

OptiDAT

- database reference document -

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TC

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revision 1	June 27, 2005	17	updated with new functionalities of OptiDAT: progress monitoring, optidat toolbar
revision 2	December 15 th , 2005	19	general update. Added note on documentation and extra progress sheets
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Introduction

OptiDAT started out as the project database for the OPTIMAT BLADES project, which was carried out between March 2002 and May 2006. The objective of the OPTIMAT project is, to investigate a multitude of phenomena that possibly lead to degradation of material properties for wind turbine composites. The OPTIMAT research results are consolidated as degradation models and design rules.

During a subsequent wind turbine research programme, UPWIND, some of the OPTIMAT research was expanded in UPWIND Work Package 3. OptiDAT is augmented with these data.

This report is a reference document, which describes the lay-out of this database, and provides guidance to users of OptiDAT, and to test labs inputting data.

Both OptiDAT and this reference document are working documents during the OPTIMAT and UPWIND projects, and therefore are subject to continuous modifications.

Comments/questions/suggested modifications, etc, can be directed to r.p.l.nijssen@kc-wmc.nl.



Previous wind turbine rotor blade materials databases

The following brief description of both databases does not do the effort that was put into producing them any justice, but it is necessary in order to understand the lay-out of OptiDAT.

Besides OptiDAT, there are two other public databases containing test results from various tests on wind turbine rotor blade composites. These are the database 'FACT', and the DOE/MSU (published by the Department of Energy, tests performed by Montana State University's Composite Group). The latest version of FACT was published around 1995, the DOE/MSU database is updated annually. Some data in FACT were taken from literature research, and as a result there is some overlap between the two databases.

At first glance, the databases differ in the information density: FACT has most of the (meta-)data in the database itself, whereas DOE/MSU comes with a detailed test report and only displays the most important test parameters in the database. Therefore, the format of the FACT database lends itself better for basic 'data-mining' operations. This is also facilitated by the publication of FACT as an Excel-type datafile, with each datapoint represented by a row, and selected properties or test parameter listed in columns. The DOE/MSU database is published as a .pdf of a word-perfect document, where changes in test parameters are given serially, i.e. a heading is given for each set of data describing the test parameters, and limited parameters are given per test in the following set of tests. These differences in format can be partly overcome by the currently available powerful format conversions, but FACT can be most easily used in a spreadsheet.

For those interested in a consistent, detailed description of one type of material, The DOE/MSU is more attractive than the FACT database because it contains more records (i.e. more tests), on basically the same material, with very little variation in specimen geometry. All tests were prepared and carried out in the same laboratory (mostly even by the same person). Thus its contents are much more intraconsistent than the contents of the FACT database. Those who are interested in how a similar material behaves when tested in different laboratories, under different conditions and using different test standards, would therefore find more use in the FACT database. But as was stated in the previous paragraph, outside the database it is hard to retrieve the exact testing conditions, since there is little reference to test reports. Also, the FACT database is confined to the raw data, whereas data in the DOE/MSU database is analysed in several (mostly MSU-) publications.

OptiDAT general format

OptiDAT was made in MS EXCEL. The reasons for this are:

- Compatibility
- Visualisation of results
- History

The database is made public, and this spreadsheet-format ensures maximum compatibility with most operating systems used by potential users of the database.

The EXCEL software package has standard charting facilities that are not included in dedicated database software, such as MS Access.

The historical reason is: the FACT database was the last previous European Community-funded wind turbine material database, and it was decided to integrate FACT into OptiDAT, so that the data would be available for comparison with the new data from OPTIMAT (FACT was not actively made available via the Internet since its publication). As mentioned earlier, FACT was presented as a spreadsheet.



After opening the database OPTIDAT.xls, the user is presented with several 'worksheets' containing different information. The main worksheet is 'Database', which contains the main part of the information collected in OPTIMAT. There are several auxiliary worksheets with information on specimen geometry, delivery, plate characteristics, etc. An important sheet is 'Major Changes', which basically describes the history of the document as it evolved, with addition of data and changes in lay-out or numbering system.

Description of the sheets in OptiDat

Version

During opening of the spreadsheet, an opening screen is briefly displayed, showing the version number (indicated by publication date). The publication data is also included in the top left of sheet 'Database'. Typically, a new version was uploaded as new data became available, or for other major modifications. During the OPTIMAT project, some 50 updates were issued since September 2002, see '**Error! Reference source not found.**'.

The different sheets are described below. Emphasis is on the main sheet, 'Database'.

Introduction

Linked list of all database contributors and project (OPTIMAT and UPWIND) participants.

Instructions

Brief instructions for use.

Database

The FACT database has determined the format of OptiDAT to a great extent. This is clear from the fact, that each test is represented by a row in OptiDAT and the test characteristics, material properties, measurement equipment used etc., are given in columns. Each test can be identified by its "OPTIMAT NAME", which is a unique name which is different for each specimen tested in the course of the OPTIMAT project. A description of the naming system is given in the chapter 'OPTIMAT name', and also in the worksheet 'OPTIMAT name'. In addition, a sequential number was given to each test that entered OptiDAT. On a few occasions, these numbers have changed, e.g. through elimination of identical coupon names. At the end of the project, the numbers were fixed. However, it is wisest to use the OPTIMAT name as a unique identifier. The sequential number can be used for sorting purposes (e.g. to get the data in the same order as the order in which it was downloaded).

Most of the data will be retrieved from this worksheet, see 'Retrieving data from OptiDat' for tips on working with the database.

In previous versions of OptiDAT, the FACT database was appended to this worksheet. As the database grew, the FACT database was moved to a separate sheet, which is now the rightmost worksheet in the excel workbook.

Example plot1 & Example data for plot1

Example data, generated by the Plot tool (see Use of 'Plot tool').

Geometries (graphically & list)

To facilitate interpretation, the geometries listed in the following sheet are also shown as drawings, with dimensions and, where appropriate, frames of reference.



The codes for all the different geometries that were used in the project are listed in 'list' with a brief description.

Laminates

There are two sheets that describe the laminates used in OPTIMAT. 'Laminates' gives a general description of the standard laminates used in the project. 'Plates' gives a more detailed description of the plates used in the project. For this sheet, the results from LM's plate analysis is used [1].

OPTIMAT name

This worksheet contains a brief description and example of the OPTIMAT naming system, which is used to uniquely identify each record.

Test types

A brief description per test type, as mentioned in the column 'Test type' in the database.

Equipment

This sheet describes some of the equipment, such as hydraulic test frames, measurement equipment, relevant to the test programmes within OPTIMAT.

FACT database

This is the database FACT as published earlier [2]. It is the rightmost sheet of the workbook.

Retrieving data from OptiDat

FACT is a very descriptive database, and to accommodate for detailed information on the OPTIMAT tests, some more columns had to be added in the course of the project. Already early in the project, this led to a very large amount of columns in the database (ca. 100), which does not facilitate easy analysis of the data. A more detailed description of the sheet 'Database' is given below, and some 'Tips & Tricks' for retrieving data are given. Most of these are also described in the help-file that is included in EXCEL.

It is recommended, that the reader has a working version of OptiDAT opened as an EXCEL document, with macro's enabled.

The characteristics of the test, given in the database columns, are grouped. There are a few distinct groups. The leftmost columns describe the specimen: its OPTIMAT name, which plate it was cut from, the material, the lay-up, its geometry and dimensions. Some of these characteristics are coded, such as the material and specimen shape. In the other sheets in the database, more information on the meaning of these codes is found. Previously, hyperlinks provided fast access to these sheets, but they were found to be confusing and were therefore abolished.

More to the right, the most important test conditions and results are listed: which part of the programme the test belonged to, the test date, -type, maximum stress and strain, no. of cycles to failure, test speeds, machine used. In the leftmost columns additional information is given: measurement equipment used, gripping force/pressure, remarks, and a reference to the relevant test report.

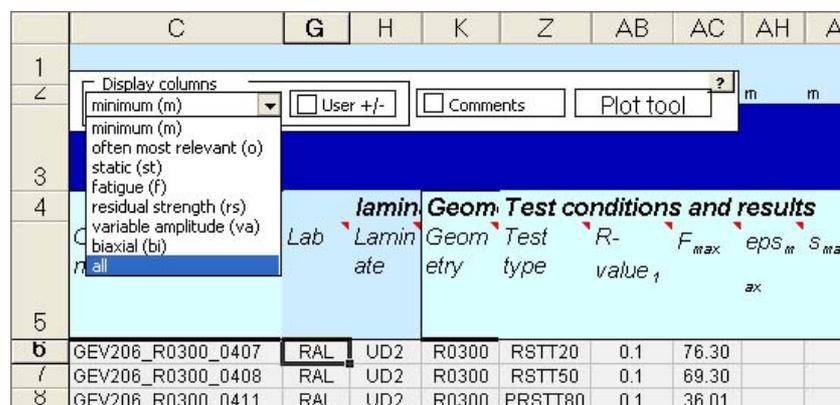
Documentation

Numerous reports have been produced on sub-sets of data in OptiDAT, and can be downloaded from the website. In the column 'Reference', relevant reports are mentioned for the respective records.

For standard OB specimens, some of the most relevant data has been extracted and summarised in [4].

The OptiDAT toolbar

Buttons were included which give access to some basic functions, such as the plot tool, hiding/unhiding comments and columns. The buttons are grouped in a box that 'floats' atop the worksheet.



	C	G	H	K	Z	AB	AC	AH	A
1	Display columns								
2	minimum (m)	<input type="checkbox"/> User +/-	<input type="checkbox"/> Comments	Plot tool		m	m		
3	minimum (m)								
4	often most relevant (o)								
5	static (st)								
6	Fatigue (f)								
7	residual strength (rs)								
8	variable amplitude (va)								
9	biaxial (bi)								
10	all								
11									
12									
13									
14									
15									
16	GEV206_R0300_0407	RAL	UD2	R0300	RSTT20	0.1	76.30		
17	GEV206_R0300_0408	RAL	UD2	R0300	RSTT50	0.1	69.30		
18	GEV206_R0300_0411	RAL	UD2	R0300	PRSTT80	0.1	36.01		

Figure 1: Buttons in OptiDAT

Limit number of visible columns

To display only the most 'common' information about tests (in practice this is: type of test, maximum strain, number of cycles), select 'minimum' or 'often most relevant' from the pull-down



menu. Only the most 'interesting' characteristics are shown. Select 'all' to show all columns. Other selections also lead to a filtering of the database, showing only static tests, fatigue tests (CA), residual strength, etcetera. The settings can be overruled by including a 'h' or 'u' for 'hide' and 'unhide' in row two, and checking the 'User +/-' box.

Read column header comments

Many of the headings in the database are equipped with comments, that display additional information about the column. A single comment can be made visible by right clicking the cell and selecting 'Show comment'. All comments can be made visible or hidden at once by checking/unchecking 'Comments'.

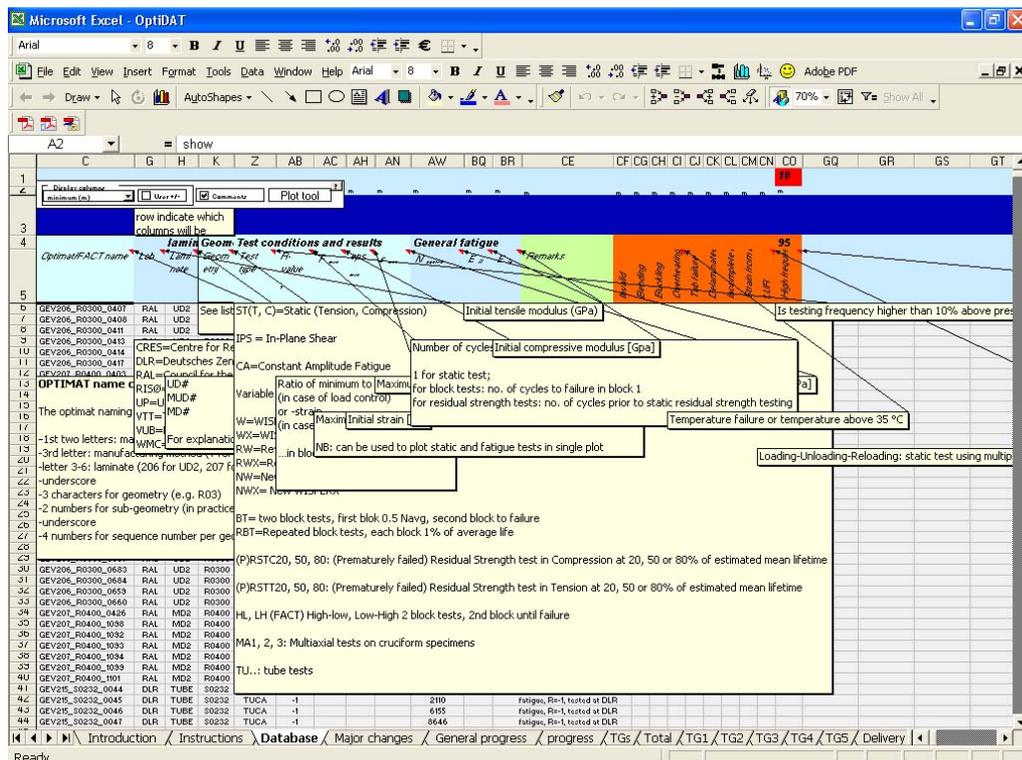


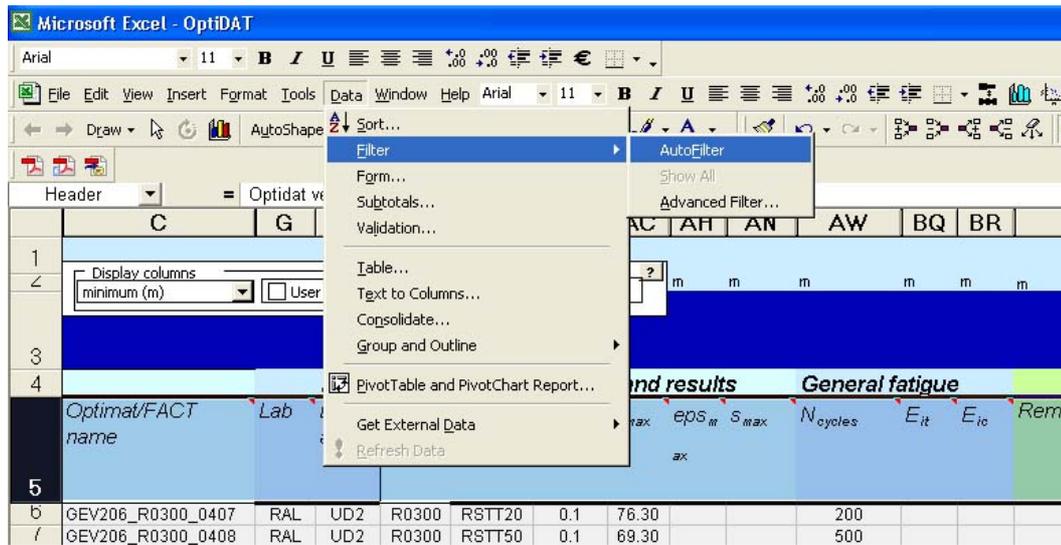
Figure 2: Making all the header comments visible

Sort data

Data can be sorted (in ascending or descending order), to group data according to up to three criteria. Use 'Data'-->'Sort', and make appropriate selections.

Use of 'Autofilter'

The 'Autofilter' function can be used for showing limited sets of data that match certain criteria. Select 'Data'-->'Autofilter' to access this EXCEL functionality. The row containing the column headers must be selected for autofiltering to work properly!



Optimat/FACT name	Lab	Lamin ate	Geom etry	Test type	R-value	F _{max}	eps _m	s _{max}
GEV206_R0300_0407	RAL	UD2	R0300	RS	(All)	76.30		
GEV206_R0300_0408	RAL	UD2	R0300	RS	(Top 10...)	69.30		
GEV206_R0300_0411	RAL	UD2	R0300	PRS	(Custom...)	36.01		
GEV206_R0300_0413	RAL	UD2	R0300	RS	-2.5	69.70		
GEV206_R0300_0414	RAL	UD2	R0300	PRS	-0.4	26.62		
GEV206_R0300_0417	RAL	UD2	R0300	RS	0.1	51.00		
GEV207_R0400_0403	RAL	MD2	R0400	RS	0.4	-86.20		
GEV207_R0400_0406	RAL	MD2	R0400	RS	0.5	81.20		
GEV207_R0400_0407	RAL	MD2	R0400	RS	2.0			
GEV207_R0400_0412	RAL	MD2	R0400	RS	8.7			
GEV207_R0400_0413	RAL	MD2	R0400	RS	10	-83.50		
GEV207_R0400_0414	RAL	MD2	R0400	PRS	90	39.25		
GEV207_R0400_0414	RAL	MD2	R0400	PRS	(blanks)	39.15		
GEV207_R0400_0416	RAL	MD2	R0400	PRSTT80	(NonBlanks)	39.12		
GEV207_R0400_0417	RAL	MD2	R0400	RSTT20	-1	77.60		
GEV207_R0400_0418	RAL	MD2	R0400	RSTT80	-1	58.90		

Figure 3: Autofiltering data

Use of 'Plot tool'

A built-in tool is available in OptiDat to quickly plot S-N data for use in reports: The 'Plot tool'.

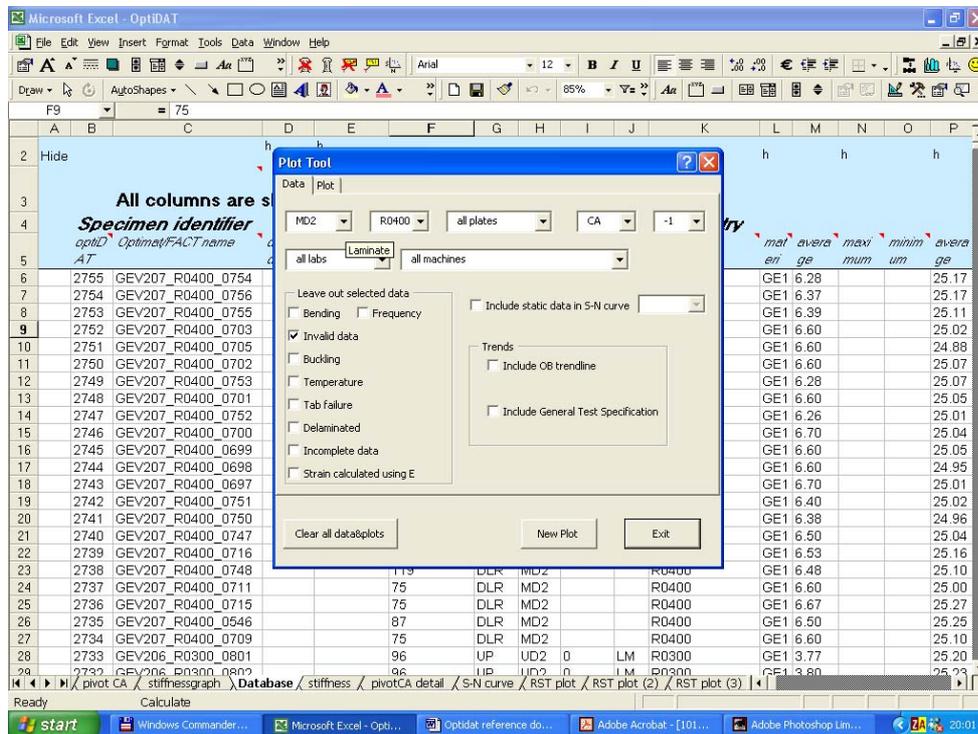


Figure 4: The 'Plot tool'

The plot tool has two pages. On the first page, the Laminate, geometry, R-ratio, test lab, test machine can be chosen for fatigue data. Also, data can be excluded if they have an 'x' in the columns that describe the validity of the data. In addition, a checkbox enables inclusion of the static data (a pull-down menu gives the option of which static data).

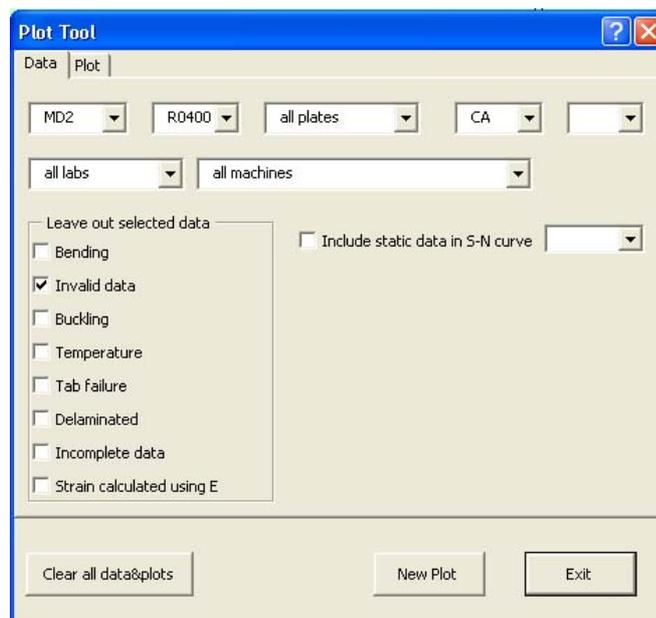


Figure 5: First page of plot tool

The second page enables the user to define axis range (possibility of autorange), what parameter to plot (s-max or e-max), provides the option of an alternative text on the axes. The plot tool generates a legend, the contents of which can be indicated in this second page.

Pressing 'New Plot' after choosing all parameters activates the automatic plot routine. A standard plot is drawn. The source data are given in a separate sheet, with a general report of the plot routine's input and output parameters.

Note that, when a record matches the criteria for the plot, but it lacks either s_max or e_max or no. of cycles to failure, the record is listed in this report as 'eliminated record'. This means, that the record should be properly completed for successful inclusion in the plot.

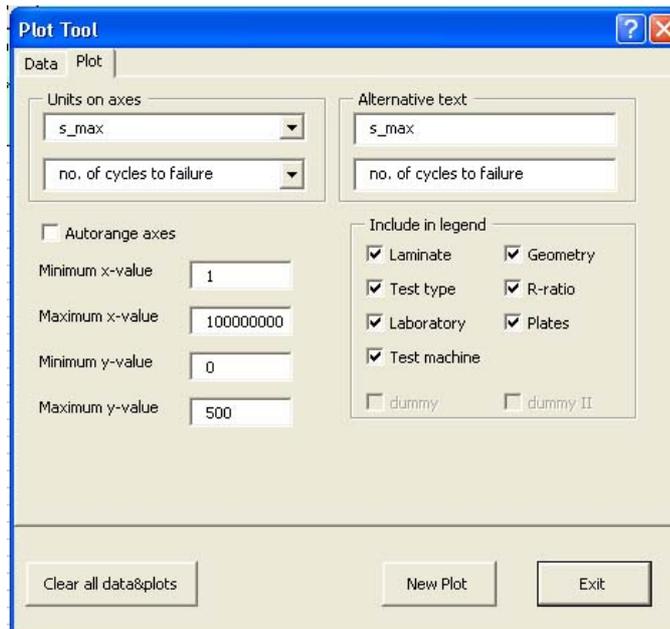


Figure 6: Second page of plot tool

Note, that the pull-down menus are generated at start-up of the tool, and it IS possible to choose combinations of parameters that do not correspond to any of the data in the database. In that case, a message will appear that no data are available. No graph is plotted or report sheet generated in this case.

See next page for an example plot and data sheet.

Multiple plots can be made in this way. They can be combined manually. Pressing 'Clear all data&plots' does exactly this, but it only deletes the sheets that are named 'plot#' and 'data for plot #'. If you want to keep a sheet, renaming the sheet should preserve it.

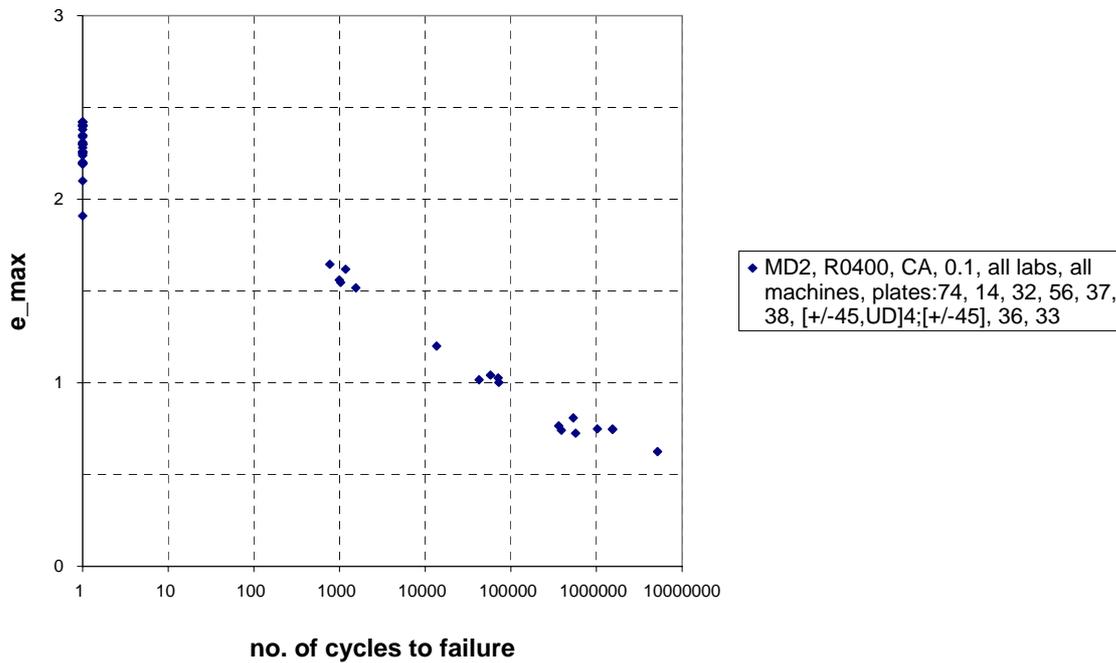


Figure 7: Example plot

File Edit View Insert Format Tools Data Window Help											
Draw AutoShapes											
A1 = plot 1, dataset 1											
A	B	C	D	E	F	G	H	I	J	K	
1	plot 1, dataset 1									Specimen identifier	laminate
2	Plot characteristics	MD2, R0400, CA, R=0.1, all labs, all machines, include ST: STT									
	Exclude data?	invalid: True, bending: False, buckling: False, temperature: True, tab failure: False, delaminated: True, strain calculated: False, incomplete data: False									
3	Plates	74, 14, 32, 56, 37, 38, [+/-45,UD]4:[+/-45], 36, 33									
4	Plot type	e_max vs no. of cycles to failure									
6	Autorange	TRUE									
7	Number of records	51									
	Records eliminated (no x or y value available)	GEV207_R0400_0645, GEV207_R0400_0646, GEV207_R0400_0647, GEV207_R0400_0648, GEV205_R0400_0078, GEV205_R0400_0074, GEV205_R0400_0064, GEV205_R0400_0058, GEV207_R0400_0145, GEV207_R0400_0144, GEV207_R0400_0143, GEV207_R0400_0142, GEV207_R0400_0141									
8					1568	GEV207_R0400_0641		74	VUB	MD2	
					1567	GEV207_R0400_0642		74	VUB	MD2	
					1566	GEV207_R0400_0643		74	VUB	MD2	
					1565	GEV207_R0400_0644		74	VUB	MD2	
					1200	GEV207_R GEV207		14	CRES	MD2	
8					1199	GEV207_R GEV207		14	CRES	MD2	
9					1198	GEV207_R GEV207		14	CRES	MD2	
	Legend	MD2, R0400, CA, 0.1, all labs, all machines, plates:74, 14, 32, 56, 37, 38, [+/-45,UD]4:[+/-45], 36, 33									
10					1197	GEV207_R GEV207		14	CRES	MD2	
11					1196	GEV207_R GEV207		14	CRES	MD2	
12					1062	GEV207_R0400_0123		32	DLR	MD2	
13					1061	GEV207_R0400_0294		56	DLR	MD2	
14					1060	GEV207_R0400_0130		32	DLR	MD2	
15					1059	GEV207_R0400_0119		32	DLR	MD2	
16					1058	GEV207_R0400_0126		32	DLR	MD2	
17					1057	GEV207_R0400_0296		56	DLR	MD2	
18					1056	GEV207_R0400_0121		32	DLR	MD2	

Figure 8: Example plot report



References

1. Hans Knudsen, 'Results of Lab. Test', OB_TC_R-16, doc. no. 10180_0, regular updates via website www.ecn.nl/optimat
2. De Smet, B.J., Bach, P.W., "DATABASE FACT", the Netherlands Energy Research Foundation, report nr. ECN-C--94-045, 1994
3. Hans Knudsen, 'Manufacture and Delivery of Specimens', OB_TC_R011, doc. no. 10122_26, regular updates via website www.ecn.nl/optimat
4. Nijssen, R., 'OptiDAT data summary – strength and life of standard OB specimens', OB_TG1_R022_002, doc. no. 10284
5. daniel samborsky, **personal communication on comparison of FACT and DOE/MSU (?)**



Appendix: OPTIMAT name

The OPTIMAT name is composed as shown in figure A-1:

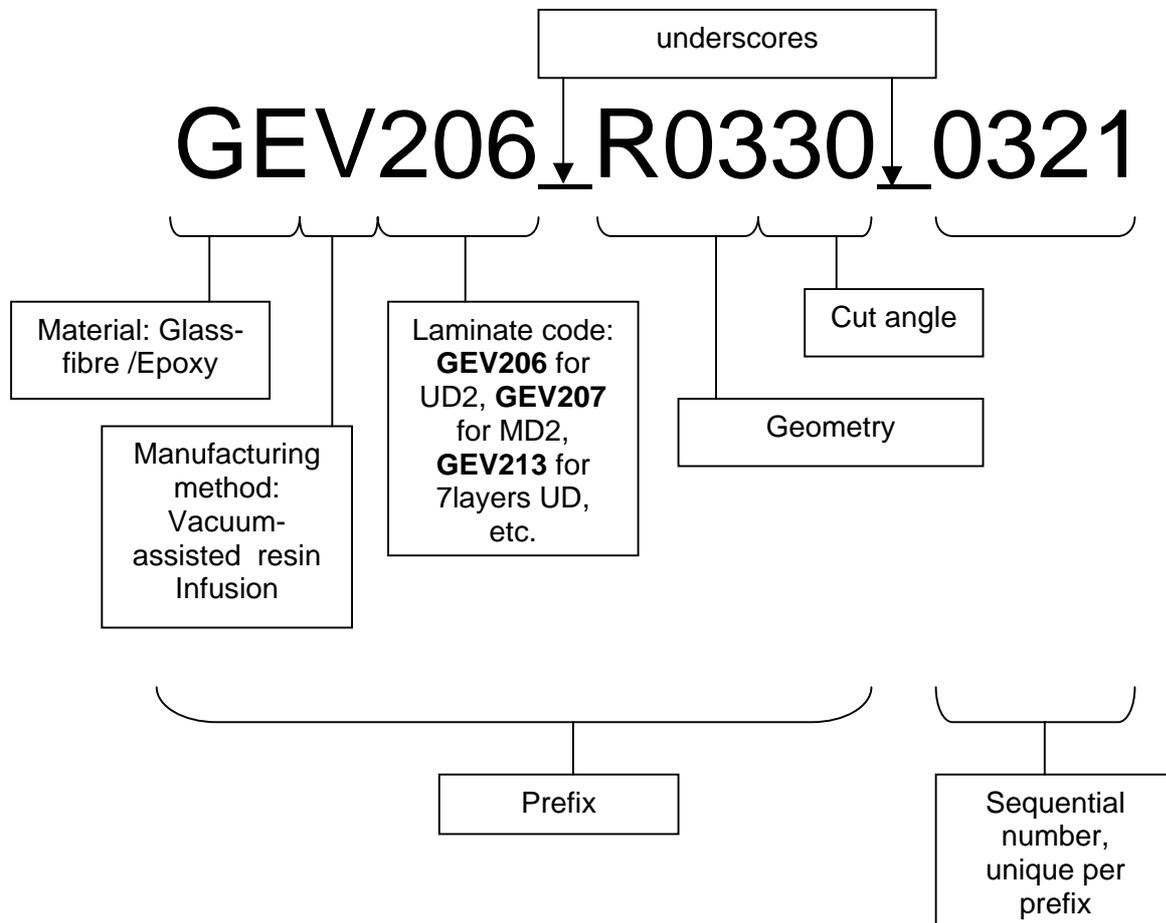


Figure A-1: The OPTIMAT naming system

Generally, this naming system allows for allocating a unique name to each specimen, which contains information about its laminate and geometry. A few important remarks on the naming system:

- ✓ In practice, most of the data from phase I in OPTIMAT start with GEV206 (for the standard UniDirectional material UD2), or GEV207 (standard MultiDirectional (MD2)).

---> Most specimen names start with GEV206 or GEV207

- ✓ Standard geometries were chosen following the preliminary tests, viz. R03 (for the standard UD2 specimen) and R04 (for the standard MD2 specimen).

---> Most specimen names start with GEV206_R03 or GEV207_R04.

There is a historical reason for this redundancy: initially, the combination '2##' was meant to represent year of plate manufacturing and plate number. However, it was found easier not to include plate number in the OPTIMAT name. This has to do with the fact that in the initial project definition it was planned to manufacture all specimens from a single large plate, but this was not feasible, so they were made from many small plates.



- ✓ The most frequently used cut-angle is 00 (0°). Other cut-angles are 90, 30, and 60. This is the angle with respect to the fibre direction in the UD layer.

-->Most specimen names start with GEV206_R0300, or GEV207_R0400

Originally, these two numbers were reserved for a 'subgeometry' code. However, this was found to be confusing, because sometimes a subgeometry would mean a different cut angle, and sometimes it would mean 'no tabs'. It was decided to process any non-cut-angle characteristics into either the geometry or, in some cases, into the sequential number.

Details on the (sub) geometry are also found in the sheets 'Geometry' in OptiDat.