VALIDATION OF PROGRAMME UNIT

DELTA STRETCHING OF CURRENT FLOW VELOCITY

Date: Zo 20-Jan-2002

Time: 12:40:44

Project: IMPROVEMENTS OF FUTURE DEVELOPMENTS

Jobnr: PV2002

ABSTRACT:

This Case study was originaly performed in 1995 to validate the programme unit for delta stretching of the offshore pipestress analysis programme of Paul W.H. Voorhaar.

For validation of the unit reference is made to the worked out example in RP E305 of Veritec. As can be seen that the calculated velocities comply completely.

There is a minor difference in the calculated mass. This is because the accuracy of the programme is of a higher level and fully in-line with hand calculations. The difference in this presentation is 0.004 m^3/sec over a water depth of 110 m.

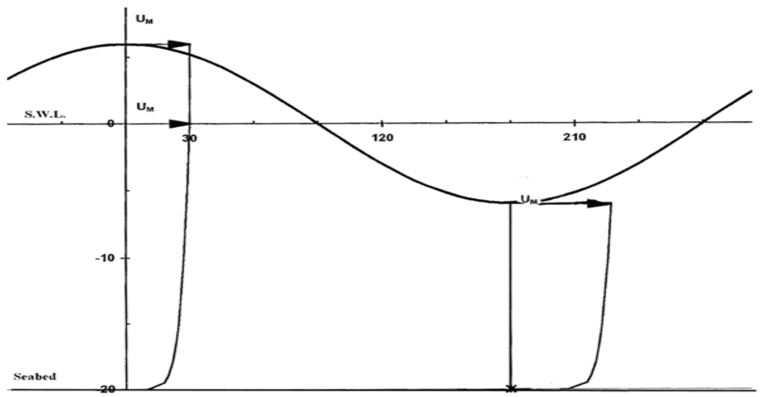
REFERENCES:

Mechanics of Wave Forces on Offshore Structures by Turgut Sarpkaya / Michael Isaacson
Rules For Submarine Pipeline Systems by Det Norske Veritas (DNV) 1981/1982
Fifth order Gravity Wave theory by Lars Skelbreia Proc. Coastal Eng. 1961
NEN 3650 1992 Transportleidingsystemen
Report UR8 CIRIA underwater Engineering Group
Handbook of Ocean and Underwater Engineering by John J. Myers
Recommended Practice RP E305 by Veritec 1988
Validation computerprogramme SP95037 by P.W.H. Voorhaar 1995
Validation programme unit SP102002 by P.W.H. Voorhaar 2002

REV	BY	DATE	DESCRIPTION	CHECKED	PROJECT APPROVAL	THIRD PARTY APPROVAL
1	PVo	Zo 20-Jan-2002	Added graphs from programme			
0	PVo	Za 12-Jan-2002	First Issue	AVo	-	-

STATUS CODE		DOCUMENT NUMBER	REVISION	STATUS
A	Preliminary for information only	**WEBSITE EXAMPLE**	**1**	**A**
B	For review			
C	Authorized for construction			

Delta stretching of current flow velocity



The current flow is influenced by the height of the wave. Compaired with the mean seawaterlevel the velocity wil decrease at the wavecrest and increase at the wave hull.
In the computer programmes of Paul W.H. Voorhaar a unit has been build-in that calculates the deltastretching on the basis of the "constant mass flow" principle.
Most programmes make assumptions of constant velocity over a part of the wave period. This assumption is not addopted here.
The current profile is adjusted for every step in the calculation.
Moreover the current velocities are calculated in components perpendicular and along the pipeline. This will make it possible to make an addition with the local wave velocities.
The Reynolds Number and Dragcoefficient are influenced by the water velocities perpendicular to the pipeline. The programme also adjust these over the wave period.
This very tedious approach is avoided by most programmes. That is the reason why it was included in my own programmes.

Verification calculation with logaritmic current velocity profile:

Pipe diameter $D := 0.5 \cdot m$

Current velocity at reference height $v := 0.6 \cdot \frac{m}{sec}$

Reference height of current velocity $z := 3 \cdot m$

Seabed roughness parameter $r := 4.17 \cdot 10^{-5} \cdot m$

Mean sea water level $d := 110 \cdot m$

Wave height $H_s := 14.5 \cdot m$

von Karman's constant $\kappa := 0.4$

Elevation above seabed h as a function from the mean seawater level

$H := d$ $H_2 := d - H_s$

Friction velocity according Veritec RP E305

$$U := \frac{v \cdot \kappa}{\ln\left(\frac{z + r}{r}\right)} \qquad U = 0.0214599266 \cdot \frac{m}{sec}$$

Water particle velocity at elevation 'H' according RP E305 Appendix A par. A2.:

$$vel(U, H) = 0.793 \cdot \frac{m}{sec}$$

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Check with Veritec RP E305 Appendix B example B.2

$$U_d := \frac{1}{D}\cdot\int_{0\cdot m}^{D} vel(U, z)\, dz \qquad U_d = 0.45024\cdot\frac{m}{sec}$$

Check to see if formula gives ref. velocity at ref. height: $vel(U, 3\cdot m) = 0.6\cdot\frac{m}{sec}$

FIND FRICTION VELOCITY THAT GIVES SAME VOLUMETRIC DISPLACEMENT

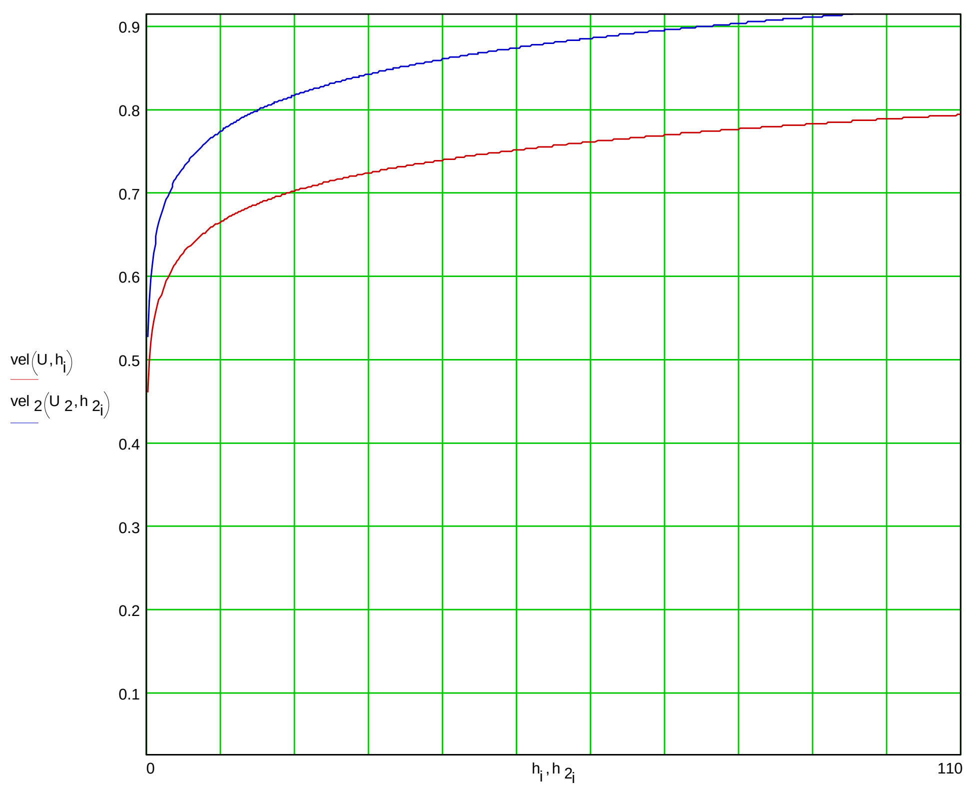
$$U_2 := root\left(\int_{0\cdot m}^{H} vel(U, h)\, dh - \int_{0\cdot m}^{H_2} vel_2\left(U_2, h_2\right) dh_2, U_2\right)$$

VOLUME COMPAIRISING

$$\int_{0\cdot m}^{H} vel(U, h)\, dh = 81.35313941\cdot\frac{m^2}{sec} \qquad \int_{0\cdot m}^{H_2} vel_2\left(U_2, h_2\right) dh_2 = 81.35313941\cdot\frac{m^2}{sec}$$

Friction velocity according Veritec RP E305

$$U = 0.0214599266\cdot\frac{m}{sec} \qquad U_2 = 0.0249743077\cdot\frac{m}{sec}$$



Water particle velocity at sea water surface level

$vel(U, H) = 0.79323884 \cdot \frac{m}{sec}$

$vel_2(U_2, H_2) = 0.9143179 \cdot \frac{m}{sec}$

Friction velocity according Veritec RP E305

$U = 0.0214599266 \cdot \frac{m}{sec}$

$U_2 = 0.0249743077 \cdot \frac{m}{sec}$

Reference velocity for water level H_2:

$vel_2(U_2, 3 \cdot m) = 0.69825889 \cdot \frac{m}{sec}$

$vel_2\left(U_2, \frac{H_2}{10} \cdot part\right) \cdot \frac{sec}{m}$	$\frac{H_2}{10} \cdot \frac{part}{m}$
0.770554477	9.550
0.813831518	19.100
0.839146999	28.650
0.857108628	38.200
0.871040753	47.750
0.882424131	57.300
0.892048641	66.850
0.900385771	76.400
0.907739642	85.950
0.914317904	95.500

Water particle velocity [m / sec]

Elevation relative to seabed [m]

$vel\left(U, \frac{H}{10} \cdot part\right) \cdot \frac{sec}{m}$	$\frac{H}{10} \cdot \frac{part}{m}$
0.669705751	11.000
0.706892869	22.000
0.728645964	33.000
0.744080037	44.000
0.756051638	55.000
0.765833149	66.000
0.7741033	77.000
0.781267231	88.000
0.787586266	99.000
0.793238836	110.000

Water particle velocity [m / sec]

Elevation relative to seabed [m]

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