Dongre Workability Test (DWT)

The Dongre Workability Test (DWT) provides a means to predict the constructability of asphalt pavement mixtures at different placement temperatures by providing an index value related to the workability of the material. The test, performed at multiple temperatures, utilizes a Pine Model AFG2A SUPERPAVE Gyratory Compactor (SGC) equipped with custom DWT control software. Standard 150mm diameter SGC molds are utilized along with a metal insert. A specimen mass similar to that of a SUPERPAVE volumetric specimen is also utilized.

The DWT protocol utilizes a constant loading rate applied to a loose material specimen at a known temperature confined within a cylindrical mold. The resulting normal stress is recorded along with the strain as the material specimen is consolidated into a cylindrical form. The slope of the stress versus strain curve is used as a metric related to the workability of the mixture at the test temperature.

The test result represents the relative ease at which at which a loose material develops into an organized structure that can withstand a stress at a given temperature. A high DWT value is indicative of a material easily manipulated to a point in which it can withstand stress at the test temperature. A low DWT value indicates a material which is more difficult to manipulate at the test temperature to a point it can withstand stress.

When materials are tested at multiple temperatures, the DWT Index may provide information for predicting appropriate paving temperatures. DWT threshold values of 150 and 170 are offered as nominal limits for field compaction temperatures. However, these values may need to be adjusted for specific applications or materials.

The material temperature information provided by the DWT Index may be applicable for a variety of purposes including; estimating warm mix additive performance, extending construction haul distances, predicting constructability at lower ambient construction temperatures, as well as other material behavior related to temperature, workability, and compactability.

AFG2 "Strain Rate" Compaction Mode (v12.12.A/S01)

To use the DWT compaction mode, update the control software on the AFG2 compactor.

- Profile Type (1-9): defines the number of discrete velocity to pressure shift points in the test.
  - DWT (Dongre Workability Test) utilizes Profile Type 3
- Settings screens are used to select Profile Velocities and Pressure shift points.
- Velocity (mm/s) V_1 - V_9: defined in 0.01 increments from 0.01 through 8.47 mm/s.
- Pressure (kPa) P_1 - P_5: range from 6 through 999 and defines the point where the next profile velocity will be engaged. Profile Pressures must be increasing (P1<P2<P3…).
- Spacer Height (mm): defined from 0.0 to 250.0. This represents the height of a spacer placed in the mold with the material specimen. Gyrations are restricted to 0 if a spacer is used. DWT does not use a spacer (set to 0.0mm).

Dongre Workability Test (DWT) Settings

- Set the compaction mode to Strain Rate.

```
┌─────────────────────────────┐
│ MOLD DIAM (mm): 150         │
│▶COMPACT:STRAIN RATE         │
│ TEST DATA:        +         │
│ SETUP/CALIBRTE    +         │
└─────────────────────────────┘
```

```
┌─────────────────────────────┐
│ COMPACTION MODE:            │
│                             │
│      STRAIN RATE            │
│                             │
└─────────────────────────────┘
```

- Set the Profile Type to 3.

```
┌─────────────────────────────┐
│ GYRATIONS(N):       0       │
│ HEIGHT (mm)     ---.-       │
│▶STRAIN RATE SETUP +         │
│ PRESSURE (kPa)   600        │
└─────────────────────────────┘
```

```
┌─────────────────────────────┐
│▶Profile Type:      3        │
│ Settings          +         │
│ Spacer (mm):     0.0        │
│ Exit                        │
└─────────────────────────────┘
```

- Confirm each profile setting.

```
┌─────────────────────────────┐
│ Profile Type:      3        │
│▶Settings          +         │
│ Spacer (mm):     0.0        │
│ Exit                        │
└─────────────────────────────┘
```

DWT Profile 1: Set V_1 to 4.00 mm/s. This is velocity (strain rate) that the ram travels from 0 kPa to 25 kPa (@150mm mold). When P_1 is achieved, Profile 2 is engaged (V_2 strain rate applied).

```
┌─────────────────────────────┐
│ Work Profile #:    1        │
│ Velocity(mm/s):4.00         │
│ Pressure (kPa):  25         │
│▶Next Profile                │
└─────────────────────────────┘
```

DWT Profile 2: Set V_2 to 150 mm/s and P_2 to 40 kPa. This is velocity (strain rate) that the ram will travel from a stress of 25 kPa to 40 kPa (@150mm mold). When P_2 is achieved, Profile 3 is engaged (V_3 strain rate applied).

```
 Work Profile #:   2
 Velocity(mm/s):1.50
 Pressure (kPa):  40
▶Next Profile
```

DWT Profile 3: Set V_3 to 0.05 mm/s and P_3 to 950 kPa. Profile 3 is the final DWT profile. Velocity will decrease as stress approaches the final target pressure (P_3). Once P3 is achieved, if gyrations are set to 0 the test is complete. If gyrations are other than 0, the G2 will compact to the specified number of gyrations. If a non-zero spacer value is utilized, the gyrations are fixed to 0 to prevent damage to the G2.

```
 Work Profile #:   3
 Velocity(mm/s):0.05
 Pressure (kPa): 950
▶Exit
```

DWT Output File (saved to USB Flash Memory)

```
============================================
File Name: AUG16_08.DWT
     Time: 12:45
     Date: 08/16/2012
 Diameter: 150 mm
      S/N: 8000
Profile:          0     1     2     3
Velocity (mm/s)  4.0   1.0   0.01  0.05
Pressure (kPa)    6    50    90    950
============================================
Index,Height(mm),Pressure(kPa),Velocity(mm/s)
0.600,183.1,15.0,4.936
0.700,176.3,22.3,4.973
```

DWT Analysis Workbook (Excel)

The DWT_Workbook_(v01.0.3).xls workbook provides the calculations needed to determine the DWT value for each specimen.

This workbook is under construction.

Height Worksheet

1. Select the height worksheet
2. Select the column to place the data. Use different temperatuire groups for different temperatures or different materials.
3. Select the DWT menu
4. Select Load Data File. Navigate and select the appropriate *.dwt file.
5. Enter the final test temperature of the specimen.
6. Temperature Groups may be renamed (i.e.: Temperature or Material ID)
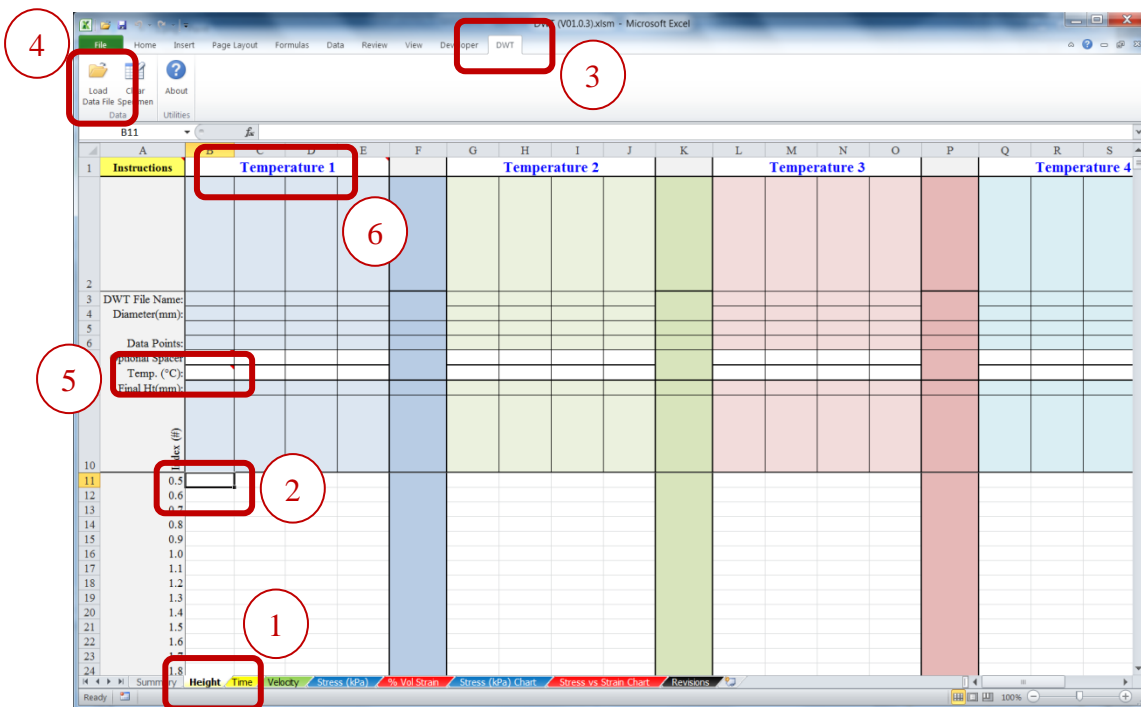
Summary Worksheet

Blue text cells are user defined. Black text cells are calculated.
1. Enter Project Information.
2. Select the DWT target values for the temperature predictions
3. A linear prediction fit is recommended. A polynomial fit is provided for research purposes.
   The polynomial fit requires 5 temperatures and must be used with caution as results vary. .

Dongré Workability Test Report   **V01.0.2**

Project:	Trial 1		Date:	8/22/2012
File Name:	DWT (V01.0.2 - with data).xlsm			
Laboratory:	DL		Technician:	EM

①

Material		Aggregate		Binder		Additive	
JMF No.:		Code:		Grade:		Type:	
Design:		Class:		%AC:		%:	
Plant/Lab:		Supplier:		%Virgin:			
%RAP:		Nom.Size:		% Rec:			

DWT Profile	0	1	2	3	4	5
Velocity (mm/S)	4.00	1.50	0.05			
Stress (kPa)	25	40	950			

Test Results	DWT kPa	Temperature °C	Temperature °F
Temperature 1	126.2	57.0	134.6
Temperature 2	130.3	78.5	173.3
Temperature 3	151.2	90.5	194.9
Temperature 4	157.9	108.5	227.3
Temperature 5	174.7	124.5	256.1

Workability	Target DWT kPa	Predicted Temperature C	Predicted Temperature F
Limit A	140	81.7	179.0
Limit B	150	94.3	201.7
Limit C	170	119.5	247.1
Limit D	180	132.1	269.8

②

	a3	a2	a1	a0
☐ PolyFit	0.0013	-0.5850	89.752	-4519.1

Temperature vs. DWT

$$y = 0.0013x^3 - 0.585x^2 + 89.752x - 4519.1$$
$$R^2 = 0.945$$

$$y = 1.2608x - 94.858$$

Legend:
- Trial 1
- Limit A
- Limit B
- Limit C
- Limit D
- Poly. (Trial 1)
- Linear (Trial 1)

X-axis: DWT (kPa)
Y-axis: Temperature

Stress vs. Strain Chart

More workable materials will trend to the left (steeper) while less workable materials will trend to the right (less steep). DWT is the slope between 550kPa and 650kPa.