAR(100)
ProjectTitle2	NVARCHAR(100)
ProjectTitle3	NVARCHAR(100)
JobTitle1	NVARCHAR(100)
JobTitle2	NVARCHAR(100)
OwnerCompany	NVARCHAR(100)
InspectionCompany	NVARCHAR(100)
ProjectStartDate	DateTime
IsEnglish	BIT

Figure 6-7. Contents of ProjectData Record

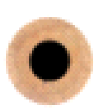
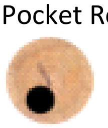
7
APPENDIX

D-Calc 4 uses Microsoft SQL Server Compact Edition (CE) database. The table shown in Figure 7-1 lists the required parameters for each defect

Damage Type	Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5
Shell Damage	1	Shell Thickness	--	--	--
Heart Damage	2	Shell Thickness	--	--	--
Pocket Damage	3	Angle to Minimum Shell	Pocket Diameter	Shell Thickness	--
Misc. Damage -Wedge	4)	Angle to Damage	Circumference Missing	Depth Missing	--
Misc. Damage - Section	5	Angle to Opening	Missing Depth	Circumference Missing	Shell Thickness
Misc. Damage - Slice	6	Angle to Damage	1: Depth Missing 2: Width Missing	Width Missing or Depth Missing	--
Bolt Hole	7	Angle to Opening	Hole Diameter	--	--
Woodpecker Cavity	8	Angle to Opening	Circumference Missing	Shell Thickness at Opening	Nest Diameter

Figure 7-1. Defect Parameters

The Damage Types and Measurement Parameters are shown in Figure 7-2

Damage Type	D-Calc Measurement Parameters
Heart Rot 	• Pole Diameter (or Circumference) • Shell Thickness
Shell Rot 	• Pole Diameter (or Circumference) • Depth of Damage
Pocket Rot 	• Pole Diameter (or Circumference) • Angle to Minimum Shell • Pocket Diameter • Shell Thickness

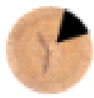
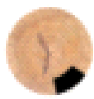
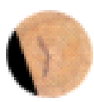
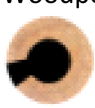
Wedge 	• Pole Diameter (or Circumference) • Angle to Damage • Circumference Missing • Depth Missing
Section 	• Pole Diameter (or Circumference) • Angle to Opening • Missing Depth • Circumference Missing • Shell Thickness (may be 0)
Slice 	• Pole Diameter (or Circumference) • Angle to Damage • Circumference or Depth Missing
Woodpecker 	• Pole Diameter (or Circumference) • Angle to Opening • Circumference Missing • Shell Thickness at Opening • Nest Diameter
Bolt Hole 	• Pole Diameter (or Circumference) • Angle to Opening • Hole Diameter

Figure 7-2 Defect Types and Measurement Parameters