Explanation of content gef-data files

1. Introduction

A GEF data file consists of a header and a data block. The header contains static information, i.e. information that does not change during a measurement. It contains information about the organization and structure of the data and the experiment. The data block contains dynamic information. An example of information in the header is the identification of the equipment used. An example of information in the data block is the pore pressure under the dolphin.

The header contains a variety of information. It is organized in keywords and parameters. A full description of the keywords and the accompanying parameters of a GEF header can be found on http://www.delftgeosystems.nl//EN/page6728.asp in the file GEF-Standard.pdf. The header definition will presented here in detail as it is. In a following chapter an explanation for some keywords will be given.

2. Measurement file

Section 2.1 defines the header of a measurement file.
Section 2.2 gives an explanation of the 'values' in the definition, which are given as generic information. A specific value is given.
Section 2.3 describes the data block.

2.1 Description header

Items written in italic are to be filled in in the actual test. They will be explained in section 2.2.

```
#GEFID= 1, 1, 0
#FILEOWNER= name of the operator
#FILEDATE= year, month, date
#PROJECTID= CO, 419370, 370
#COLUMN= 12
#COLUMNINFO= 1, s, Time, 102
#COLUMNINFO= 2, mm, DT plunger, 5001
#COLUMNINFO= 3, mm, DT moving mass, 5002
#COLUMNINFO= 4, mm, DT Horizontal, 5003
#COLUMNINFO= 5, mm, DT Oblique 1, 5004
#COLUMNINFO= 6, mm, DT Oblique 2, 5005
#COLUMNINFO= 7, kN, Load set-up, 1001
#COLUMNINFO= 8, kPa, Total stress, 3001+ n*10
#COLUMNINFO= 9, kPa, PPT 1, 2001 +n*10
#COLUMNINFO= 10, kPa, PPT 2, 2002 + n*10
#COLUMNINFO= 11, kPa, PPT 3, 2003 + n*10
#COLUMNINFO= 12, kPa, PPT 4, 2004 + n*10
#COLUMNINFO= 13, mbar, P kelder lo, 42009
#COLUMNINFO= 14, mbar, P kelder hi, 42010
#COLUMNINFO= 15, rpm, Toerental, 61001
#FILINGTEXT= 1. name, Original file name
#COMPANYID= GeoDelft, 8000.97.B.01, 31
#DATAFORMAT= BINAIR
```

```
#DATATYPE= REAL4
#MEASUREMENTCODE= Incheon, 1, type, 0, 419370-0042-v08-div_contents_data_file.doc
#MEASUREMENTVAR= 101, value, mm, Diameter dolphin
#MEASUREMENTVAR= 102, value, mm, Height of dolphin
#MEASUREMENTVAR= 103, value, kg, Mass of dolphin
#MEASUREMENTVAR= 104, value, kg, Mass of the moving mass
#MEASUREMENTVAR= 105, value, m/s, Objective velocity of the moving mass
#MEASUREMENTVAR= 106, value, mm, Objective displacement dolphin
#MEASUREMENTVAR= 501, value, m, Length of the rotor beam
#MEASUREMENTVAR= 502, value, m, Depth of the container
#MEASUREMENTVAR= 503, value, degrees, angle at which centrifuge container is fixated
#MEASUREMENTVAR= 504, value, m, Point of g-reference
#MEASUREMENTTEXT= 101, type of test, type of test
#MEASUREMENTTEXT= 102, stiffness, structure of the dolphin
#MEASUREMENTTEXT= 103, where, Height of applied force
#MEASUREMENTTEXT= 104, compaction, Type of fill
#MEASUREMENTTEXT= 105, operator, The name of the operator
#MEASUREMENTTEXT= 106, version, Version of measurement software
#MEASUREMENTTEXT= 107, objective, Objective of the test
#MEASUREMENTTEXT= 201, 102, Channel number HBM of column 1
#MEASUREMENTTEXT= 202, value, Channel number HBM of column 2
#MEASUREMENTTEXT= 203, value, Channel number HBM of column 3
#MEASUREMENTTEXT= 204, value, Channel number HBM of column 4
#MEASUREMENTTEXT= 205, value, Channel number HBM of column 5
#MEASUREMENTTEXT= 206, value, Channel number HBM of column 6
#MEASUREMENTTEXT= 207, value, Channel number HBM of column 7
#MEASUREMENTTEXT= 208, value, Channel number HBM of column 8
#MEASUREMENTTEXT= 209, value, Channel number HBM of column 9
#MEASUREMENTTEXT= 210, value, Channel number HBM of column 10
#MEASUREMENTTEXT= 211, value, Channel number HBM of column 11
#MEASUREMENTTEXT= 212, value, Channel number HBM of column 12
#MEASUREMENTTEXT= 501, location, Location of transducer with quantity number qn
#MEASUREMENTTEXT= 502, location, Location of transducer with quantity number qn
#MEASUREMENTTEXT= 503, location, Location of transducer with quantity number qn
#MEASUREMENTTEXT= 504, location, Location of transducer with quantity number qn
#MEASUREMENTTEXT= 505, location, Location of transducer with quantity number qn
#MEASUREMENTTEXT= 506, location, Location of transducer with quantity number qn
#MEASUREMENTTEXT= 507, location, Location of transducer with quantity number qn
#MEASUREMENTTEXT= 508, location, Location of transducer with quantity number qn
#MEASUREMENTTEXT= 509, location, Location of transducer with quantity number qn
#MEASUREMENTTEXT= 510, location, Location of transducer with quantity number qn
#MEASUREMENTTEXT= 520, location, Location of reference point S on base of dolphin
#MEASUREMENTTEXT= 521, location, Location of point Q in the pole on the dolphin
#MEASUREMENTTEXT= 551, location, Location of attachment point on frame for transducer Oblique 1 with quantity number qn
#MEASUREMENTTEXT= 552, location, Location of attachment point on dolphin for transducer Oblique 1 with quantity number qn
#MEASUREMENTTEXT= 553, location, Location of attachment point on frame for transducer Oblique 2 with quantity number qn
#MEASUREMENTTEXT= 554, location, Location of attachment point on dolphin for transducer Oblique 2 with quantity number qn
```

#MEASUREMENTTEXT= 751, *translation*, Translation vector between coordinate systems
#MEASUREMENTTEXT= 1001, *calibration*, Calibration of transducer with quantity number qn.
#MEASUREMENTTEXT= 1002, *calibration*, Calibration of transducer with quantity number qn.
#MEASUREMENTTEXT= 1003, *calibration*, Calibration of transducer with quantity number qn.
#MEASUREMENTTEXT= 1004, *calibration*, Calibration of transducer with quantity number qn.
#MEASUREMENTTEXT= 1005, *calibration*, Calibration of transducer with quantity number qn.
#MEASUREMENTTEXT= 1006, *calibration*, Calibration of transducer with quantity number qn.
#MEASUREMENTTEXT= 1007, *calibration*, Calibration of transducer with quantity number qn.
#MEASUREMENTTEXT= 1008, *calibration*, Calibration of transducer with quantity number qn.
#MEASUREMENTTEXT= 1009, *calibration*, Calibration of transducer with quantity number qn.
#MEASUREMENTTEXT= 1010, *calibration*, Calibration of transducer with quantity number qn.
#MEASUREMENTTEXT= 1011, *calibration*, Calibration of transducer with quantity number qn.
#MEASUREMENTTEXT= 1251, *Time;Remarks*, Log entry
#MEASUREMENTTEXT= 1252, *hh:mm; Remark in the log*, Log entry
#SPECIMENTEXT= 201, *brandname*, name of the sand used
#SPECIMENVAR= 101, *value*, -, porosity base soil
#SPECIMENVAR= 102, *value*, -, porosity top soil
#SPECIMENVAR= 103, *value*, -, porosity fill
#SPECIMENVAR= 104, *value*, -, void ratio base soil
#SPECIMENVAR= 105, *value*, -, void ratio top soil
#SPECIMENVAR= 106, *value*, -, void ratio fill
#SPECIMENVAR= 107, *value*, -, Dr(e) base soil
#SPECIMENVAR= 108, *value*, -, Dr (e) top soil
#SPECIMENVAR= 109, *value*, -, Dr (e) fill
#SPECIMENVAR= 201, *value*, -, minimum porosity sand
#SPECIMENVAR= 202, *value*, -, maximum porosity sand
#SPECIMENVAR= 203, *value*, -, minimum void ratio sand
#SPECIMENVAR= 204, *value*, -, maximum void ratio sand
#SPECIMENVAR= 205, *value*, kg/m^3, volumetric mass sand
#SPECIMENVAR= 206, *value*, mm, d<sub>10 sand
#SPECIMENVAR= 207, *value*, mm, d<sub>50 sand
#SPECIMENVAR= 208, *value*, mm, d<sub>90 sand
#SPECIMENVAR= 209, *value*, m/s, permeability sand
#SPECIMENVAR= 210, *value*, -, porosity for this (209) value of the permeability
#EQUIPMENT= *Identification of the set-up*
#PROCEDURECODE= Incheon, 1, 0, 0, 419370-0042-v08-div_contents_data_file.doc
#TESTID= *Number of the test*
#PROJECTNAME= Incheon Bridge Project
#REPORTTEXT= 201, *Test description*, Description of the test
#REPORTTEXT= 202, *Phase*, Description of the phase
#REPORTTEXT= 203, Incheon bridge project, Description of the project
#REPORTTEXT= 204, *yyyy-mm-dd*, date

```
#REPORTTEXT= 205, 419370, Assignment number
#REPORTTEXT= 207, name, drawn
#REPORTTEXT= 301, legend text, short description for transducer with quantity
number qn
#REPORTTEXT= 302, legend text, short description for transducer with quantity
number qn
#REPORTTEXT= 303, legend text, short description for transducer with quantity
number qn
#REPORTTEXT= 304, legend text, short description for transducer with quantity
number qn
#REPORTTEXT= 305, legend text, short description for transducer with quantity
number qn
#REPORTTEXT= 306, legend text, short description for transducer with quantity
number qn
#REPORTTEXT= 307, legend text, short description for transducer with quantity
number qn.
#REPORTTEXT= 308, legend text, short description for transducer with quantity
number qn.
#REPORTTEXT= 309, legend text, short description for transducer with quantity
number qn.
#REPORTTEXT= 310, legend text, short description for transducer with quantity
number qn.
#REPORTTEXT= 311, legend text, short description for transducer with quantity
number qn.
#REPORTTEXT= 312, legend text, short description for transducer with quantity
number qn.
#REPORTTEXT= 313, legend text, short description for transducer with quantity
number qn.
#REPORTTEXT= 314, legend text, short description for transducer with quantity
number qn.
#REPORTTEXT= 315, legend text, short description for transducer with quantity
number qn.
#SCANTIME= scantime, 1
#STARTDATE= year, month, date
#STARTTIME= hour, minute, second
#OS= DOS
#TIMECOLUMN= 1, 1, s
#EOH=
```

2.2 Explanation header

In order to maintain a high rate of experiments per week three nearly identical set-ups are used. These are numbered 1, 2 and 3. A typical set-up consists of two parts, a cylindrically shaped container with a diameter of 0.6 m and a measuring frame. There are three of these containers and only one measuring frame. The pore pressure transducers (PPT) and the total stress transducer (TST) are fixed to the metal of the cylindrically shaped set-up. The displacement transducers and the load cell are physically connected to the measuring frame.

As a result there are three sets of PPT's and TST, each with their own –and slightly different- calibration. In order to distinguish between the individual transducers, their quantity numbers are slightly different, see Table 0.1. The basic number for PPT's 1 until 4 are 2001:2004. The basic quantity number for the TST is 3001. For set-up 1 10 is added to the basic quantity number, for set-up 2 20 is added and for set-up 3 30 is added. So the final quantity number is given by:

$$final\ quantity\ number = basic\ quantity\ number + number\ of\ the\ setup \times 10 \quad (0.1)$$

Transducer	Set-up 1	Set-up 2	Set-up 3
PPT 1	2011	2021	2031
PPT 2	2012	2022	2032
PPT 3	2013	2023	2033
PPT 4	2014	2024	2034
TST 1	3011	3021	3031

Table 0.1 Quantity numbers for different set-ups.

This will simplify the recognition of the Pore Pressure Transducers and Total Stress Transducer.

`#FILEOWNER=` *`abbreviation of the name of the operator`*
The person in charge of the project, is reported here. Usually it will be Sme, the official abbreviation for Schaminée.

`#FILEDATE=` *`year`*`,` *`month`*`,` *`date`*
This reports the year, month and date on which the file is created, i.e. the day of the experiment.

The column for a particular transducer may vary due to the set-up of the hardware. A transducer is however always recognizable by its quantity number.

```
#COLUMNINFO= 7, kPa, Total pressure, 3001 +n*10
```

There are three set-ups. The transducer in set-up 1 has quantity number 3011, the one in set-up 2 3021, the one in set-up 3 3031.

```
#COLUMNINFO= 8, kPa, PPT 1, 2001 +n*10
#COLUMNINFO= 9, kPa, PPT 2, 2002 + n*10
#COLUMNINFO= 10, kPa, PPT 3, 2003 + n*10
#COLUMNINFO= 11, kPa, PPT 4, 2004 + n*10
```

The quantity numbers of the transducers in the set-ups 1, 2 and 3 are numbered according to Table 0.1

```
#COLUMNINFO= 9, mm, DT Moving mass, 5002
#COLUMNINFO= 10, mm, DT Horizontal, 5003
#COLUMNINFO= 11, mm, DT Oblique 1, 5004
#COLUMNINFO= 12, mm, DT Oblique 2, 5005
#COLUMNINFO= 13, mbar, P kelder lo, 42009
#COLUMNINFO= 14, mbar, P kelder hi, 42010
#COLUMNINFO= 15, rpm, Toerental, 61001
```

Note 1. In the measurement files the readings of the Displacement Transducers: DT moving mass, DT Horizontal and the DT obliques are uncorrected readings. These readings are accurate to 1.5 % Full Scale (FS). During analysis a correction is applied.

Note 2. The order of the columns is not fixed. It is determined by the hardware, depending on the sample rate of transducers. Transducers with the highest sample rate are grouped first. Transducers with a low sample rate are last. The order is not a problem, since transducers can be easily –even in software- recognised by their quantity number.

Note 3. Columns 13, 14 and 15 are of no specific use for the reader, they are recorded for reasons of statistics and making corrections.

`#FILINGTEXT= 1. `*`name`*`, Original file name`
The original file name is reported here.

`#MEASUREMENTCODE= Incheon, 1, `*`p3`*`, 0, 419370-0042-v08-div_contents_data_file.doc`
The first parameter states that we are dealing with test for the Incheon Bridge Project. The third parameter *p3*, is either 1 (Static test) or 2 (Dynamic test).

`#MEASUREMENTVAR= 101, `*`value`*`, mm, Diameter dolphin`
The diameter of the dolphin can be either 150 mm or 100 mm.

`#MEASUREMENTVAR= 102, `*`value`*`, mm, Height of dolphin`
The height of the scale model of the dolphin is expressed in mm.

`#MEASUREMENTVAR= 103, `*`value`*`, kg, Mass of dolphin`
The mass of the dolphin. There are two types of dolphins: the stiff ones, which have a considerable mass and the modelled sheet dolphins, which are much lighter.

`#MEASUREMENTVAR= 104, `*`value`*`, kg, Mass of the moving mass`
The mass of the moving mass includes the suspension system and the cart on which the moving mass is fixed.

`#MEASUREMENTVAR= 105, `*`value`*`, m/s, Objective velocity of the moving mass`
This is the velocity of loading the dolphin. In a dynamic test, the value is higher than 1 m/s, in a static test the value is roughly 300 mm/h, less than 1 mm/s.

`#MEASUREMENTVAR= 106, `*`value`*`, mm, Objective displacement of the moving mass`
This is the displacement as expected for the dolphin. This value makes only sense for a static test. The displacement during a dynamic test is subject of research.

`#MEASUREMENTVAR= 501, `*`value`*`, m, Length of the rotor beam`
The distance between the centre of the rotor and the swivelling point of the centrifuge container.

`#MEASUREMENTVAR= 502, `*`value`*`, m, Depth of the container`
The distance between the swivelling point of the centrifuge container and the bottom of the centrifuge container.

`#MEASUREMENTVAR= 503, `*`value`*`, degrees, angle at which centrifuge container is fixated`
This is the actual angle of the centrifuge container, after it has been fixated. During spin up and spin down the angle of the container varies with the speed of rotation of the centrifuge container. When the angle is in agreement with the angle belonging to a N_g level of 200, the centrifuge container is fixated in its orientation.

`#MEASUREMENTVAR= 504, `*`value`*`, m, point of g-reference`
The point of g-reference states the distance between this point and the centre of the rotor. At this distance the acceleration of gravity is exactly 200g. The bottom of the dolphin coincides with the point of g- reference.

`#MEASUREMENTTEXT= 101, `*`type of test`*`, type of test`

There are static tests and dynamic tests. The difference between both is the rate of loading the dolphin. A static test is typically loaded with 300 mm/h, whereas a dynamic test the rate of loading is higher than 1 m/s.

`#MEASUREMENTTEXT= 102, `*`stiffness`*`, structure of the dolphin`
There are three types of dolphins: two stiff ones (150 and 100 mm in diameter) and the modelled sheet dolphins, all 150 mm in diameter. The description for stiffness may be either Stiff stainless steel, Stiff aluminium or Modelled sheet.

`#MEASUREMENTTEXT= 103, `*`where`*`, Location of application force`
The position where the force acts on the dolphin. It may be either WL or -9 m. WL is water line.

`#MEASUREMENTTEXT= 104, `*`compaction`*`, Type of fill`
This reflects the desired degree of compaction of the fill of the dolphin. It may be either loose-medium or very dense. The actual porosity of the sand is given in specimenvars 101 until 103.

`#MEASUREMENTTEXT= 105, `*`name`*`, meetpl`
Name is the name of the person that has performed the test. He is in control of the centrifuge, pushes the buttons,

`#MEASUREMENTTEXT= 106, `*`compaction`*`, Type of fill`
This reflects the desired degree of compaction of the fill of the dolphin. It may be either loose-medium or very dense. The actual porosity of the sand is given in specimenvars 101 until 103.

`#MEASUREMENTTEXT= 107, `*`compaction`*`, Type of fill`
This reflects the desired degree of compaction of the fill of the dolphin. It may be either loose-medium or very dense. The actual porosity of the sand is given in specimenvars 101 until 103.

`#MEASUREMENTTEXT= 201, 102, Channel number HBM of column 1`
`#MEASUREMENTTEXT= 202, `*`value`*`, Channel number HBM of column 2`
These data are references to our data acquisition system, for internal use, quality control.

```
#MEASUREMENTTEXT= 501, location, Location of transducer with quantity number
5001
#MEASUREMENTTEXT= 502, location, Location of transducer with quantity number
5002
#MEASUREMENTTEXT= 503, location, Location of transducer with quantity number
1001
#MEASUREMENTTEXT= 504, location, Location of transducer with quantity number
3011/3021/3031
#MEASUREMENTTEXT= 505, location, Location of transducer with quantity number
2011/2021/2031
#MEASUREMENTTEXT= 506, location, Location of transducer with quantity number
2012/2022/2032
#MEASUREMENTTEXT= 507, location, Location of transducer with quantity number
2013/2023/2033
#MEASUREMENTTEXT= 508, location, Location of transducer with quantity number
2014/2024/2034
```

The location parameter has the following format:
quantity number; (x coordinate; y coordinate; z coordinate); coordinatesystemID
The quantity number is linked to the transducers functionality in an experiment. It can be found as the last parameter of keyword COLUMNINFO. The coordinatesystemID refers to the coordinate system, with respect to what the location is expressed. In this case we use one coordinate

system, see MEASUREMENTTEXT 751. The x, y and z coordinates are in mm. The x, y and z coordinates are placed between parentheses. All values within a field are separated by a semicolon.

`#MEASUREMENTTEXT= 520, `*`location`*`, Location of reference point S on base of dolphin`

Point S is located in the plane y = 0, at the bottom of the dolphin. It is located at the side opposite to where the dolphin is hit by the moving mass.

`#MEASUREMENTTEXT= 521, `*`location`*`, Location of point Q in the pole on the dolphin`

Point Q is located in the pole attached in the centre of the cap on the dolphin, see Figure 0.1. Q is located in the attachment point for the horizontal displacement transducer DT H.

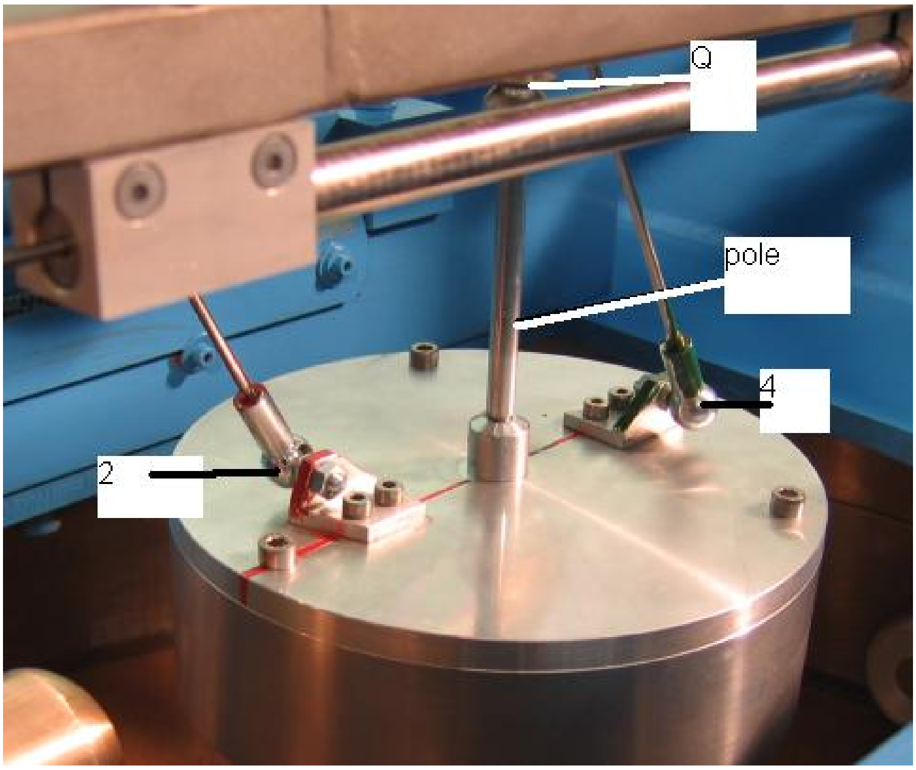

Figure 0.1 Top plate of the dolphin with pole and point Q

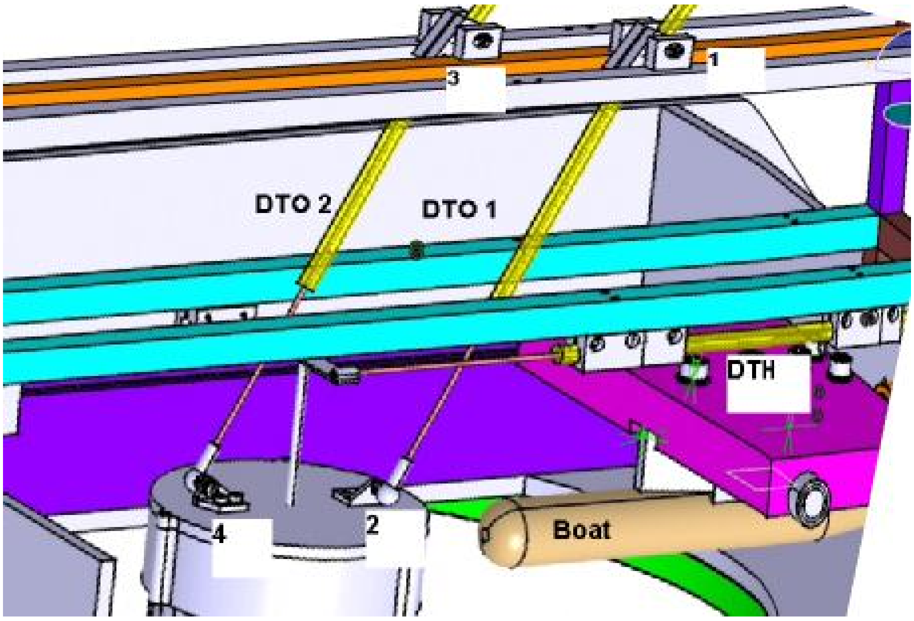

Figure 0.2 Arrangement for the attachment of the oblique displacement transducers DTO 1 and 2 and the horizontal transducer DTH

`#MEASUREMENTTEXT= 551, `*`location`*`, Location of attachment point on frame for transducer Oblique 1 with quantity number 5004`
`#MEASUREMENTTEXT= 552, `*`location`*`, Location of attachment point on dolphin for transducer Oblique 1 with quantity number 5004`
`#MEASUREMENTTEXT= 553, `*`location`*`, Location of attachment point on frame for transducer Oblique 2 with quantity number 5005`
`#MEASUREMENTTEXT= 554, `*`location`*`, Location of attachment point on dolphin for transducer Oblique 2 with quantity number 5005`

The two oblique transducers (DTO 1 and DTO 2) have the primary task to determine the rotation (tilt) of the dolphin. The upper mounting points (points 1 and 3) of these transducers will rotate. Since the calculation of the amount of rotation of the dolphin depends on the total distance between both attachment points of a displacement transducer, two sets of coordinates for the oblique DT's are needed. The bottom points of the DT's (points 2 and 4) are attached to the cap on the dolphin, see Figure 0.2.

Measurementtext	Transducer	Quantity number	Attached to	Point number
551	DT O1	5004	Frame	1
552	DT O1	5004	Dolphin	2
553	DT O2	5005	Frame	3
554	DT O2	5005	Dolphin	4

Table 0.2 Numbers for the measurementtext of the displacement transducers connected to the dolphin.

`#MEASUREMENTTEXT= 751, `*`translation`*`, Origin of the cell in centrifuge container coordinates`

The origin of the main (number 0) coordinate system is in the centre of the container. The origin of the (1st) local coordinate system is located within the measuring set-ups. Translation describes the position of the origin of the local coordinate system as expressed in coordinates of the main system. Translation has the following format:

coordinatesystemID; (O_x; O_y; O_z)

where coordinatesystemID is the identifier of the resulting coordinate system, O_x is the x coordinate of the resulting local origin with respect to the previous main coordinate system. O_y and O_z analogously for y and z coordinate respectively. Values are expressed in mm. The coordinates are placed between parentheses. The values within a field are separated by a semicolon.

```
#MEASUREMENTTEXT= 1001, calibration, Calibration data of transducer with
quantity number 5001.
#MEASUREMENTTEXT= 1002, calibration, Calibration data of transducer with
quantity number 5002.
#MEASUREMENTTEXT= 1003, calibration, Calibration data of transducer with
quantity number 5003.
#MEASUREMENTTEXT= 1004, calibration, Calibration data of transducer with
quantity number 5004.
#MEASUREMENTTEXT= 1005, calibration, Calibration data of transducer with
quantity number 5005.
#MEASUREMENTTEXT= 1006, calibration, Calibration data of transducer with
quantity number 1001.
#MEASUREMENTTEXT= 1007, calibration, Calibration data of transducer with
quantity number 3011/3021/3033.
#MEASUREMENTTEXT= 1008, calibration, Calibration data of transducer with
quantity number 2011/2021/2031.
#MEASUREMENTTEXT= 1009, calibration, Calibration data of transducer with
quantity number 2012/2022/2032.
#MEASUREMENTTEXT= 1010, calibration, Calibration data of transducer with
quantity number 2013/2023/2033.
#MEASUREMENTTEXT= 1011, calibration, Calibration data of transducer with
quantity number 2014/2024/2034.
```

These parameters reflect the actual conversion factors which are used in the data acquisition system. This system provides the calibration data for each of the transducers. The field *calibration* consists of five sub fields, separated by means of a semi colon:

offset; sensitivity; span; quantity number; serial number

Basically a transducer produces a voltage. This voltage is converted into a physical quantity by means of:

$$mV/V = Offset + Sensitivity \times Voltage \qquad (0.2)$$

The values for Offset and Sensitivity are the same as programmed in the data acquisition system for a specific transducer. Span is the physical value, which corresponds to the sensitivity. The quantity number refers to the last (4^{th}) number in COLUMNINFO. The serial number is a unique number for a specific brand of transducer. Usually its manufacturer assigns the serial number to a transducer.

```
#MEASUREMENTTEXT= 1251, Time Remarks, Log entry
#MEASUREMENTTEXT= 1252, 10:20 Start of test 15RR; spinning up;, Log entry
```

The logbook, which is maintained at the website, is copied into measurementtexts 1251 and following. There is a maximum number of entries, i.e. 250. Usually 10 to 40 entries.

#SPECIMENTEXT= 201, *Baskarp*, name of the sand used
This is the type of sand used, its generic name.

#SPECIMENVAR= 101, *value*, -, porosity base soil
The actual porosity of the base soil.

#SPECIMENVAR= 102, *value*, -, porosity top soil
The actual porosity of the top soil.

#SPECIMENVAR= 103, *value*, -, porosity fill
The actual porosity of the fill.

#SPECIMENVAR= 104, *value*, -, void ratio base soil
The actual void ratio of the base soil.

#SPECIMENVAR= 105, *value*, -, void ratio top soil
The actual void ratio of the top soil.

#SPECIMENVAR= 106, *value*, -, void ratio fill
The actual void ratio of the fill.

#SPECIMENVAR= 107, *value*, -, Dr(e) base soil
The actual relative density of the base soil.

#SPECIMENVAR= 108, *value*, -, Dr(e) top soil
The actual relative density of the top soil.

#SPECIMENVAR= 109, *value*, -, Dr(e) fill
The actual relative density of the fill.

#SPECIMENVAR= 201, *0.34*, -, minimum porosity sand
The minimum value of the porosity of the sand

#SPECIMENVAR= 202, *0.469*, -, maximum porosity sand
The maximum value of the porosity of the sand

#SPECIMENVAR= 203, *0.515*, -, minimum void ratio sand
The minimum value of the void ratio of the sand

#SPECIMENVAR= 204, *0.883*, -, maximum void ratio sand
The maximum value of the void ratio of the sand

#SPECIMENVAR= 205, *2647*, kg/m^3, volumetric mass sand
The volumetric mass of the sand.

#SPECIMENVAR= 204, *0.09*, mm, d<sub>10 sand
The d_{10} of the sand, the equivalent diameter of the grains of which 10% of the total mass is smaller than this diameter. .

#SPECIMENVAR= 205, *0.13*, mm, d<sub>50 sand

The d_{50} of the sand, the equivalent diameter of the grains of which 50% of the total mass is smaller than this diameter..

#SPECIMENVAR= 206, *0.2*, mm, d<sub>90 sand
The d_{90} of the sand, the equivalent diameter of the grains of which 90% of the total mass is smaller than this diameter.

#SPECIMENVAR= 207, 8.85E-5, m/s, permeability sand
The permeability of the sand, as measured with water. The permeability depends strongly on the porosity of the sample, the accompanying porosity is found in specimenvar 208.

#SPECIMENVAR= 208, 0.34, -, porosity for the permeability above
The permeability depends strongly on the porosity of the sample, the accompanying permeability is found in specimenvar 207.

#EQUIPMENT= *Identification of the set-up*
The experiments will be done in three different set-ups. Each set-up consists of a Top part and an Base part. The height of the Top part may vary. Each part will be identified with numbers and text. B1, B2 and B3 for the base part, H1, H2 H3 of a high top part, L1, L2 or L3 for a low top part. The total identification of the equipment will be the combination of Base and Top part. Examples: B1H2 or B3L1.

#TESTID= *Number of the test*
The tests are numbered according to the table on page 32 of the Model Test Plan, (419370-0008). Tests are numbered 1 until 18, with or without an addition R for repetition.

#PROJECTNAME= Incheon Bridge Project
The official name of the project at GeoDelft.

#REPORTTEXT= 201, *Test description*, Description of the test
A compact description of the test. De description consists of:
diameter (stiff material) dolphin; type of fill; loading location; loading speed
Two examples:
30 m stiff stainless steel dolphin; very dense fill; WL; 3 m/s
30 m dolphin; loose medium fill; -9 m; 300 mm/h

#REPORTTEXT= 202, *Phase*, Description of the phase
A short description of the phase of the test. Basically a test has three phases: spinning up, testing when the dolphin is loaded and spinning down. For a dynamic test, the phase is usually 02, for a static test it is 01.

#REPORTTEXT= 203, Incheon Bridge Project, Name of project
This is always Incheon Bridge Project.

#REPORTTEXT= 204, *yyyy-mm-dd*, Date
The date when the test was executed.

#REPORTTEXT= 205, 419370, Assignment number
This is fixed: 419370.

#REPORTTEXT= 207, *adel*, Drawn
The name of the person who has made the annexes.

#REPORTTEXT= 301, *generic qn;specific qn;legend text*, short description for transducer with quantity number 5001
#REPORTTEXT= 302, *generic qn;specific qn;legend text*, short description for transducer with quantity number 5002
#REPORTTEXT= 303, *generic qn;specific qn;legend text*, short description for transducer with quantity number 5003
#REPORTTEXT= 304, *generic qn;specific qn;legend text*, short description for transducer with quantity number 5004
#REPORTTEXT= 305, *generic qn;specific qn;legend text*, short description for transducer with quantity number 5005
#REPORTTEXT= 306, *generic qn;specific qn;legend text*, short description for transducer with quantity number 1001
#REPORTTEXT= 307, *generic qn;specific qn;legend text*, short description for transducer with quantity number 3011/3021/3031.
#REPORTTEXT= 308, *generic qn;specific qn;legend text*, short description for transducer with quantity number 2011/2021/2031.
#REPORTTEXT= 309, *generic qn;specific qn;legend text*, short description for transducer with quantity number 2012/2022/2032.
#REPORTTEXT= 310, *generic qn;specific qn;legend text*, short description for transducer with quantity number 2013/2023/2033.
#REPORTTEXT= 311, *generic qn;specific qn;legend text*, short description for transducer with quantity number 2014/2024/2034.
The long description for a transducer is given in the third field of the COLUMNINFO keyword. Its length may interfere with the graphical representation of the transducers, if a graph with legend is displayed. When legends are used, the legend text in REPORTTEXTs 301 until 311 are used.

The generic quantity number is the quantity number independent of the number of the set-up used. In the specific quantity number the number of the set-up is encoded. 2001 is the generic quantity number of PPT 1, 2021 is the specific quantity number of PPT 1, i.e. PPT 2-1. The generic function of PPT 1 is the same in all three set-ups, however there is an electrical difference between PPT 1-1, PPT 1-2 and PPT 1-3, e.g. the sensitivity and offset.

#SCANTIME= *scantime*, 1
The difference in time between adjacent scans in the data block. It is measured in seconds.

#STARTDATE= *year*, *month*, *date*
#STARTTIME= *hour*, *minute*, *second*
This reflects the date and time on which the data acquisition system has started.

#OS = DOS
Since the numbers in the data block of the file is binary, this states that the type of data is Little Endean, i.e. made for computers running with INTEL processors.

#TIMECOLUMN = 1, 1, s
This identifies that the time in the file is in column 1, it is expressed in seconds.

2.3 Description data block

The data in the measurement file is of type binary, little Endean. GEF software for the Windows operating system is available to visualize the data in any valid GEF file. The time is recorded row wise, i.e. each row contains the data of all transducers on a specific moment in time. Data is recorded scan after scan. The organization of the data is described in the header, most importantly the keywords COLUMNINFO provide information about the quantities and units which are measured in a column.

3. Analysis file

In this chapter the analysis of the measurement is discussed.
Section 3.1 describes the new items in the header of an analysis file and explains the content of the new items in the header. Many keywords in the header of an analysis file are the same as in the header of the measurement file. These keywords are not repeated here. Just the new keywords are introduced and discussed.

3.1 Analysis

During the analysis phase the data of the test is processed. Both constant and varying data are derived. Data of the first type is added to the header, data of the second type is added as a new column to the data block. Two examples:

- The average N_g level during the loading phase is added to the header, .since it is a constant value.
- The values of the rotation of the dolphin are added to the data block, since this value varies at each scan.

During the analysis phase a series of actions and calculations have to be done.

1. Correct the displacement transducers DT moving mass, DT Horizontal, DT Oblique 1 and 2 for their non-linearity.
2. Add these values to the data block.
3. Add “unc” in the quantity field of the keyword COLUMNINFO for the columns of the uncorrected displacement transducers
4. Calculate the N_g level and add it to the data block
5. Calculate the horizontal and vertical translation and the rotation of the centre of the cap of the dolphin.
6. Add the horizontal translation of the centre of the cap of the dolphin to the data block
7. Add the vertical translation of the centre of the cap of the dolphin to the data block
8. Add the rotation of the centre of the cap of the dolphin to the data block
9. Add the air pressure in the centrifuge to the data block
10. Correct the total stress for the changes in pressure in the centrifuge and add the corrected total stress to the data block
11. Calculate the effective stress from the total stress and the pore pressure.
12. Derive the average N_g level during the test and add it to the header
13. Change the quantity numbers which depend on the identification of the set-up (see Table 0.1) independent of the set-up.
14. Add a code indicating that the file has been analysed.
15. Calculate the velocity of the moving mass and add it to the data block.
16. For a dynamic test the acceleration of the moving mass is calculated. The section of the data when the moving mass is in contact with the dolphin is selected. The acceleration in during contact is negative. The acceleration is then multiplied with minus the mass of the moving mass. The result is positive: it is the force on the dolphin. It is added to the data block. For reasons of uniformity the force on the dolphin for a static test is copied from the Loadcell plunger and given the save quantity number.
17. Finally the dissipated energy is added. For a static test this is the product of the recorded force on the dolphin times the displacement. For a dynamic test the energy is calculated from the decrease in kinetic energy, i.e. $\frac{1}{2}mv^2$. This has been compared with the product of force and displacement. Both are within 2.5% in agreement with each other.

3.2 Explanation header

The header is mainly the same as in the measurement file. A few items are added. Only the item which are added or changed are described here.

```
#COLUMN= 28
```
The number of columns is extended from 15 to 28.

The order in which transducers are listed in the data block may vary. The COLUMNINFO provides sufficient information about the interpretation of columns in the data block. A transducer is always recognizable by its quantity number, specifically suitable for automated processing.

```
#COLUMNINFO= 9, mm, DT Moving mass unc., 5002
#COLUMNINFO= 10, mm, DT Horizontal unc., 5003
#COLUMNINFO= 11, mm, DT Oblique 1 unc., 5004
#COLUMNINFO= 12, mm, DT Oblique 2 unc., 5005
```
These columns represent the raw signal of the displacement transducers. “unc” is added, since a correction should still be added.

```
#COLUMNINFO= 13, mbar, P cellar lo, 42009
#COLUMNINFO= 14, mbar, P cellar hi, 42010
```
These data are intended for correcting the total stress transducer. They are part of the control system of the centrifuge.

```
#COLUMNINFO= 15, rpm, Spinning frequency, 61001
```
The spinning frequency is used for calculating the N_g level. This column is part of the control system of the centrifuge.

```
#COLUMNINFO= 16, mm, DT Moving mass, 5302
#COLUMNINFO= 17, mm, DT Horizontal, 5303
#COLUMNINFO= 18, mm, DT Oblique 1, 5304
#COLUMNINFO= 19, mm, DT Oblique 2, 5305
```
The displacement transducers are corrected for their non-linearity. The corrected values are added to the data block.

```
#COLUMNINFO= 20, -, Ng level, 61501
```
The N_g level is calculated using the distance between the rotor and the point of g-reference (measurementvar 504) and the spinning frequency of the centrifuge (quantity number 61001).

```
#COLUMNINFO= 21, mm, T_x, 5101
#COLUMNINFO= 22, mm, T_z, 5102
#COLUMNINFO= 23, degrees, \phi, 5103
```
The z axis is directed perpendicular to the base plane of the centrifuge container. Its direction is opposite to the direction of the centrifugal acceleration (apparent gravity). In Figure 0.1 the z axis coincides with the line MQ. The x axis is in the same direction as the movement of the plunger or the movement of the moving mass. In Figure 0.1 this line coincides with the line PT. The dolphin is loaded from left to right. Note that the displacement and rotation in this figure are exaggerated.
T_x is the horizontal translation of the dolphin. As a reference point the centre of the cap of the dolphin is used, point M.
T_z is the vertical translation of the dolphin. The same reference point (M) as for T_x is used.
φ is the angle of rotation of the dolphin. The rotation is measured in the xz plane. A positive value of φ means clockwise rotation, like in Figure 0.1.

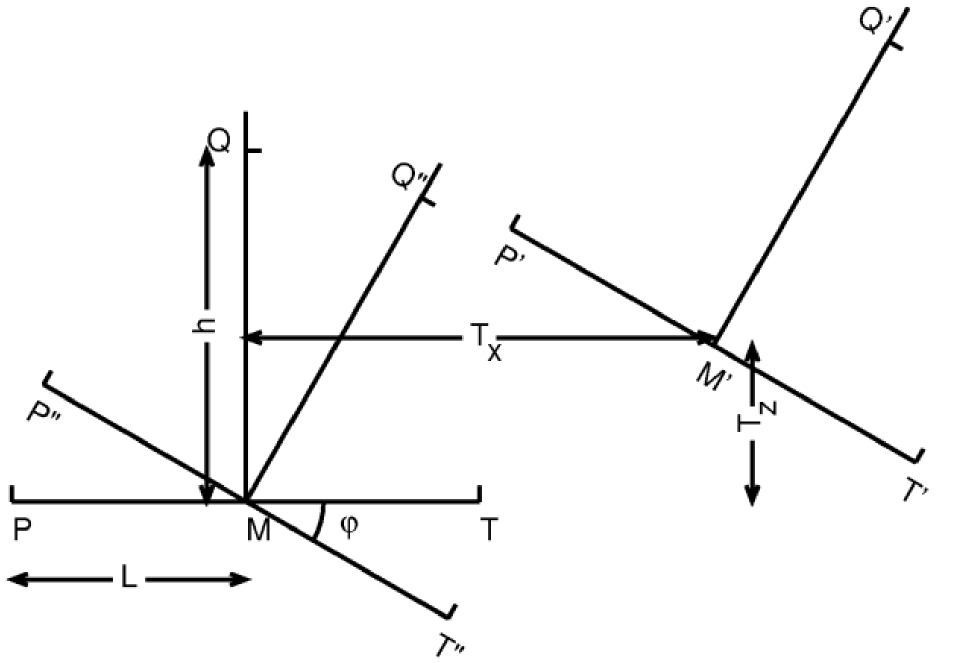

Figure 0.1 Schematic visualisation of the movement of the dolphin in the xz plane

```
#COLUMNINFO= 24, kPa, Total stress cor., 3101
```
The raw data of the total stress transducer is not corrected for any changes in atmospheric pressure in the centrifuge. Since the air pressure is reduced to 5 kPa before spinning up to N_g = 200, the value of the transducer drops slightly less then 100 kPa. Since the air pressure in the centrifuge is recorded, a correction is made.

```
#COLUMNINFO= 25, kPa, Effective stress, 4001
```
The total stress transducer and pore pressure transducer 1 are mounted at the same height in close proximity. By subtracting the pore pressure from the total stress the effective stress is obtained.

```
#COLUMNINFO= 26, m/s, Velocity of loading, 5202
```
The velocity of the loading is derived from DT moving mass. By differentiating the values with respect to time, the velocity is obtained. See section 3.3 for additional information on taking derivatives of measured data.

```
#COLUMNINFO= 27, kN, Force on dolphin, 1003
```
For a static test the force on the dolphin is copied from the force as measured by the Loadcell transducer, quantity number 1001. For a dynamic test the force on the dolphin is calculated by means of the acceleration of the moving mass (second derivative of the displacement of the moving mass, see section 3.3) and the mass of the moving mass. “Action = - reaction”, so a minus sign is added, in order to obtain the force on the dolphin. The acceleration of the moving mass is negative, since its kinetic energy is transferred to the dolphin. The resulting force on the dolphin is positive.

```
#COLUMNINFO= 28, J, Energy, 19001
```
For a static test the energy is the product of the recorded force on the dolphin times the displacement of the moving mass. For a dynamic test the energy is calculated from the decrease

in kinetic energy of the moving mass. The loss in kinetic energy has been compared with the energy delivered by the dolphin, using the same method of calculation as for a static test, i.e. the product of force on the dolphin and displacement of the moving mass. Both energies are within 2.5% in agreement with each other.

```
#ANALYSISCODE = Incheon, 1, 0, 0, 419370-0042-v08-div_contents_data_file.doc
```

The keyword states that this file has been analysed, i.e. the derived values for the transducers have been calculated.

```
#ANALYSISVAR= 101, 200.31, -, Average Ng level
```

This value reports the actual averaged N_g level when loading the dolphin.

```
#ANALYSISTEXT= 102, PPT's done, Do not correct again
```

This keyword signals that the pore pressure transducers are corrected for non-linearity. It prevents that the values are corrected again, leading to false information.

```
#COLUMNVOID= 13, 10000000000.000000
#COLUMNVOID= 14, 10000000000.000000
#COLUMNVOID= 15, 10000000000.000000
#COLUMNVOID= 20, -99.000000
#COLUMNVOID= 21, -9999.000000
#COLUMNVOID= 22, -9999.000000
#COLUMNVOID= 23, -9999.000000
#COLUMNVOID= 28, -99999.000000
```

For a few columns and specific scans values could not be measured or calculated. As an example, in a dynamic test the force on the dolphin can be calculated only when the moving mass is in contact with the dolphin. During the acceleration of the moving mass it is not yet in contact with the dolphin, so no force on the dolphin is applied. In those scans the force is void. To signal a void value in a binary file, a number is used, which will not occur. Physical insight is necessary to define a void value. The keyword COLUMNVOID defines the value which signals a void scan.

```
#REPORTTEXT= 202, Test: 15RR; Static test, The phase in the test
```

The phase of the test is changed into the type of the test: static or dynamic.

```
#REPORTTEXT= 203, Incheon Bridge Project - GeoCentrifuge tests, Name of project
```

GeoCentrifuge tests is added.

```
#REPORTTEXT= 205, CO-419370, Assignment number
```

CO- is added to the assignment number.

```
#REPORTTEXT= 311, 3101;3101;TSTC 1, Total stress transducer corrected
#REPORTTEXT= 312, 4001;4001;Eff. Str., Effective horizontal stress
#REPORTTEXT= 313, 5202;5202;Vmm, Velocity moving mass
#REPORTTEXT= 314, 1003;1003;F dol., Force on dolphin
#REPORTTEXT= 315, 1001;1001;Loadcell, Loadcell plunger
#REPORTTEXT= 316, 5302;5302;DT mm, DT Moving mass
#REPORTTEXT= 317, 5303;5303;DT H, DT Horizontal
#REPORTTEXT= 318, 5304;5304;DT O1, DT Oblique 1
#REPORTTEXT= 319, 5305;5305;DT O2, DT Oblique 2
```

For the relevant columns a short legend text is added.

3.3 Taking derivatives

The procedure for the calculation of the quantities which involve differentiation of a measured signal, needs a kind of averaging. Since all measured signals contain noise, any differentiation enhances the noise. As a result the derived quantities show an erratic behaviour. In order to reduce the noise, the next procedure, geared for velocity and acceleration, is followed.

1. A least square fit is made of a displacement transducer as a function of time. The displacement signal, consisting of several hundreds of scans, is piece wise fitted as a second or second degree polynomial in time. Piece wise means that for each recorded scan a least square fit has been made. As much as is possible the interval for the least square fit is symmetrically positioned around the desired scan: an equal amount of points earlier and later than the desired moment in time. For the scans at the beginning and end of the recorded file the demand for a symmetric interval can not be fulfilled.
2. The polynomial is differentiated with respect to time for the velocity. Second order differentiation results in the acceleration.
3. Points 1 and 2 are repeated for each recorded scan in the region of interest.
4. A piece wise least square fit contains 50 points. This is a compromise particularly for the specific scan frequency (9600 Samples/second) and duration of the collision (35 ms). An increase in the number of points smoothes the amount of noise, however it will result in a lower peak value.

4. Report file

The report file is geared up for the analysis of all tests. Extreme values will be calculated and added to the header.

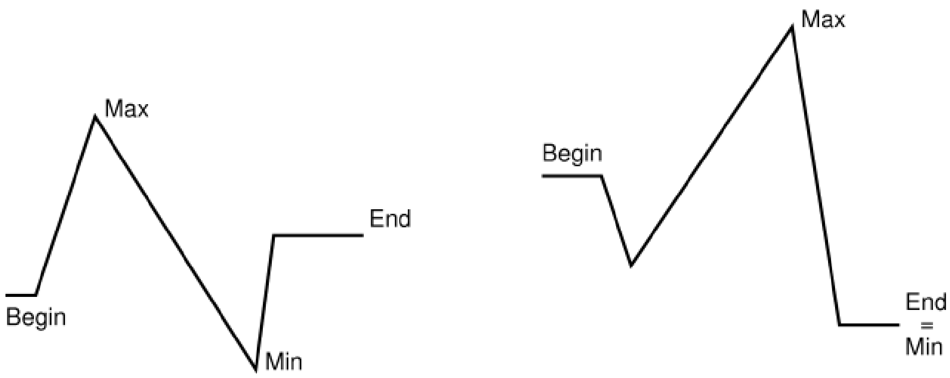

Figure 0.1 Characterisation of extreme values. Left a standard situation, right a special case

The extreme values are determined for each column in the data block. The minimum and maximum values are determined. Additionally the number of the scan when the minimum and maximum values occur, are recorded. This will provide information whether the maximum value occurs before or after the minimum value. Next the begin and end values are recorded. If the number of scans is sufficiently large, the begin and end values are averaged over 10 points. The information is rather simple. In the right part of Figure 0.1 the sub minimum in the initial phase of the registration is not found, since the end value is lower.

Combination	Description
Begin : Max	Maximum value compared to begin
End : Max	Maximum value compared to end
Begin : Min	Minimum value compared to begin
End : Min	Minimum value compared to end
Begin : End	Change in value
Max : Min	Peak – peak value

Table 0.1 Combination of extreme values

These extreme values can be combined into 6 pairs of values. They provide very condensed information about the behaviour of a quantity during a test.