Aquarius Engineering Notes

May 14-31, 2007

(c) Don Baker 2007

12 May 07

my1207c.mws

in e3 use $\left(1-\frac{a}{12}+\frac{a^2}{40}\right)$ instead of $\left(1-a/12\right)$

get 2 zeros, only one < 1

$Ph = 0.95347943$, $a = -0.082893291$

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14 May 07

REVISIT FITTING BREACH FLOW EQS TO FLUME DATA (PSWCRL)

DT's eq (1d) $\frac{Q}{\sqrt{g h_e^5}} = C_1 \left(\frac{h_e}{h_u+h_e}\right)^{C_2} \left(\frac{h_e}{h_h+h_e}\right)^{C_3} \left(\frac{b}{h_e}\right)^{C_4} \cos^{C_5}(\phi) \sin^{C_6}(\theta)$

Rewrite as $\frac{Q}{\sqrt{g h_e^3}} = C_1 \left(\frac{h_e}{h_u+h_e}\right)^{C_2} \left(\frac{h_e}{h_h+h_e}\right)^{C_3} \left(\frac{h_e}{b}\right)^{C_4} \cos^{C_5}(\phi) \sin^{C_6}(\theta)$

16raw.txt has col of Q (cfs), h_e (ft), h_h (ft), θ (rad), h_u (ft), b (in), ϕ (rad)

ARS lab notes 18 June 01:

16rawsub.prn is hh=0 data sorted on θ, ϕ, Q

16raw drp.prn is hh=0.5, 1 data sorted on θ, ϕ, hh, hu & Q

$\theta \simeq$ 0.1651, 0.2450, 0.3218, 0.3805, 0.4636, 0.7854, 1.5708

$\Rightarrow$ mu = 6:1 (h:v), 4:1, 3:1, 2.5:1, 2:1, 1:1, 0:1

$\sin\theta = y/r = \frac{v}{\sqrt{h^2+v^2}}$

$\cancel{6/\sqrt{37}}$, $\cancel{4/\sqrt{17}}$, $\cancel{3/\sqrt{10}}$, $\cancel{2.5/\sqrt{7.25}}$, $\cancel{2/\sqrt{5}}$, $\cancel{1/\sqrt{2}}$, $\cancel{0}$

$\hookrightarrow$ $1/\sqrt{37}$, $1/\sqrt{17}$, $1/\sqrt{10}$, $1/\sqrt{7.25}$, $1/\sqrt{5}$, $1/\sqrt{2}$, 1

$\phi =$ 0, 0.4636, 0.7854, 0.9823, 1.1071

$\Rightarrow$ ms = 0:1 (h:v), 1:2, 1:1, 1.5:1, 2:1

$\cos\phi = h/\sqrt{h^2+v^2} = 0, 1/\sqrt{5}, 1/\sqrt{2}, 1.5/\sqrt{3.25}, 2/\sqrt{5}$

Concatenate 16raw drp.prn onto 16rawsub.prn

Save as K:\dmbreach\arsflume\16RAWB.PRN

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$\frac{Q}{\sqrt{g h_e^3}} \rightarrow \frac{L^3/T}{\sqrt{\frac{L}{T^2} \cdot L^3}} = L$ not dimensionless $\pi_Q = \frac{Q}{\sqrt{g b^2 h_e^3}}$ $\pi_e = \frac{h_e}{b}$ are

$$\frac{Q}{b\sqrt{g h_e^3}} = C_1 \left(\frac{h_e}{h_u + h_e}\right)^{C_2} \left(\frac{h_e}{h_n + h_e}\right)^{C_3} \left(\frac{h_e}{b}\right)^{C_4} \cos^{C_5}(\phi) \sin^{C_6}(\theta)$$

Set up dimensionless variables $Q_b = \frac{Q}{b\sqrt{g h_e^3}}$ $h_1 = \frac{h_e}{h_u + h_e}$

$h_2 = \frac{h_e}{h_n + h_e}$, $h_3 = h_e/b$ (pt) $a_1 = \cos(\phi)$, $a_2 = \sin\theta$ in

MP1407a.123 by importing 16rawb.prn $g = 32.174\ ft/s^2$

Convert b to feet in the dimensionless variables

write to my1407bϕ.prn: $Q_b, H_1, H_2, H_3, A_1, A_2$ 228 lines

where $Q_b = \frac{Q}{b\sqrt{g h_e^3}}$, $H_1 = \frac{h_e}{h_u + h_e}$, $H_2 = \frac{h_e}{h_n + h_e}$, $H_3 = \frac{h_e}{b}$

$A_1 = \cos\phi$, $A_2 = \sin\theta$

simangϕ.for

Rework simanfq.for in k:\dmbreach\arsflume

to compare $\hat{Q}_b = C_1 \left(\frac{h_e}{h_u + h_e}\right)^{C_2} \left(\frac{h_e}{h_n + h_e}\right)^{C_3} \left(\frac{h_e}{b}\right)^{C_4} \cos^{C_5}\phi \sin^{C_6}\theta$

to $Q_b(i) = \frac{Q}{b\sqrt{g h_e^3}}$ $\hat{Q}_b = C_1 H_1^{C_2} \cdot H_2^{C_3} \cdot H_3^{C_4} \cdot A_1^{C_5} \cdot A_2^{C_6}$

Should also try replacing H_3 with $\left(\frac{b + h_e}{b}\right)^{\alpha}$

$H_1 = \left(\frac{h_n + h_e}{h_n}\right)$, $H_2 = \left(\frac{h_u + h_e}{h_u}\right)$

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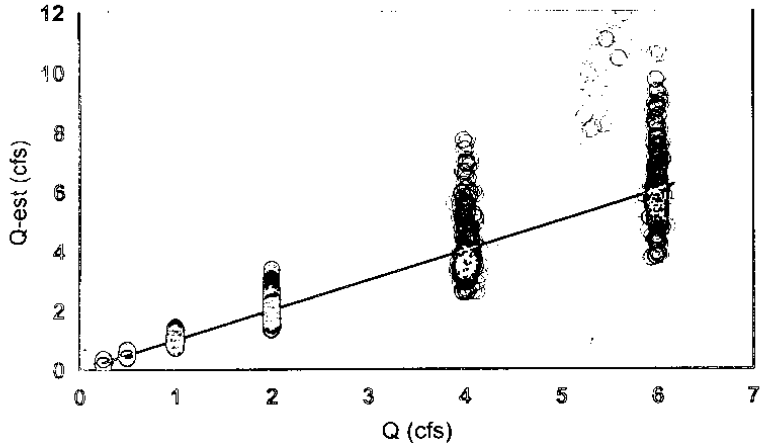
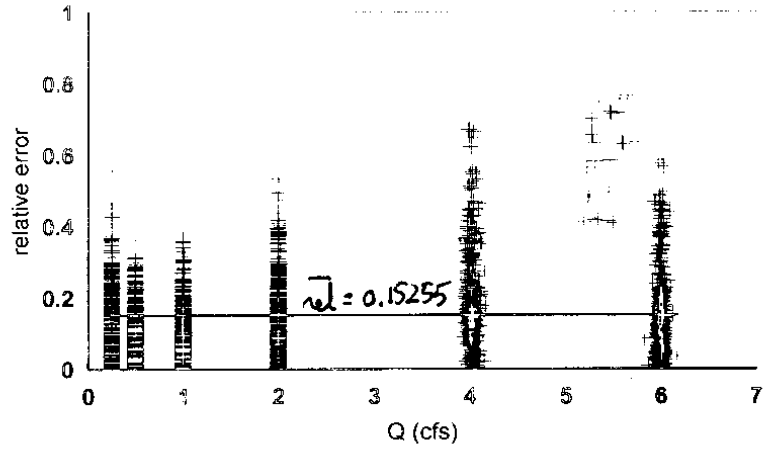
mq1407a.123

Plots $\frac{Q}{b\sqrt{g h_e^3}} = C_1\left(\frac{h_e}{h_u + h_e}\right)^{C_2}\left(\frac{h_e}{h_h + h_e}\right)^{C_3}\left(\frac{h_e}{b}\right)^{C_4}\cos^{C_5}\phi \sin^{C_6}\theta$





$$rel\ er = \frac{|Q - \hat{Q}|}{\sqrt{|Q \cdot \hat{Q}|}}$$

$C_1 = 34968$

$C_2 = -0.024797$

$C_3 = -0.33339$

$C_4 = 0.32925$

$C_5 = -0.34908$

$C_6 = -0.22005$

$rel = 0.15255$

simang1.for

Recover simang4.for to take in Q, he, hh, θ, hu, b, φ from 16raw6.prn and calculate the fit terms

Start with $\frac{Q}{\sqrt{g h_e^5}} = d_1\left(\frac{h_e}{h_u + h_e}\right)^{d_2} + \left(\frac{h_e}{h_h + h_e}\right)^{d_3}\left(\frac{b}{h_e}\right)^{d_4}\cos^{d_5}\phi \sin^{d_6}\theta$

$h_1 \quad h_2 \quad h_3 \quad a_1 \quad a_2$

$qb = ~~d_1 h_1^{d_2}~~ C$

$= d_1 h_1^{d_2} h_2^{d_3} h_3^{d_4} a_1^{d_5} a_2^{d_6}$

Convert b to feet

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imaug1.for (cont'd)

Use Watcom F77 Getdat & Gettim subroutines to set iseed1 and iseed2 in subroutine sa.

getdat(iyy, imm, idd) $0 \le iseed1 \le 31328$

$1 \le idd \le 31$ $1 \le imm \le 12$ $0 \le iyy \le 99$ $0 \le iseed2 \le 30081$

1-31, 1-12, 1-31 idd + imm*31 + iyy*365

1 2 3

31 + (12-1)*(iyy-1)*

~~iseed1 = idd + (imm-1)*31 + iyy*250~~

gettim(hrs, mins, secs, hsecs) hsecs ⇒ 0.01s * n

iseed1 = hsecs + secs*100 + (mins/12)*6000

(0 to 99 by 1) + (0 to 5900 by 100) + (0 to 24,000 by 6000) → 29999

~~+ mins*1000 → 0 to 60000 by 1000~~

iseed2 = idd + (imm-1)*31 + hrs*372 + mins*350

1 to 31 by 1, 0 to 341 by 31, 0 to 8556 by 372 0 to 20650

372 8928 29578

Read in 16rawb.prn, code.opt. based on relative errors

$\frac{Q}{\sqrt{g h_e^5}}$ vs $\left[\frac{Q}{\sqrt{g h_e^5}}\right]^{\wedge}$ then convert to Q and $\hat{Q}$ at end and write out both relative errors

16rawb.prn → $q_i, he_i, hh_i, th_i, hu_i, b_i, f_{ii}$

my1607a1.prn ← gross results

my1607a2.prn ← ~~H_{1i}~~, $H_{1i}, H_2, H_3, A_1, A_2$, he, hh, hu, b, th, θ, ϕ, f_i, Q, $\hat{Q}$, rel, Q_π, $\hat{Q}_\pi$, rel-pi

→ my1607a.123

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$$\frac{Q}{\sqrt{g}\,h_e^{5}} = D_1\left(\frac{h_e}{h_w+h_e}\right)^{D_2}\left(\frac{h_e}{h_h+h_e}\right)^{D_3}\left(\frac{b}{h_e}\right)^{D_4}\cos^{D_5}\phi\,\sin^{D_6}\theta$$

$H_1^{D_2}$ $H_2^{D_3}$ $H_3^{D_4}$ $A_1^{D_5}$ $A_2^{D_6}$

$D_1 = 3.4978$

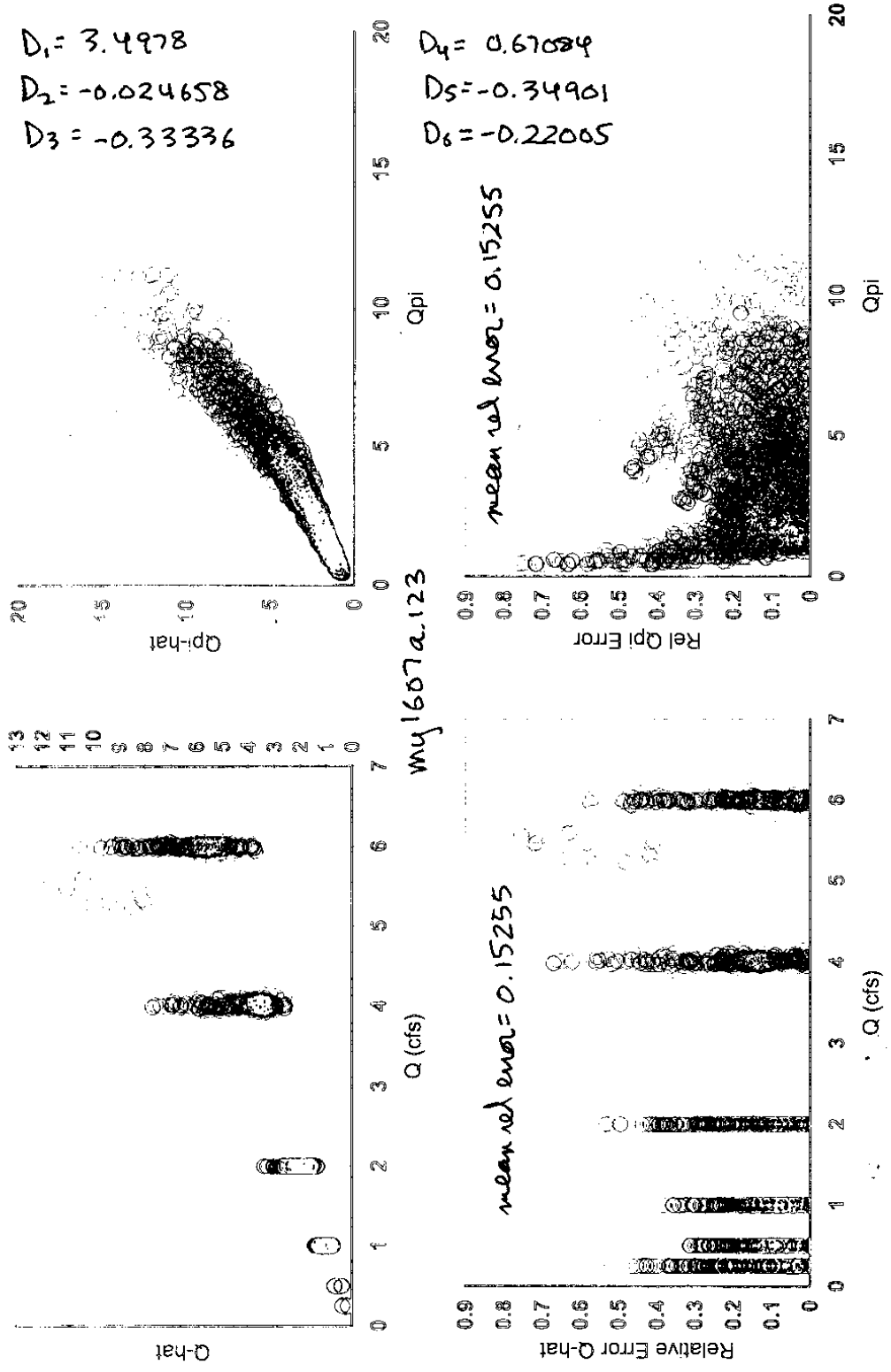
$D_2 = -0.024658$

$D_3 = -0.33336$

$D_4 = 0.670894$

$D_5 = -0.34901$

$D_6 = -0.22005$



Ran several times & got similar D_j values each time

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simang2.for

~~Run again: my16rawb.prn → my1607a3, ... a4.prn~~

Three types of flow: ~~$Q_a \sim b\sqrt{gh_e^3}$ $Q_b \sim$~~

$Q_a \sim mu\sqrt{gh_e^5}$ $Q_c \sim ms\sqrt{gh_e^5}$ $Q_b \sim b\sqrt{gh_e^3}$

Modified by h_e compared to h_h due to the transition from aerated jet to supported jet $h_e \ll h_h \rightarrow$ aerated

$h_e \gg h_h \rightarrow$ supported $mu = h:v = \cot\theta$, $ms = h:v = \tan\phi$

Several possible modifiers using h_e & h_h (headout height): $0 < h_e < 1$, $0 \rightarrow 1$ as $1 \rightarrow 0$

$0 \le \frac{h_e}{h_h} < \infty$, $0 \le \frac{h_e}{h_h + h_e} \lesssim 1$ $1 \le \frac{h_e + h_h}{h_h} < \infty$ $1 - \frac{h_e}{h_e + h_h} = \frac{h_h}{h_e + h_u}$

We know that for $h_e \gg h_u$, flow through a trapezoid channel is the dominant model, but for $h_e \ll h_u$, added flow due to the upstream slope is the dominant model (Q_c becomes dominant for high ms)

$$Q = C_1 b\sqrt{gh_e^3} + C_2 m_s^{C_3}\sqrt{gh_e^5} + C_4 M_u^{C_5}\sqrt{gh_e^5}$$

$$Q = C_1\left[b\sqrt{gh_e^3} + C_2 M_s^{C_3}\sqrt{gh_e^5}\right] + C_4 M_u^{C_5}\sqrt{gh_e^5}$$

$$Q = C_1 b\sqrt{gh_e^3} + C_2\left(\frac{h_e}{h_e+h_h}\right)^{C_3} M_s^{C_4}\sqrt{gh_e^5} + C_5\left(\frac{h_h}{h_e+h_h}\right)^{C_6} M_u^{C_7}\sqrt{gh_e^5}$$

$$\frac{Q}{b\sqrt{gh_e^3}} = C_1 + C_2\left(\frac{h_e}{h_e+h_h}\right)^{C_3} m_s^{C_4}\left(\frac{h_e}{b}\right) + C_5\left(\frac{h_h}{h_e+h_h}\right)^{C_6} m_u^{C_7}\left(\frac{h_e}{b}\right)$$

$$\frac{Q}{b\sqrt{gh_e^3}} = C_1 + C_2\frac{h_e}{b}\left[\omega^{C_3} m_s^{C_4} + C_5(1-\omega)^{C_6} m_u^{C_7}\right]^{C_8}, \quad \omega = \frac{h_e}{h_e+h_h}$$

$$= D_1 + D_2 h_b\left(\omega^{D_3} m_s^{D_4} + D_5(1-\omega)^{D_6} m_u^{D_7}\right]^{D_8}$$

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$$\frac{Q}{b\sqrt{g h_e^3}} = D_1 + D_2\left[\frac{h_e}{b}\right]^{D_3} w^{D_4} m_s^{D_5} + D_6(1-w)^{D_7} m_a^{D_8} \quad (\text{if signs})$$

$$w = \frac{h_e}{h_h + h_e} \qquad m_s = \tan\phi \;,\; m_a = \frac{1}{\tan\theta}$$

$D_1 + D_5$ at upper set limit +5
After set penalties for
$|(D_3+D_4)*D_8| + (D_6+D_7*D_8|>40$

$D_1 = 5$, $D_2 = 0.45706$, $D_3 = -0.80283$
$D_4 = 1.0333$, $D_5 = 5$, $D_6 = 2.2857$
~~$D_7 = 2.2857$~~, $D_7 = 1.2005$
$D_8 = 0.6776$
normalized error =
0.077462

my1707a.123

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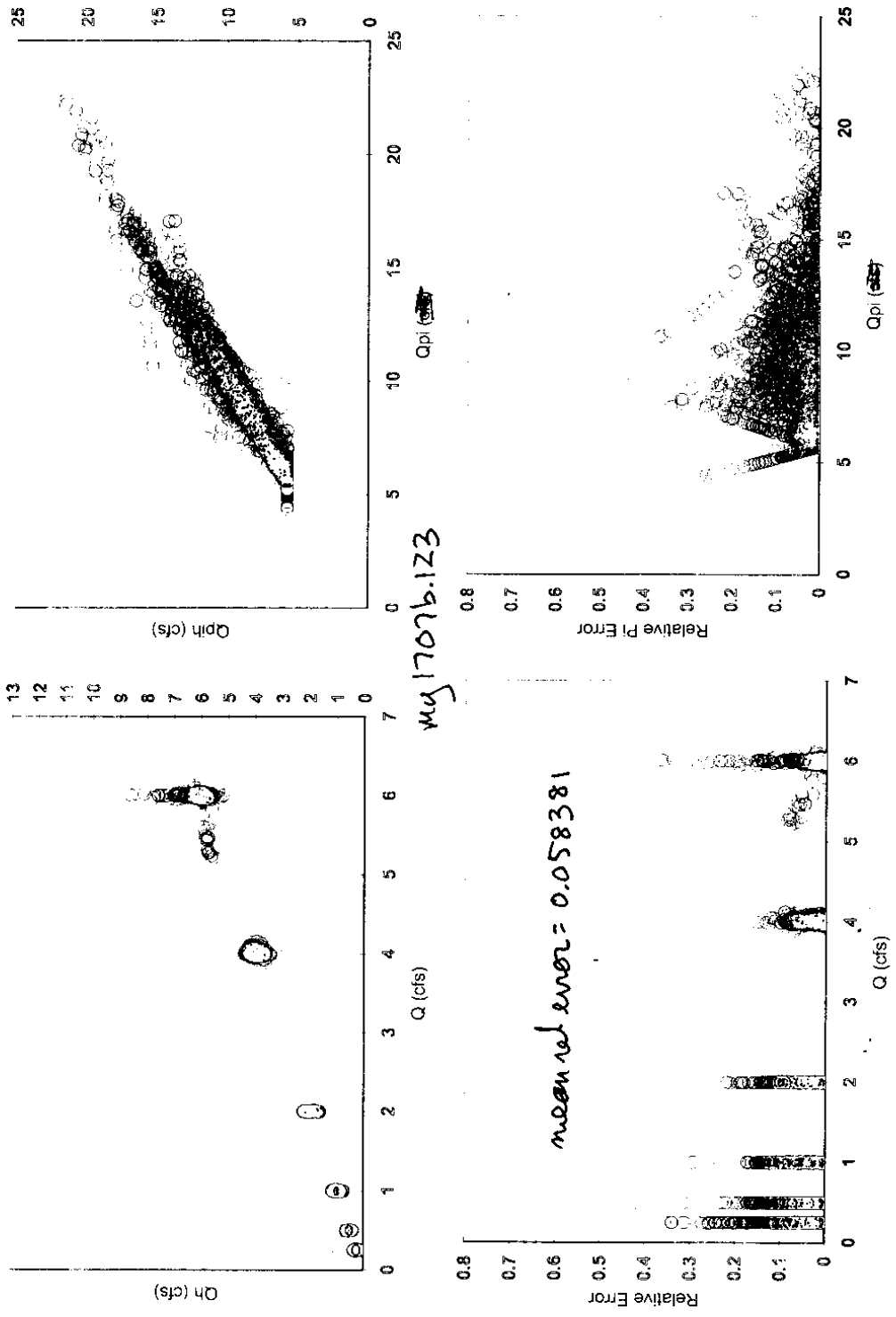
si:mang3.for (again) fix b*12 error in $\hat{Q}$, set nb(i)=8

lb(i=-5) → my1707b1, b2.prn — $D_1 = 9.7292$, $D_2 = 0.32439$

$D_3 = -0.84251$, $D_4 = 1.3365$, $D_5 = 6.349$, $D_6 = 2.0484$

$D_7 = 1.1691$, $D_8 = 0.70409$



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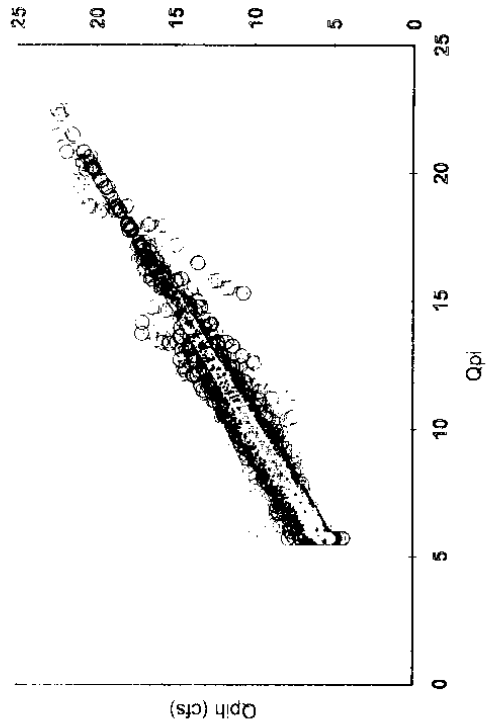
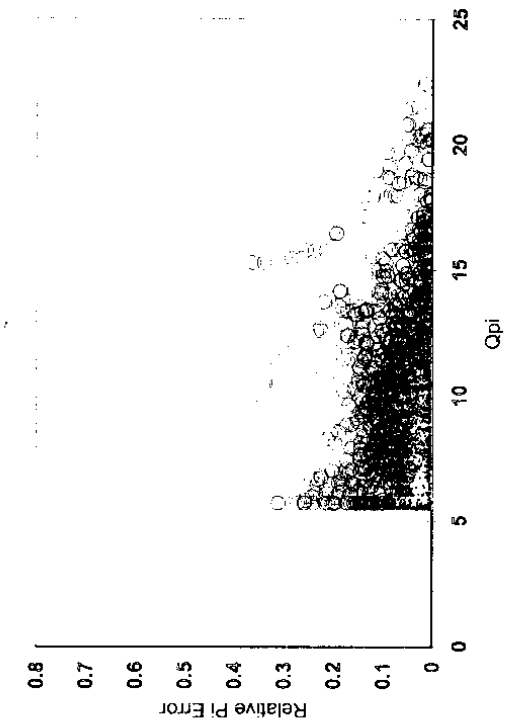
simang4.for : $\frac{Q}{b\sqrt{g}h_e^{3/2}} = D_1 + \frac{h_e}{b}\left[D_2 w^{D_3} m_s^{D_4} + D_5 w^{D_6} m_u^{D_7}\right]^{D_8}$

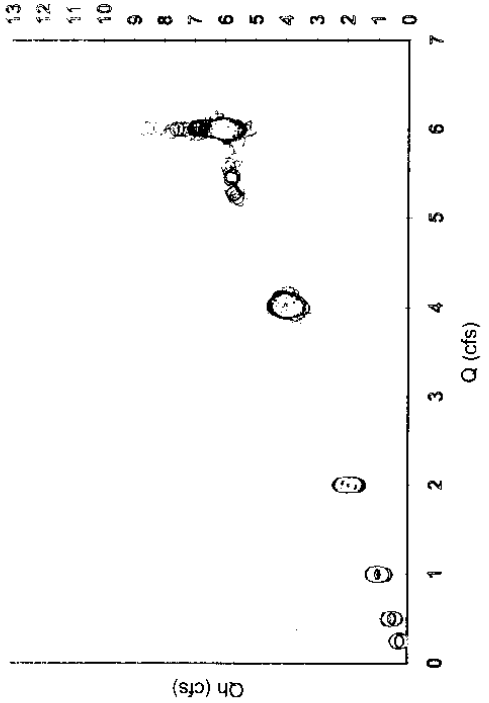
→ my1707b1, b2.prn → my1707c.123, $D_1 = 5.7292$

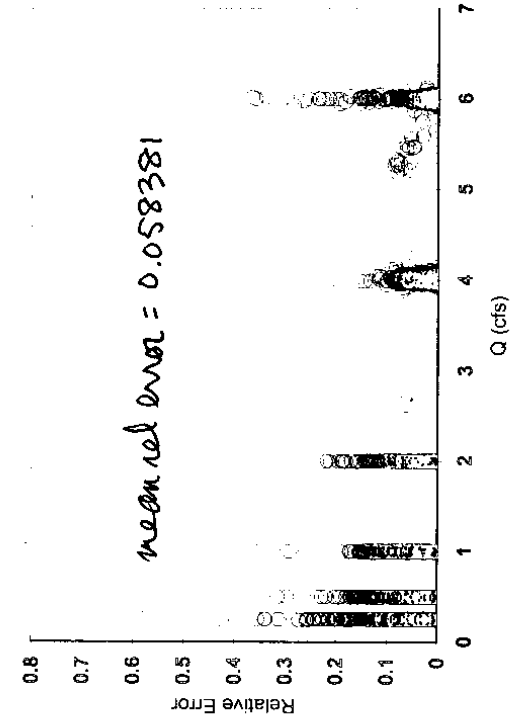
$D_2 = 0.32439$, $D_3 = -0.84251$, $D_4 = 1.3365$, $D_5 = 6.349$

$D_6 = 2.0484$, $D_7 = 1.1691$, $D_8 = 0.70409$









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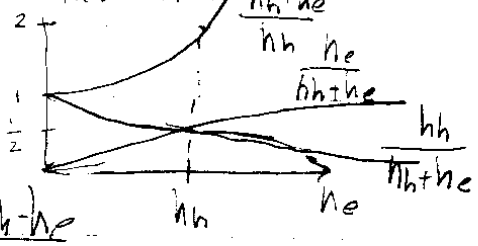
From before $Q = a_0 \frac{2\sqrt{2g}}{3} b h_e^{3/2} + a_1 \frac{8\sqrt{2g}}{15} \tan\phi\, h_e^{5/2}$

$Q = a_0 \frac{2\sqrt{2g}}{3} b h_e^{3/2} + a_1 \frac{8\sqrt{2g}}{3} \left(\underset{ms^2}{\tan^2\phi} + \underset{+mu^2}{1/\tan^2\theta}\right)^{1/2} h_e^{5/2}$

(a) $\frac{Q}{b\sqrt{g h_e^3}} = D_1 + D_2 \frac{h_e}{b} \omega^{D_3} \underset{ms}{\tan\phi} + D_4 \frac{h_e}{b} (1-\omega)^{D_5} \left(\underset{ms^2}{\tan^2\phi} + \underset{+mu^2}{\cot^2\theta}\right)^{D_6}$



for ω: $\frac{h_e}{h_h+h_e}$, $\frac{h_h+h_e}{h_h}$, $\frac{h_e}{h_h}$, $\frac{h_e}{\sqrt{b h_h}}$

$\frac{h_e}{h_h+h_e} + \frac{h_h+h_e}{h_h} - 1 = \frac{h_e h_h + (h_h+h_e)^2 - h_h - h_e}{h_h(h_h+h_e)}$

$\frac{h_h^2 + 3h_h h_e + h_e^2 - h_h - h_e}{r_{in}(r_{in}+r_e)}$ too complicated

$\omega = \frac{h_e}{h_h+h_e} \rightarrow 1-\omega = \frac{h_h}{h_h+h_e}$, $\omega = \frac{r_{in}+r_e}{r_{in}} \rightarrow 1-\omega = \frac{h_e}{h_h}$

(b) $\frac{Q}{b\sqrt{g h_e^3}} = D_1 + D_2 \frac{r_e}{b} \omega^{D_3} (1-\omega)^{D_4} \tan\phi + D_5 \frac{h_e}{b} \omega^{D_6} (1-\omega)^{D_7} \left(\tan^2\phi + \frac{1}{\tan^2\theta}\right)^{1/2}$

(c) $\frac{Q}{b\sqrt{g h_e^3}} = D_1 + \frac{h_e}{b}\left[D_2 \omega^{D_3}(1-\omega)^{D_4} \tan\phi + D_5 \omega^{D_6}(1-\omega)^{D_7} \left(\tan^2\phi + \frac{1}{\tan^2\theta}\right)^{1/2}\right]^{D_8}$

(d) $\frac{Q}{b\sqrt{g h_e^3}} = D_1 + \frac{h_e}{b}\left[(D_2 + D_3\omega + D_4\omega^2)\tan\phi + (D_5 + D_6\omega + D_7\omega^2)\left(\tan^2\phi + \frac{1}{\tan^2\theta}\right)^{1/2}\right]^{D_8}$

(e) $\frac{Q}{b\sqrt{g h_e^3}} = D_1 + \left(D_2 + D_3\omega + D_4\omega^2\right)\left(\frac{r_e}{b}\right)^{D_5} \tan\phi + \left(D_6 + D_7\omega + D_8\omega^2\right)\left(\frac{r_e}{b}\right)^{D_9} \left(\tan^2\phi + \frac{1}{\tan^2\theta}\right)^{1/2}$

(f) $\frac{Q}{b\sqrt{g h_e^3}} = D_1 + \left(D_2 + D_3\omega + D_4\omega^2\right)\left(\frac{h_e}{b}\right)^{D_5} \tan\phi + \left(D_6 + D_7(1-\omega) + D_8(1-\omega)^2\right)\left(\frac{h_e}{b}\right)^{D_9} \left(\tan^2\phi + \frac{1}{\tan^2\theta}\right)^{1/2}$

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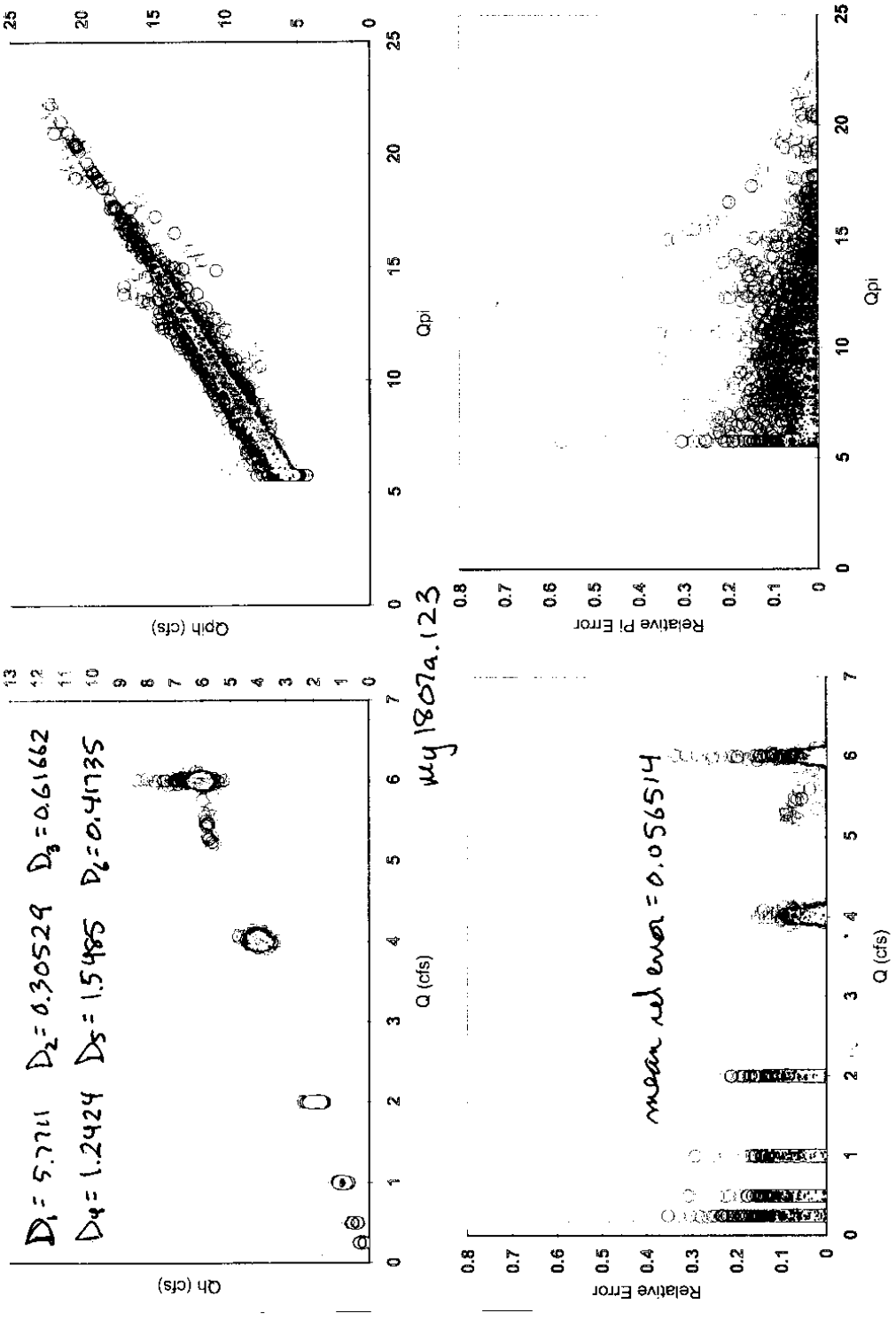
simangS.for $\frac{Q}{b\sqrt{g h_c^3}} = D_1 + D_2 \omega^{D_3} ms + D_4 (1-\omega)^{D_5} (ms^2 + mu^2)^{\frac{1}{2} D_6} \left(\frac{h_c}{b}\right)$

Initial ~~Dif~~ except $D_1 = 5$, $D_2 = D_4 = 4$, $D_6 = 0.5$, $D_3 = D_5 = 0$

→ my1807a1, a2.prn → my1807a.123



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simang6.for $\frac{Q}{b\sqrt{g}he^3} = D_1 + \left[D_2 w^{D_3}(1-w)^{D_4} MS + D_5 w^{D_6}(1-w)^{D_7}(MS^2+MU^2)^{1/2}\right]\frac{he}{b}$

→ my1807b1,b2.prn → my1807b.123

Initial: $D_1=6$, $D_2=0.5$, $D_3=D_4=0$, $D_5=1.5$, $D_6=D_7=0$

Final $D_1=5.9132$ $D_2=0.37484$ $D_3=0.61305$ $D_4=0.011564$

$D_5=1.3752$ $D_6=0.18567$ $D_7=1.8523$

rel-err = 0.0592030

simang6.for $\frac{Q}{b\sqrt{g}he^3} = D_1 + \left(\frac{he}{b}\right)\left[D_2 w^{D_3} MS + D_4 (1-w)^{D_5}(MS^2+MU^2)^{D_6}\right]^{D_7}$

→ my1807b1,c2.prn BAD RESULT

Initial: $D_1=6$, $D_2=0.4$, $D_3=0.6$, $D_4=1.4$, $D_5=2$, $D_6=0.5$, $D_7=1$

Final $D_1=5.7711$, $D_2=0.30529$, $D_3=0.61671$, $D_4=1.2425$

$D_5=1.5485$ $D_6=0.41735$ $D_7=-0.64351$

rel error = 148.21 but it started out < 0.1

Try again, this time $D_7>0$ lb(7) = 1.d-10

→ my1807d1,d2.prn Also, if VM_i out of bounds

time 937: VM(i) = (0.75d0 + 0.2499 * ranmar()) * (ub(i) - lb(i))

~~Blew up again at the end - calculating rel~~

Fix fcn & try again w/ my1807c1,c2.prn leave lb(7) = ~~1.d-10~~ -5

Final: $D_1=5.8259$ $D_2=0.32423$ $D_3=0.79090$

$D_4=1.2047$ $D_5=1.4213$ $D_6=0.38377$ $D_7=1.0941$

rel-error = 0.0562866

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simang7.for $\frac{Q}{b\sqrt{g}he^{3}} = D_1 + D_2\left(\frac{h_o}{b}\right)^{D_3} w^{D_4} ms^{D_5} + D_6\left(\frac{he}{b}\right)^{D_7}(1-w)^{D_8}\left(ms^2+mu^2\right)^{D_9}$

Initial: $D_1=5.8$, $D_2=0.3$, $D_3=1$, $D_4=0.8$, $D_5=1$
$D_6=1.2$, $D_7=1$, $D_8=1.4$, $D_9=0.4$

→ my1707d1, d2.prn

Final: $D_1=5.6922$ $D_2=0.316$ $D_3=0.99742$, $D_4=0.77434$
$D_5=0.99867$ $D_6=1.4626$ $D_7=0.80660$
$D_8=1.1513$ $D_9=0.39619$ rel-err = .0530831

---

simang7.for → $\frac{Q}{b\sqrt{g}he^{3}} = D_1 + \frac{he}{b}\left[\left(D_2+D_3w+D_4w^2\right)ms\right]\left(D_5+D_6(1-w)+D_7(1-w)^2\right)\left(ms^2+mu^2\right)^{D_8}\left(\frac{he}{b}\right)^{D_9}$

Initial $D_1=5.7$ $D_2=0$, $D_3=0.3$, $D_4=0$, $D_5=0$
$D_6=1.5$ $D_7=0$ $D_8=1.4$ $D_9=0.8$ → my1807e1,e2.prn

Set $C_i=2$ initially → ~4 times as many uphill accepted as rejected; set $C_i=\sqrt{2}$ → not much difference

Final: $D_1=5.6662$ $D_2=0.070971$ $D_3=0.1036$ $D_4=0.14113$
$D_5=0.020553$ $D_6=1.9651$ $D_7=-0.5539$ $D_8=0.39012$
$D_9=0.70376$ mean relative error = 0.0531255

---

simang7.for → $\frac{Q}{b\sqrt{g}he^{3}} = D_1 + \left(D_2w+D_3w^2+D_4w^3\right)\frac{he}{b}ms + \left(D_5(1-w)+D_6(1-w)^2+D_7(1-w)^3\right)\left(ms^2+mu^2\right)^{D_8}\left(\frac{he}{b}\right)^{D_9}$

Initial: $D_1=5.66$, $D_2=0.1$, $D_3=0.15$, $D_4=0$, $D_5=2$, $D_6=-0.6$
$D_7=0$, $D_8=0.4$, $D_9=0.7$ → my1807f1,f2.prn

Final: $D_1=5.6936$ $D_2=0.6605$ $D_3=-0.74566$ $D_4=0.4002$
$D_5=0.059846$ $D_6=5.8043$ $D_7=-5$ $D_8=0.39358$
$D_9=6.67065$ mean rel error = 0.0469441

18 May 07

simang7.for Same formula, but change lb(i) to -10 except

$lb_1 = 0.01$ Initial: $D_1 = 5.7$, $D_2 = 6.7$, $D_3 = -0.7$ $D_4 = 0.4$

$D_5 = 0.06$, $D_6 = 5.8$, $D_7 = -5$, $D_8 = 0.4$, $D_9 = 0.67$

→ my1807g1, g2.prn

Final: $D_1 = 5.6619$ $D_2 = 2.5556$ $D_3 = -6.8380$ $D_4 = 4.6032$

$D_5 = 2.5860$ $D_6 = -0.44892$ $D_7 = -1.1077$ $D_8 = 0.38545$

$D_9 = 0.60557$ mean rel error = 0.0532038

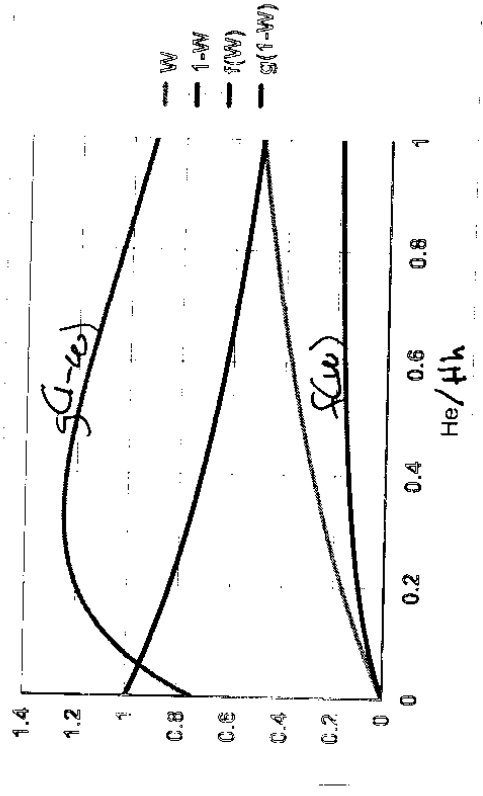
rerun with changes: iseed1 = 1 → 362, iseed2 = 2 → 95

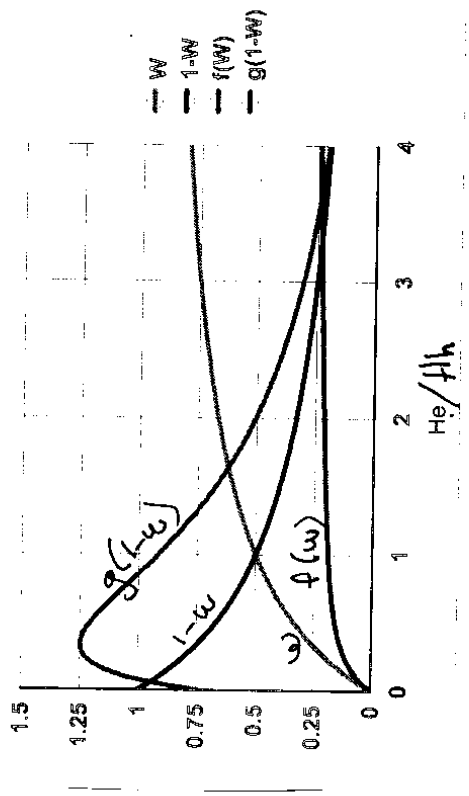
ns = 20 → 21 → my1807h1, h2.prn

Final: $D_1 = 5.6920$ $D_2 = 0.78240$ $D_3 = -1.1427$ $D_4 = 0.67575$

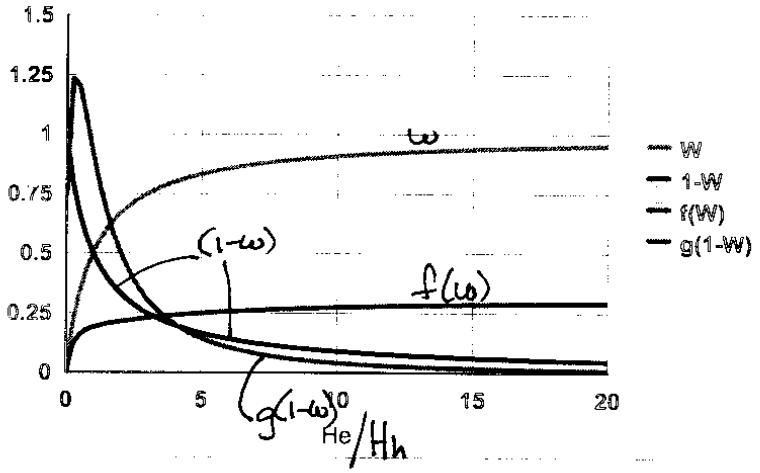
$D_5 = -0.11588$ $D_6 = 6.9264$ $D_7 = -6.0681$ $D_8 = 0.38644$

$D_9 = 0.64499$ mean rel error = 0.0468260 ~4.7%





18 May 07

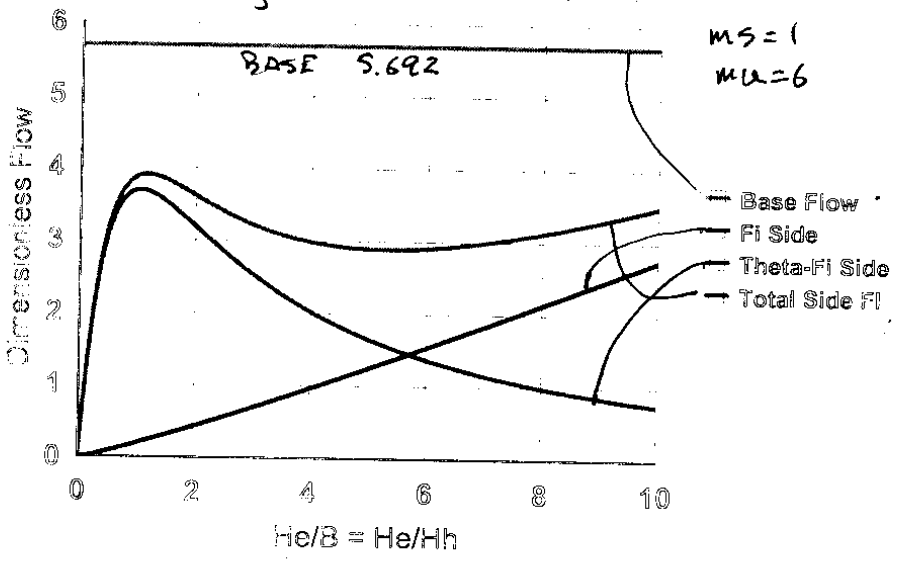


Hours slant

$$\frac{Q}{b\sqrt{g}he^{3}} = D_1 + (D_2 + D_3\omega + D_4\omega^2)\frac{he}{b}\,ms + (D_6 + D_7\frac{}{(1-\omega)} + D_8\frac{}{(1-\omega)^2})\left(\frac{he}{b}\right)^{D_9} mu^{D_{10}}$$

19 May 07

Create file of flume datee scaletst.prn from Allrawa1.prn, containing just the 8 & 32 in breadth data



19 May 07

scaleadj.for

Calculate fit of my1807h data eqn in siman g7.for to scaletst.prn 8d32-inch data → mean rel error = 0.0813 with std = 0.103 Plot in scaletest.123, sheet A

scaleal.for

Calculate fit of my1807a data from eqn in ~~simang8.for~~ siman

$$\frac{Q}{\sqrt{g h_e^5}} = D_1 \left(\frac{h_e}{h_u + h_e}\right)^{D_2} \left(\frac{h_e}{h_h + h_e}\right)^{D_3} \left(\frac{b}{h_e}\right)^{D_4} \cos\Phi^{D_5} \sin\theta^{D_6}$$

$D_1 = 3.4978$, $D_2 = -0.024658$, $D_3 = -0.33336$ $D_4 = 0.67084$

$D_5 = -0.34901$ $D_6 = -0.22005$

→ mean relative error = 0.1946 with std = 0.1501

FIXED UP - b is in feet already

Rerun everything into same files with factors of 12*b or b/12 taken out of fits.

simangl.for

Rerun to same files my1607a1, a2.prn, iseed1 = 19, iseed2 = 32

Put new data in second sheet of my1607a.123

$D_1 = 0.66038$, $D_2 = -0.024799$, $D_3 = -0.33339$, $D_4 = 0.67075$

$D_5 = -0.34908$ $D_6 = -0.22007$ mean rel error = 0.15255

The same to all else except scaling by the change in b.

Get the same plots and scales ~~to~~ because b is not part of $Q_\pi = Q/\sqrt{g h_e^5}$

19 May 07

simang7.for Run again fix b-factor iseed = 96
→ my1807h5, h6.prn instead iseed = 407
add statistical calculations from scaleal.for → my1807h7
Remove 12-factor from scaleal.for → scalea2.for
Final: $D_1 = 0.47369$ $D_2 = 1.7421$ $D_3 = -4.0343$
$D_4 = 2.6095$ $D_5 = 0.15759$ $D_6 = 2.1996$ $D_7 = -2.0603$
$D_8 = 0.39272$ $D_9 = 0.63536$ reten = 0.492461
scaling test fit reten = ~~7.06801~~ std = 13.0028
screwed up the scaling test do it again w/ scaleal.for
overwrite my1807h7.prn ⟹ reterror = 0.0794835
std = 0.102761

Need to create a subroutine to hold the discharge relation as a separate function to be used in fcn, siman and the scale test routine — all in simang*.for

20 May 07

simang8.for ← simang7.for
Create subroutine fit to hold fitting function
subroutine fit (n, d(n), m, v(m), q)
Suppose $q = d_1 + w*(d2 + w*(d3 + w*d4)) \cdot ms \cdot hb$
$wm*(d5 + wm*(d6 + wm*d7)) * (ms^2 + mu^2)^{d8} hb^{d9}$ → n = 9
Let $v_1 = hb$, $v_2 = w$, $v_3 = ms$, $v_4 = mu$, → m = 4

```
      subroutine fit (n, d, m, v, q)
      real*8 d(n), v(m), q
C     hb = v(1)
      w = v(2)                    EXAMPLE
      wm = 1.d0 - w
      ms = v(3)
      mu = v(4)
      q = d(1) + w*(d(2)+w*(d(3)+w*d(4)))*ms*hb
     + + wm*(d(5)+wm*(d(6)+wm*d(7)))*
     +  ((ms*ms+mu*mu)**d(8))*(hb**d(9))
      return
      end
```

Set up fcn(n, x, rel) with integer flag in common /i/ to do std processing if istd = 1, feed ans back in /r1/ (istd)

```
      subroutine fcn(n, x, rel)
      :
      common /r1/ d1, ..., fit(nd), stdpi
      common /i1/ np, istd
      rel = 0.d0 ; stdpi = 0.d0
      d1 = x(1) ...  , gpi =
      do i = 1, np
        v(1) = hb(i) ; v(2) = w(i) , v(3) = mu(i), v(4) = ms(i)
        if(v(2) .le. 0.d0) v(2) = 1.d-10 also v(3) & v(4)
        if(v(2) .gt. 1.d0) v(2) = 1.d0 - 1.d-10
        call fit(n, x, 4, d, gph)
```

20 May 97

(subroutine fcn (cont'd))

```
do i = 1, np
   v(1) = hb(i), ...
   do j = 1, 4
      if (v(j) .le. 0.d0) v(j) = 1.d-10
   end do
   if (v(2) .gt. 1.d0) v(2) = 1.d0 - 1.d-10
   call fic (n, x, 4, v, qpin)
   if (qph .lt. 0.d0)
      rel1 = 20.d0 + rel1*rel1
   rel1 = dabs(qph - qp(i)) / dsqrt(dabs(qph*qp(i)))
   rel = rel + rel1
   if (istd .eq. 1) std = std + rel1*rel1
end do
xn = dble(np)
if (istd .eq. 1)
   std = dsqrt((xn*std - rel*rel) / (xn*(xn-1)))
rel = rel / xn
return, end
```

$$\frac{Q}{b\sqrt{g}\,he^{3}} = D_1 + D_2\left(\frac{he}{b}\right)^{D_3} w^{D_4} MS^{D_5} + D_6\left(\frac{he}{b}\right)^{D_7} (1-w)^{D_8} mcl^{D_9}$$

20 May 07

simag8.for

Set up to fit: $\frac{Q}{b\sqrt{g}he^3} = D_1 + D_2\left(\frac{he}{b}\right)^{D_3} w^{D_4} ms^{D_5} + D_6\left(\frac{he}{b}\right)^{D_7}(1-w)^{D_8} mu^{D_9}$

$w = \frac{he}{hh+he}$ $D_6 = 1.5$

Initial: $D_1 = 0.5$, $D_2 = 0.5$, $D_3 = 1$, $D_4 = 1$, $D_5 = 1 = D_7 = D_8 = D_9$

iseed1 = 931, iseed2 = 1, $lb_i = -10$, $lb_1 = 0.01$ $ub_i = 10$

mg16rawb.prn & scaletst.prn → my2007a1, a2, a3.prn

a1 contains finished values of xopt, vm, ret, std

a2 contains linear fitting data: hb, w, mu, ms, he, hh, hu, b, θ, Φ, q, $\hat{q}$, rel-error, Φ_π, $\hat{\Phi}_\pi$, rel-fit-error

a3 contains the same data as a2, but for 8 & 32 in scale test data - application of fitted eqn to new data at diff scales followed by mean rel-error & std dev

FINAL: $D_1 = 0.54967$, $D_2 = 0.22773$, $D_3 = 1.5508$, $D_4 = -1.5326$, $D_5 = 0.71519$, $D_6 = 0.51208$, $D_7 = 0.77378$, $D_8 = 10^{-6}$, $D_9 = 0.38104$

ret error = 0.14459 std err = 0.13137 errors in calc ms <-> mu

Some errors in writing out the files, fix & do again, overwriting files, w/ iseed1 = 950 iseed2 = 99

Initial $D_1 = 0.5$, $D_2 = 0.2$, $D_3 = 1.5$, $D_4 = 1.0$, $D_5 = 0.7$, $D_6 = 0.5$

$D_7 = 0.8$, $D_8 = 1.0$ $D_9 = 0.4$

~~ret comes up NaN~~ fixed it (mu & ms not integer) 0**D8 outside of simag

Final: ret & std still not calculating consistently, but

ret = 0.0591161 $D_1 = 0.48272$ $D_2 = 0.31522$ $D_3 = 1.0541$

$D_4 = -0.34019$ $D_5 = 1.0091$ $D_6 = 0.80461$

$D_7 = 0.79369$ $D_8 = 1.1367$ $D_9 = 0.77909$

std = 0.058761 scale test cases need work

21 May 07

scale~~test~~a2.for ← scalea1.for

in k:\dubreach\arsflume\scaleTest\

Use subroutine fit ~~from~~ from simang8.for

change scalea1.for to a2 to do what subroutine scale should have done in simang8.

write over my2007a3 Use $D_1 = 0.48272$, $D_2 = 0.31522$, $D_3 = 1.0541$, $D_4 = -0.34019$, $D_5 = 1.0091$, $D_6 = 0.80461$ $D_7 = 0.79369$, $D_8 = 1.1367$ $D_9 = 0.77909$ for

$$\frac{Q}{b\sqrt{g}he^3} = D_1 + D_2\left(\frac{he}{b}\right)^{D_3} w^{D_4} ms^{D_5} + D_6\left(\frac{he}{b}\right)^{D_7} (1-w)^{D_8} mu^{D_9}$$

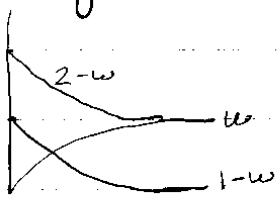
Now get consistent results $\overline{ret} = \overline{retpi} = 0.133301$

$std = stdpi = 0.136353$

simang8.for

Copy sub fit to end of program & rename fitasp

Modify fit to $Q/b\sqrt{g}he^3 = D_1 + D_2\left(\frac{he}{b}\right)^{D_3}(2-w)^{D_4} ms^{D_5} + D_6\left(\frac{he}{b}\right)^{D_7}(1-w)^{D_8} mu^{D_9}$



→ my2107a1, a2, a3.prn

Initial $D_1 = 0.5$, $D_2 = 0.3$, $D_3 = 1$, $D_4 = 0.3$ $D_5 = 1$ $D_6 = 0.8$ $D_7 = 0.8$ $D_8 = 1.1$, $D_9 = 0.8$ same iseed#s

Set $c(i) = 1.1$ $vm(i) = 0.67(ub(i) - lb(i))$

A lot of trials are still out of bounds. Should try for the golden ratio ∴ a b ; $\frac{1-b}{b} = \frac{b-a}{a} = r$

$b - a = ar$ $b = a(1+r)$

$1 - b = br$ $1 = b(1+r) = a(1+r)^2$ NG Golden ratio = 1.618

$\frac{1}{1.618} = 0.618$

next time $c(i) = 1.618$

$vm(i) = 0.618(ub(i) - lb(i))$

21 May 07

my 2107a

Final: $D_1 = 0.47747$ $D_2 = 0.27343$ $D_3 = 1.0009$

$D_4 = -0.49738$ $D_5 = 1.0582$ $D_6 = 0.036133$

$D_7 = 1.1446$ $D_8 = 5.8750$ $D_9 = 0.81281$

$\overline{ret} = 0.0785408$ std = ~~out of whack~~ (~~0.0645695~~ 0.0645837 by 1-23)

scale fit $\overline{ret} = 0.146692$ std = 0.134813

$D_6 + D_8$ indicate a certain struggle for balance, confirmed by the larger $\overline{ret}$

The ~~to~~ $(1-w)^{D_4}$ and $(2-w)^{D_4}$ term with ms may have $D_4 < 0$ because ms is strongly a part of the $(ms^2 + mu^2)^{D_x}$ term not used this time. It would bump up the ms term for $h_e << h_h$ using ~~[illegible]~~ w^{D_4} ~~or~~ $(2-w)^{D_4}$ is not ~~so~~ clear

Screwed up, Actually had $Q/b\sqrt{h_e^3} = D_1 + D_2\left(\frac{h_e}{b}\right)^{D_3} w^{D_4} ms^{D_5} + D_6\left(\frac{h_e}{b}\right)^{D_7}(2-w)^{D_8} mu^{D_9}$ → fita1

Fix it and → my2107b1, b2, b3.prn, f fita2

$$Q/b\sqrt{h_e^3} = D_1 + D_2\left(\frac{h_e}{b}\right)^{D_3}(2-w)^{D_4} ms^{D_5} + D_6\left(\frac{h_e}{b}\right)^{D_7}(1-w)^{D_8} mu^{D_9}$$

Start with same initial D_i, set $C_i = 1.618$, $VM_i = 0.618(ub_i - lb_i)$

Move print *, np, relpi, stdpi, rel, std within fcn + print when istd = 1

Final: $D_1 = 0.48372$ $D_2 = 0.30733$ $D_3 = 1.0346$ $D_4 = 0.82399$

$D_5 = 0.98372$ $D_6 = 0.80064$ $D_7 = 0.79163$ $D_8 = 1.1873$

$D_9 = 0.78981$ $\overline{ret} = 0.0581800$ std = 0.057524

Scale fits ⇒ $\overline{ret} = 0.161001$ std = 0.149401

simang9.for

Run again w/same initial conditions & iseed1 = 685

iseed2 = 761

Change at line numbers 502 - 504 from

```
if (ratio .gt. .6) then
    vm(i) = vm(i)*(1.+c(i)*(ratio-0.6)/.4)
else if (ratio .lt. 0.4) then
    vm(i) = vm(i)+(1.+c(i)*(0.4-ratio)/.4)
end if
```

to ~~vm(i) = vm(i)*(ratio-0.618)/0.382)~~

...

~~vm(i) = vm(i)*(ratio~~

~~vm(i) = vm(i)*(1.+C(i)*(ratio-0.618)/0.382)~~

...

~~vm(i) = vm(i)*(1.+c(i)*(0.382-ratio)/0.382)~~

~~vm(i) = vm(i)*c(i)*(ratio-0.618)~~

...

~~vm(i) = vm(i)/(c(i)*(0.382-ratio))~~

$r > 0.618$: $Vm(i) = Vm(i) * (1. + (c(i) - 1.) * (r - .618)/0.382)$ $\quad r = 0.618 - 1$, $f = 1 - c$

$r < 0.382$: $Vm(i) = Vm(i)/(1. + (c(i) - 1.) * (.382 - r)/.382)$ $\quad r = 0 \quad 0.382$, $f = c \quad 1$

→ my2107c1, C2, C3.prn

→ $D_1 = 0.48373$ $D_2 = 0.30732$ $D_3 = 1.0347$ $D_4 = 0.82406$

$D_5 = 0.98376$ $D_6 = 0.80061$ $D_7 = 0.79161$

$D_8 = 1.1872$ $D_9 = 0.78980$ $\overline{ret} = 0.05880$

std = 0.0575237

Scale $\overline{ret} = 0.161000$ std = 0.149399

$$Q/b\sqrt{h_e^3} = D_1 + D_2\left(\frac{h_e}{b}\right)^{D_3}(2-w)^{D_4} ms^{D_5} + D_6\left(h_e/b\right)^{D_7}(1-w)^{D_8} mu^{D_9}$$

22 May 07

$$Q/b\sqrt{h_e^3} = D_1 + D_2\left(\frac{h_e}{b}\right)\left(\omega^{D_3} + (1-\omega)^{D_4}\right) ms \qquad \text{fit a3}$$
$$+ D_5\left(\frac{h_e}{b}\right)^{D_6}\left(\omega^{D_7} + (1-\omega)^{D_8}\right) Mu^{D_9}$$

$$Q/b\sqrt{h_e^3} = D_1 + D_2\left(\frac{h_e}{b}\right)\left(\omega^{D_3} + (1-\omega)^{D_4}\right) ms$$
$$+ D_5\left(\frac{h_e}{b}\right)^{D_6}\left(\omega^{D_7} + (1-\omega)^{D_8}\right)\left(ms^2 + mu^2\right)^{D_9}$$

simang9.for fit a3 → my2207a1, a2, a3.prn

Initial $D_1 = 0.5$, $D_2 = 0.3$, $D_3 = 0$, $D_4 = 0.8$, $D_5 = 0.8$

$D_6 = 0.8$ $D_7 = 0$ $D_8 = 0.4$ $D_9 = 0.8$

ratio > 0.618 : $VM_i = VM_i * (1 + 1.618 * (ratio - 0.618))$

ratio < 0.382 : $VM_i = VM_i / (1 + 1.618 * (.382 - ratio))$

$VM_i > ub_i - lb_i$ $VM_i = (0.618 + 0.382 * ranmar()) * (ub_i - lb_i)$

define gr in fcn iseed1 = 685 iseed2 = 761

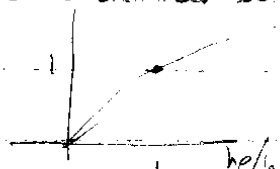
Final: $D_1 = 0.47124$ $D_2 = 0.21182$ $D_3 = -0.51399$

$D_4 = 0.19575$ $D_5 = 0.10216$ $D_6 = 0.87379$ $D_7 = -1.0750$

$D_8 = 0.22172$ $D_9 = 0.77961$ $\overline{rat} = 0.111182$ std = 0.0933584

Scale test $\overline{rat} = 0.181188$ std = 0.140026 NG

$\left(\frac{h_e}{b}\right)^{0.87}$ means what?



fit a3 → my2207b1, b2, b3.prn iseed1 = 887 iseed2 = 410

$lb(1) = lb(2) = lb(5) = $ ~~0.010~~ 0.001

Initial: $D_1 = 0.5$, $D_2 = 0.2$, $D_3 = D_4 = $ ~~0~~, $D_5 = 0.8$, $D_6 = 0.9$

$D_7 = D_8 = 0$, $D_9 = 0.8$

Final: $\overline{rat} = 0.111182$ std = 0.0933628 $D_1 = 0.47126$, $D_2 =$

0.21183, $D_3 = -0.51393$ $D_4 = 0.19584$ $D_5 = 0.10215$

$D_6 = 0.87394$ $D_7 = -1.0752$ $D_8 = 0.22158$ $D_9 = 0.77974$

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$$\frac{\Phi}{b\sqrt{he^3}} = D_1 + D_2\left(\frac{he}{b}\right)\left(\omega^{D_3} + (1-\omega)^{D_4}\right) ms + D_5\left(\frac{he}{b}\right)^{D_6}\left(\omega^{D_7} + (1-\omega)^{D_8}\right)\left(ms^2 + mu^2\right)^{D_9}$$ fita4

→ simang9.for, mg2207c1, c2, c3.prn iseed1 = 298 iseed2 = 772

Initial: $D_1 = 5.8$, $D_2 = 0.7$, $D_3 = 0.7$, $D_4 = 0$, $D_5 = 1.5$, $D_6 = 0.8$

$D_7 = 0$ $D_8 = 1.2$ $D_9 = 0.4$ $lb(1,2,3) = 0.001$

Final: $D_1 = 0.42491$ $D_2 = 0.12418$ $D_3 = -0.18752$ $D_4 = 0.30582$

$D_5 = 0.16678$ $D_6 = 0.63583$ $D_7 = -0.68160$ $D_8 = 0.21843$

$D_9 = 0.30664$ $\overline{rel} = 0.106200$ $std = 0.0988598$

Scale $\overline{rel} = 0.168273$ $std = 0.127501$

$$\frac{\Phi}{b\sqrt{he^3}} = D_1 + \left(\frac{he}{b}\right)\left(D_2 + D_3\omega^{D_4} + D_5(1-\omega)^{D_6}\right) ms + \left(\frac{he}{b}\right)^{D_7}\left(D_8 + D_9\omega^{D_{10}} + D_{11}(1-\omega)^{D_{12}}\right)\left(ms^2 + mu^2\right)^{D_{13}}$$

~~simang~~ simanh9.for ← fita5

Initial $D_1 = 0.5$ $D_2 = 0.8$ $D_3 = -0.1$ $D_4 = 1$ $D_5 = 1$ $D_6 = 0$

$D_7 = 0.6$ $D_8 = -0.1$ $D_9 = 0.5$ $D_{10} = 1$ $D_{11} = 1$, $D_{12} = 0$, $D_{13} = 0.4$

iseed1 = 214 iseed2 = 430 ~~$lb(1,2,3) = 0.001$~~ $lb_i = 0.001$

→ mg2207d1, d2, d3.prn

Add constraints if $D_2 + D_3 < 0$, $rel = rel + (D_2 + D_3)^2$

if $D_8 + D_9 < 0$, $rel = rel + (D_8 + D_9)^2$

FINAL: $D_1 = 0.47476$ $D_2 = 1.4130$ $D_3 = -1.1009$ $D_4 = -0.10503$

$D_5 = -1.0704$ $D_6 = 8.0194$ $D_7 = 0.75755$ $D_8 = 0.071643$

$D_9 = -0.071643$ $D_{10} = 1.7030$ $D_{11} = 0.82630$ $D_{12} = 1.3058$

$D_{13} = 0.39161$ $\overline{rel} = 0.0519579$ $std = 0.0563382$

Scale $\overline{rel} = 0.154591$ $std = 0.150237$

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my2207e1, e2, e3.prn - remove $D_8 + D_9$ constraint since that term can disappear, set iseed1 = 923 iseed2 = 526

Initial: $D_1 = 0.474$, $D_2 = 1.413$, $D_3 = -1.100$ $D_4 = -0.105$

$D_5 = -1.070$ $D_6 = 8.019$ $D_7 = 0.758$ $D_8 = 0.072$

$D_9 = -0.072$ $D_{10} = 1.703$ $D_{11} = 0.826$ $D_{12} = 1.306$ $D_{13} = 0.392$

Final: $D_1 = 0.47477$, $D_2 = 1.4171$, $D_3 = -1.1045$

$D_4 = -0.10564$ $D_5 = -1.0563$ $D_6 = 8.0313$ $D_7 = 0.75634$

$D_8 = 0.077102$ $D_9 = -0.077104$ $D_{10} = 1.7010$ $D_{11} = 0.81794$

$D_{12} = 1.3064$ $D_{13} = 0.39126$ $\overline{rel} = 0.0519548$

std = 0.0563272 Scale: $\overline{rel} = 0.154647$ std = 0.150224

$$Q/b\sqrt{he^3} = D_1 + \left(\frac{he}{b}\right)\left(D_2 + D_3\omega + D_4\omega^2 + D_5\omega^{D_6}\right) ms$$

$$\text{fitab}\left(\frac{he}{b}\right)^{D_7}\left(D_8 + D_9(1-\omega) + D_{10}(1-\omega)^2 + D_{11}(1-\omega)^{D_{12}}\right)\left(ms^2 + mi^2\right)^{D_{13}}$$

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simanh.for fitab → my2307a1, a2, a3.prn

iseed1 = ~~736~~, iseed2 = 650, Initial $D_1 = 0.47$~~2~~, $D_2 = 0.$~~78~~

$D_3 = -1.1$ ~~-0.75~~ $D_4 = 0.67$ $D_5 = 0$ $D_6 = 3$ $D_7 = 0.65$ $D_8 = -0.11$

$D_9 = 6.9$ $D_{10} = -6.0$ $D_{11} = 0$ $D_{12} = 3$ $D_{13} = 0.39$

Constraints: $D_2 + D_3 + D_4 + D_5 > 0$, $D_7 > 0$, $D_8 + D_9 + D_{10} + D_{11} > 0$

$D_{13} > 0$ Try $Vm_i = \frac{0.618}{2}(ub_i - lb_i)$,

out of bounds $\Rightarrow Vm_i = (0.309 + 0.382 * \text{ranmar}())(ub_i - lb_i)$

final: $\overline{rel} = 0.0531863$ std = 0.0606666 $D_1 = 0.47099$

$D_2 = 5.7430$ $D_3 = -7.2118$ $D_4 = 4.0162$ $D_5 = -2.2272$

$D_6 = -0.42278$ $D_7 = 0.60336$ $D_8 = 0.0012259$ $D_9 = -6.9091$

$D_{10} = -1.0605$ $D_{11} = 8.4767$ $D_{12} = 1.0461$ $D_{13} = 0.37552$

Scale $\overline{rel} = 0.173340$ std = 0.149847

23 Aug 07

fit6 → $0.471 + \left(\frac{he}{b}\right)\left(9.74 - 7.21\omega + 4.02\omega^2 - 2.23\omega^{-0.423}\right) ms$
$+ \left(\frac{he}{b}\right)^{0.603}\left(0.0012 - 6.91(1-\omega) - 1.06(1-\omega)^2 + 8.48(1-\omega)^{1.05}\right)\left(ms^2+mu^2\right)^{0.376}$

6: $D_1 + \left(\frac{he}{b}\right)\left(D_2 + D_3\omega + D_4\omega^2 + D_5\omega^3 + D_6(1-\omega)^{D_7}\right) ms$
$+ \left(\frac{he}{b}\right)^{D_8}\left(D_9(1-\omega) + D_{10}(1-\omega)^2 + D_{11}\omega^{D_{12}}\right)\left(ms^2+mu^2\right)^{D_{13}}$
~~or $(D_9 + D_{10}\omega + D_{11}\omega^2 + D_{12}\omega^3)$~~ fit7

fit7 → my2307b1, b2, b3.prn iseed1 = 628 iseed2 = 673

INITIAL: $D_1 = 0.471$ $D_2 = 7.0$ $D_3 = -7.21$ $D_4 = 4.02$ $D_5 = 0$
$D_6 = -2.23$ $D_7 = 0.423$ $D_8 = 0.603$ $D_9 = 1.57$ $D_{10} = 1.06$
$D_{11} = 0$ $D_{12} = 3$ $D_{13} = 0.376$ Remove extra constraints on ~~D_2 D_7~~ D_i, set constraint $D_8 > 0$, $D_{13} > 0$

$Um_i > ub_i - lb_i \Rightarrow Um_i = (0.618 + ranmar() \times 0.382) * (ub_i - lb_i)$

Final: $D_1 = 0.47726$ $D_2 = -2.5283$ $D_3 = 5.1051$ $D_4 = -4.0490$
$D_5 = 1.7897$ $D_6 = 2.2441$ $D_7 = 1.2471$ $D_8 = 0.67272$
$D_9 = 0.83298$ $D_{10} = -0.085090$ $D_{11} = -0.0033756$
$D_{12} = -1.6756$ $D_{13} = 0.38749$ rel = 0.0507254
std = 0.0572296 Sealed ret = 0.163497 std = 0.149432

$0.477 + \left(\frac{he}{b}\right)\left(-2.53 + 5.1051\omega - 4.05\omega^2 + 1.79\omega^3 + \text{~~2.24~~}\right.$
$\left. + 2.24(1-\omega)^{1.25}\right) ms + \left(\frac{he}{b}\right)^{0.673}\left(0.833(1-\omega) - 0.0851(1-\omega)^2\right.$
$\left. - 0.00338\omega^{-1.68}\right)\left(ms^2+mu^2\right)^{0.387}$ fit7

fit8 $D_1 + \left(\frac{he}{b}\right)\left(D_2 + D_3\omega + D_4\omega^2 + D_5\omega^3 + D_6\omega^4\right) ms$
$+ \left(\frac{he}{b}\right)^{D_7}\left(D_8 + D_9\omega + D_{10}\omega^2 + D_{11}\omega^3 + D_{12}\omega^4\right)\left(ms^2+mu^2\right)^{D_{13}}$

23 May 07

fita8 → my2307c1, c2, c3.prn iseed1 = 662 iseed2 = 812

*NITIAL: $D_1 = 0.477$ $D_2 = -2.53$ $D_3 = 5.11$ $D_4 = -4.05$ $D_5 = 1.79$

$D_6 = 0$ $D_7 = 0.673$ $D_8 = 0.8$ $D_9 = -0.8$ $D_{10} = -0.1$ $D_{11} = 0.1$

$D_{12} = 0.1$ $D_{13} = 0.387$ Constrain $D_7 > 0$ $D_{13} > 0$

Final: $D = 0.47407$ $D_2 = 0.022351$ $D_3 = -1.3943$

$D_4 = 6.8855$ $D_5 = -8.3826$ $D_6 = 3.1843$ $D_7 = 0.83444$

$D_8 = 0.80218$ $D_9 = 1.2836$ $D_{10} = -7.3987$ $D_{11} = 7.9989$

$D_{12} = -2.6860$ $D_{13} = 0.37486$ $\overline{ret} = 0.0512813$

std = 0.0524032 Scale $\overline{ret}$ = 0.139982 std = 0.153130

$\cancel{0.474}\ 0.474 + \left(\frac{h_e}{b}\right)\left(0.022 - 1.39w + 6.89w^2 - 8.38w^3 + 3.18(w-w)^{0.834}\right) ms$

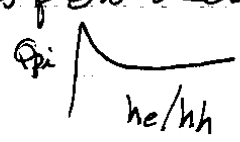
$+ \left(\frac{h_e}{b}\right)^{0.802}($

fita8: $0.474 + \left(\frac{h_e}{b}\right)\left(.022 - 1.39w + 6.89w^2 - 8.38w^3 + 3.18w^4\right) ms$

$+ \left(\frac{h_e}{b}\right)^{0.834}\left(0.802 + 1.28w - 7.40w^2 + 8.00w^3 - 2.67w^4\right)\left(ms^2 + mu^2\right)^{0.375}$

Plot fita8 curves in my2307c.123, given b/hh, mu, ms

Get plots showing the dimensionless flow decreasing with h_e/h_h for some parameter sets

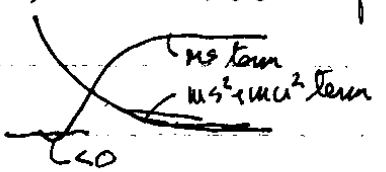


Need $b\sqrt{g h_e^3}$ given h_e/h_h & b/h_h

$h_\pi = h_e/h_h$ $b_\pi = b/h_h$ $h_e = h_\pi h_h$ $b = b_\pi h_h$

$b\sqrt{g h_e^3} = b_\pi h_h \sqrt{g h_\pi^3 h_h^3} = b_\pi \sqrt{g h_\pi^3}\, h_h^{5/2}$ Have to have h_h in ft

This fit shows behaviors found in the ~~exp~~ plotted experimental data where the slope of $\log \hat{Q}/\log h_e$ dropped to a lower value as h_e got bigger than h_h. The $f(w)$, $g(w)$ multipliers for the ms and $(ms^2 + mu^2)$ terms have rapidly changing values for $h_e/h_h < 1$



Plotted in my2307c.123

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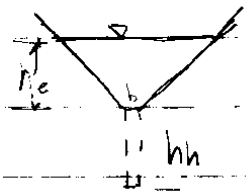
Another possible effect - pinch-off of the head cut.



If $h_e >> b$ then h_h has much less effect.

A different weight?

$$w = \frac{h_e}{h_h + h_e} \qquad \frac{w}{b+w} = \frac{h_e}{b(h_h+h_e)+h_e} \; ? \qquad \frac{b}{b+h_e} \; ?$$

but if $h_e << b$, h_h is important

$b << h_e$ then ms term predominates

$b >> h_e$ then $ms^2 + mu^2$ term predominates if $h_h >> h_e$

$$\frac{h_e}{b+h_e} = w_2 \qquad \frac{h_e}{h_h+h_e} = w_1$$

$$\cancel{\frac{1}{b\sqrt{h_e^3}} = D_1 + \left(\frac{h_e}{b}\right) ms \left(D_2 + D_3 w_1^{D_4} + D_5 w_1^{D_6} w_2^{D_7} + D_8 w_2^{D_9}\right)}$$

$$\cancel{\left(\frac{h_e}{b}\right)^{0.83} \left(D_{10} w_1 + D_{11} w_1 w_2^{D_{12}} + D_{13} w_2\right) \left(ms^2 + mu^2\right)^{0.38}}$$

$$D_1 + \left(\frac{h_e}{b}\right) ms \left(D_2 + D_3 w_1 + D_4 w_1 w_2 + D_5 w_2 + D_6 w_1^2 + D_7 w_2^2\right)$$

$$\left(\frac{h_e}{b}\right)^{0.83} \left(D_8 + D_9 w_1 + D_{10} w_1 w_2 + D_{11} w_2 + D_{12} w_1^2 + D_{13} w_2^2\right) \left(ms^2 + mu^2\right)^{0.38}$$

fital → my2307 d1, d2, d3.prn

simanhl.for Rework fit, fcn, add $w2(i) = he(i)/(he(i)+b(i))$

No extra constraints on D_i iseed1 = 645 iseed2 = 49

Initial: $D_1 = 0.474$ ~~$D_3 = -1.39$~~ $D_2 = 0.1$ $D_3 = -1.4$ $D_4 = 1$

$D_5 = 1$ $D_6 = 6.9$ $D_7 = 1$ $D_8 = 0.8$ $D_9 = 1.28$ $D_{10} = 1$

$D_{11} = 1$ $D_{12} = -2.4$ $D_{13} = 1$ Final: ret = 0.0671472

std = 0.0852215 $D_1 = 0.47040$ $D_2 = 0.72531$ $D_3 = -4.7859$

$D_4 = -1.7998$ $D_5 = 0.65858$ $D_6 = 4.7031$ $D_7 = 0.82529$

$D_8 = 63170$ $D_9 = 1.8049$ $D_{10} = 1.0458$ $D_{11} = -0.53902$

$D_{12} = -2.5731$ $D_{13} = -0.37167$ Scale ret = 0.180737 std = 0.206667

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fit eq: $\frac{Q}{b\sqrt{h_e^3}} \simeq 0.470 + \left(\frac{h_e}{b}\right)\left(0.725 - 4.79\omega_1 - 1.80\omega_1\omega_2 + 0.659\omega_2 + 4.70\omega_1^2 + 0.825\omega_2^2\right) ms + \left(0.632 + 1.80\omega_1 + 1.05\omega_1\omega_2 - 0.539\omega_2 - 2.57\omega_1^2 - 0.372\omega_2^2\right) \times \left(\frac{h_e}{b}\right)^{0.83} \left(ms^2 + mc^2\right)^{0.38}$

$\frac{Q}{b\sqrt{h_e^3}} \simeq 0.470 + D_1 - 4.79\omega_1 - 1.8\omega_1\omega_2 + 0.659\omega_2 + 4.7\omega_1^2$

fit bf $+ 0.825\omega_2^2 + D_2\omega_1^3 + D_3\omega_1^2\omega_2 + D_4\omega_1\omega_2^2 + D_5\omega_2^3 + D_6\omega_1^2\omega_2^2) ms + \left(\frac{h_e}{b}\right)^{D_7} \left(D_8 + 1.8\omega_1 + 1.05\omega_1\omega_2 - 0.539\omega_2 - 2.57\omega_1^2 - 0.372\omega_2^2 + D_9\omega_1^3 + D_{10}\omega_1^2\omega_2 + D_{11}\omega_1\omega_2^2 + D_{12}\omega_2^3\right) \left(ms^2 + mc^2\right)^{D_{13}}$

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simanh1.for

fit bf → my240701, a2, a3.prn iseed1 = 551 iseed2 = 249

Initial $D_1 = 0.474$ $D_2 = 0.1$ $D_3 = 0.1$, $D_4 = 0.1$, $D_5 = 0.1$

$D_6 = 0.1$, $D_7 = 0.83$ $D_8 = 0.632$ $D_9 = 0.1$ $D_{10} = 0.1$

$D_{11} = 0.1$ $D_{12} = 0.1$ $D_{13} = 0.38$

Final: $\overline{rel} = 0.0639289$ std = 0.0789690 $D_1 = 0.79659$

$D_2 = -0.12283$ $D_3 = -0.24297$ $D_4 = 1.5252$ $D_5 = -0.63189$

$D_6 = -0.59222$ $D_7 = 0.67196$ $D_8 = 0.44745$ $D_9 = 0.21877$

$D_{10} = 0.10280$ $D_{11} = -0.50746$ $D_{12} = 0.36542$ $D_{13} = 0.35813$

Scale $\overline{rel} = 0.172739$ std = 0.162891 Not much help

~~Probably~~ Maybe not enough data to demonstrate the effect

Lost this data + ran again, only to get $\overline{rel} = 0.0653932$

std = 0.0810111 WORSE Scale $\overline{rel} = 0.169072$

Scale std = 0.175185

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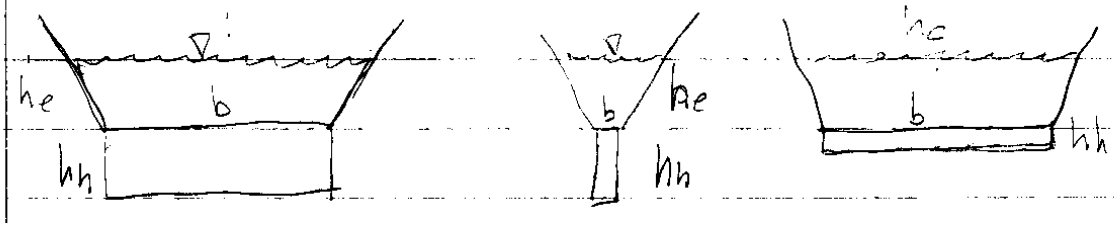

More influence by ms^2+mu^2 term for larger $b \cdot h_h$

$w = \frac{h_e^2}{b \cdot h_h + h_e^2}$? $w = \frac{h_e}{h_e + \sqrt{b \cdot h_h}}$?

simanh2.for ← simanh4.for

Use fita8 with $w = h_e / (h_e + \sqrt{b \cdot h_h})$ → my2407 b1, b2, ~~b3~~.prn

iseed1 = 744 iseed2 = 426 $D_1 = 0.474$ $D_2 = 0.022$

$D_3 = -1.39$ $D_4 = 6.89$ $D_5 = -8.38$ $D_6 = 3.18$ $D_7 = 0.834$

$D_8 = 0.802$ $D_9 = 1.28$ $D_{10} = -7.4$ $D_{11} = 8.0$ $D_{12} = -2.69$

$D_{13} = 0.375$ combine my16rawb.prn & scaletst.prn into myallraw.prn to get b-effect, No scale test

if $vm_i > ub_i \rightarrow lb_i$, $vm_i = 0.618(ub_i - lb_i)$

Final: $\overline{rel} = 0.503132$ std = 0.0595807

$D_1 = 0.47388$ $D_2 = 0.20685$ $D_3 = -1.7971$ $D_4 = 7.2746$

$D_5 = -8.9451$ $D_6 = 3.5739$ $D_7 = 0.85966$ $D_8 = 0.77078$

$D_9 = 1.1446$ $D_{10} = -7.5927$ $D_{11} = 7.9337$ $D_{12} = -2.2559$

$D_{13} = 0.37967$

Use fita8 with $w = h_e^2 / (h_e^2 + b \cdot h_h)$ → my2407 c1, c2, ~~c3~~.prn

iseed1 = 655 iseed2 = 194 Same initial D_i

Final: $\overline{rel} = 0.0486357$ std = 0.0581986 D

$D_1 = 0.47339$ $D_2 = 0.20513$ $D_3 = -1.8145$ $D_4 = 7.6523$

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$D_5 = -9.7548$ $D_6 = 4.0252$ $D_7 = 0.66670$ $D_8 = 0.46398$

$D_9 = 1.3276$ $D_{10} = -6.7966$ $D_{11} = 8.3136$ $D_{12} = -3.3079$

$D_{13} = 0.38134$

Use fit a8 with $w = h_e / \sqrt{h_e^2 + b \cdot hh}$ → my2407d1, d2, d3.prn

iseed1 = 51 iseed2 = 842, some initial D_i

$\overline{rel} = 0.0510617$ std = 0.0597127

$D_1 = 0.47534$ $D_2 = 0.11562$ $D_3 = -1.6678$ $D_4 = 6.9427$

$D_5 = -8.5836$ $D_6 = 3.5051$ $D_7 = 0.94627$ $D_8 = 0.94680$

$D_9 = 1.3695$ $D_{10} = -7.4894$ $D_{11} = 7.9376$ $D_{12} = -2.7648$

$D_{13} = 0.36541$

Use fit a8 with $w = h_e^2 / (h_e^2 + hh \cdot b)$ and limit fit to scalecap data from my16rawb.prn, with scale test on scaleco4.prn data iseed1 = 543 iseed2 = 75 → my2407e1, e2, e3.prn

Some initial D_i Final: $\overline{rel} = 0.0477524$ std = 0.0509212

~~Scale test~~ forget to take c off call scale

$D_1 = 0.47175$ $D_2 = 0.20017$ $D_3 = -2.0328$ $D_4 = 8.0383$

$D_5 = -9.1150$ $D_6 = 3.2259$ $D_7 = 0.62922$ $D_8 = 0.44992$

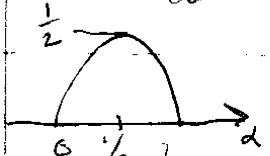
$D_9 = 1.5502$ $D_{10} = -7.1752$ $D_{11} = 7.7394$ $D_{12} = -2.5628$

$D_{13} = 0.36655$)

scaleal.for ← reading scalecap → my2407e3.prn

⇒ Scale $\overline{rel} = 0.0758288$ std = 0.0949470

$\frac{d}{d\alpha}\sqrt{h \cdot b} = \frac{d}{d\alpha}(\alpha(1-\alpha))^{1/2} = \frac{1}{2}(\alpha(1-\alpha))^{-1/2}(-\alpha + 1 - \alpha) = \frac{1-2\alpha}{2\sqrt{\alpha(1-\alpha)}}$ $\alpha = 1/2$ is the zero slope



Contraction coef should become smaller as $\theta \to \pi/2$ $\phi \to 0$ $d_1 + d_2 m_s^{d_3} m_u^{d_4}$

$\tau_{in\theta} \to 0$ $\tau_{in\phi} \to 0$

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contraction coeff

Contraction should increase (flow get smaller) as $M_S \to 0$ and $M_U \to 0$, also as $h_e >> b$

a) $d_1 + d_2 M_S^{d_3} M_U^{d_4}$ b) $d_1 + d_2 M_S^2 + d_3 M_S^{d_4} M_U^{d_5} + d_6 M_U^2)^{d_7}$

c) $\left(d_1 + d_2 \frac{M_S^{d_3} M_U^{d_4}}{1 + M_S^{d_5} M_U^{d_6}}\right)^{d_7}$ d) $d_1 + d_2 \frac{M_S^{d_3} M_U^{d_4}}{1 + c_5 M_S^{d_5} M_U^{d_6}} \left(\frac{r_0}{b}\right)^{d_7}$

e) $\left[\left(d_1 + \frac{d_2 M_S^{d_3} M_U^{d_4}}{1 + c_5 M_S^{d_5} M_S^{d_6}}\right)\left(d_8 + \frac{d_9 \left(h_e/b\right)^{d_{10}}}{1 + d_{11}\left(h_e/b\right)^{d_{12}}}\right)\right]^{d_{13}}$

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$$\omega = \frac{h_e^2}{h_e^2 + b \cdot h_h}$$

Siman h2.for ← my raw16b.prn, fit a8 with my 2407e coefficients multiplied by possible contraction coefficients

fit a8, $\frac{h_e^2}{h_e^2 + b h_h}$ → Qpic a8 with $D_1 = 0.47175$ constants

$D_2 = 0.20017$ $D_3 = -2.0328$ $D_4 = 8.0383$ $D_5 = -9.115$

$D_6 = 3.2259$ $D_7 = 6.62922$ $D_8 = 0.49922$ error 0.44992 $D_9 = 1.5502$

$D_{10} = -7.1752$ $D_{11} = 7.7394$ $D_{12} = -2.5628$ $D_{13} = 0.36655$

Then redefine D_i

$$\frac{Q}{b\sqrt{g h_e^3}} = \left[\left(d_1 + \frac{d_2 M_S^{d_3} M_U^{d_4}}{1 + d_5 M_S^{d_6} M_U^{d_7}}\right)\left(d_8 + \frac{d_9 \left(h_e/b\right)^{d_{10}}}{1 + d_{11}\left(h_e/b\right)^{d_{12}}}\right)\right]^{d_{13}} \cdot Qpic8$$

iseed1 = 297 iseed2 = 409 $-10 \le d_i \le 10$ ← fitb1

$d_1 = 1$ $d_2 = 0.001$ $d_3 = 1$ $d_4 = 1$ $d_5 = 0.001$ $d_6 = 1$, $d_7 = 1$

$d_8 = 1$ $d_9 = 0.001$ $d_{10} = 1$ $d_{11} = 0.001$ $d_{12} = 1$ $d_{13} = -1$

→ my2507 a1, a2, a3. prn

$$Qpic8 \simeq 0.472 + \left(\frac{h_e}{b}\right)\left(0.200 + \omega\left(-2.03 + \omega\left(8.04 + \omega\left(-9.12 + \omega \cdot 3.23\right)\right)\right)\right) M_S$$

$$+ \left(\frac{h_e}{b}\right)^{0.629}\left(0.492 + \omega\left(1.55 + \omega\left(-2.18 + \omega\left(7.24 + \omega\left(-2.56\right)\right)\right)\right)\right) \cdot \left(M_S^2 + M_U^2\right)^{0.367}$$

25 May 07

simanh2 has error 0.49922 instead of 0.44992 in Qa8

Something odd here tape starts off at > 0.6 instead of 0.0478 FINAL: rel = 0.0471548 std = 0.0512489

$D_1 = 8.5073$ $D_2 = 0.65821$ $D_3 = -0.062313$ $D_4 = 0.011479$

$D_5 = 0.0093485$ $D_6 = -0.25833$ $D_7 = 5.0890$ $D_8 = 6.10260$

$D_9 = -0.0078405$ $D_{10} = -1.1749$ $D_{11} = -6.7532$ $D_{12} = -0.15133$

$D_{13} = 1.0727$ Scale rel = didn't work = didn't work

$$\frac{Q/Q_{as}}{b\sqrt{g h_e^3}} = \left[\frac{1}{1+d_1\left(h_e/b\right)^{d_2}}\right]\left[\frac{1}{1+d_3 Q_{pias}^{d_4}}\right]\left[d_5 + \frac{d_6 M_S^{d_7} M_U^{d_8}}{1+M_S^{d_7} M_U^{d_8}}\right]$$

m e

$\to 1-a$ $\quad \frac{m+\alpha}{1+m}(1+b)$ $\quad 1-a = \alpha(1+b)$ $\quad \alpha = \frac{1-a}{1+b}$ $\quad d_5 < 1$

$\infty \; 1+b$ $\quad d_6 > 1$

$$\frac{m+\frac{1-a}{1+b}}{m+1}(1+b) = \frac{m(1+b)+1-a}{m+1}$$

$$\frac{\hat{Q}/Q_{as}}{b\sqrt{g h_e^3}} = \left[\frac{1}{1+d_2\left(h_e/b\right)^{d_3}}\right]^{d_4}\left[\frac{1}{1+d_5 Q_{as}^{d_6}}\right]^{d_7}\left[\frac{d_8+M_S^{d_9}}{1+M_S^{d_9}}\right]^{d_{10}}\left[\frac{d_{11}+M_U^{d_{12}}}{1+M_U^{d_{12}}}\right]^{d_{13}} d_1$$

$$d + \frac{(1-d)m^e}{1+m^e} = \frac{d+dm^e+m^e-dm^e}{1+m^e} = \frac{d+m^e}{1+m^e} \quad d_8 < 1 ?\; d_{11} < 1 ?$$

$$\frac{\hat{Q}/Q_{as}}{b\sqrt{g h_e^3}} = d_1\left[\frac{d_2+d_3\left(h_e/b\right)^{d_4}}{1+\left(h_e/b\right)^{d_4}}\right]\left[\frac{d_5+d_6 Q_{as}^{d_7}}{1+Q_{as}^{d_7}}\right]\left[\frac{d_8+d_9 M_S^{d_{10}}}{1+M_S^{d_{10}}}\right]\left[\frac{d_{11}+d_{12} M_U^{d_{13}}}{1+M_U^{d_{13}}}\right]$$

scalea2.for

Incorporate fit61, and solution D_i above, run against scaleta4 → my2507a3.prn

→ Scale rel = 0.0761296 std = 0.0902313

Fix index error in call scale(n, ...) in simanh2

25 May 07

simanh3.for

Modify simanh2 to 11 parameters. Calculate $\hat{Q}_{as}$

$$\frac{\hat{G}/\hat{Q}_{as}}{b\sqrt{g}he^3} = \left[\frac{1}{1+d_1 Q_{as}^{d_2}}\right]\left[\frac{1}{1+d_3\left(he/b\right)^{d_4}}\right]\left[\frac{d_5+d_6\left(hh/he\right)^{d_7}}{1+\left(hh/he\right)^{d_7}}\right]$$

$$\left[\frac{d_8+MS^{d_9}}{1+MS^{d_9}}\right]\left[\frac{d_{10}+MU^{d_{11}}}{1+MU^{d_{11}}}\right]$$

$$\hat{Q}_{as} = 0.47175 + \left(\frac{he}{b}\right)\left[\begin{matrix}0.20017 - 2.0328\omega + 8.0383\omega^2 \\ -9.1150\omega^3 + 3.2259\omega^4\end{matrix}\right] MS$$

$$+\left(\frac{he}{b}\right)^{0.62922}\left[\begin{matrix}0.44992 + 1.5502\omega - 7.1752\omega^2 \\ +7.7399\omega^3 - 2.5628\omega^4\end{matrix}\right]\left(MS^2+MU^2\right)^{0.36655}$$

$$\omega = he^2/(he^2+hh\cdot b)$$

Initial $D_1=0$, $D_2=1$, $D_3=0$, $D_4=1$, $D_5=1$, $D_6=0$

$D_7=1$, $D_8=1$, $D_9=0$, $D_{10}=1$, $D_{11}=0$ $\quad -10 \le D_i \le 10$

→ my2507b1, b2, b3.prn iseed1=749 iseed2=683

Final: $\overline{rel} = 0.0453381$ $\quad std = 0.0487630$

$D_1 = -0.034828$ $\quad D_2 = -1.5325$ $\quad D_3 = 5.0756$ $\quad D_4 = -0.014672$

$D_5 = 6.2949$ $\quad D_6 = 5.7346$ $\quad D_7 = -0.35269$

$D_8 = 0.91378$ $\quad D_9 = 0.33978$ $\quad D_{10} = 1.0615$ $\quad D_{11} = -0.33626$

Scale test failed again, generated NaN

Errors in subroutine scale 1) wrong ω, 2) wrong U(n) array 3) no heh term. Fix them

$$\left[\frac{1}{1-0.03485\,Q_{as}^{-1.53}}\right]\left[\frac{1}{1+5.08\left(\frac{he}{b}\right)^{-0.0147}}\right]\left[\frac{6.29+5.73\left(\frac{hh}{he}\right)^{-0.353}}{1+\left(hh/he\right)^{-0.353}}\right]$$

$$\left[\frac{0.914+MS^{0.34}}{1+MS^{0.34}}\right]\left[\frac{1.0615+MU^{-0.336}}{1+MU^{-0.336}}\right]$$

26 May 07

$$\frac{1}{1-0.0348\,Q_{a8}^{-1.53}} = \frac{Q_{a8}^{1.53}}{Q_{a8}^{1.53}-0.0348} \qquad 0.1 < Q_{a8} < 1$$

goes neg for small #

Needs doing again with penalties for negative coefficients perhaps gentle penalty for $\neq 1$ per term & replace hh/he factor with $\left[\frac{d_5+(hh/he)^{d6}}{1+(hh/he)^{d6}}\right]$ Maybe do each term one at a time to see which reduces the most error

24 May 07 my2407e2.prn → $\overline{rel}$ = 0.0477524 std = 0.0509212

25 May 07 my2507b2.prn → $\overline{rel}$ = 0.0453381 std = 0.0487630

Any significant difference in the methods?

Run regression $Q = f(\hat{Q})$ in my2607a.123 and get

24 May 07: $Q = -0.004388 + 1.00316\,\hat{Q}$ ~~Std err of est = 0.1~~

std err of est = 0.172952 CFS R^2 = 0.9930281

25 May 07: $Q = -0.010234 + 1.0103743\,\hat{Q}$

std err of est = 0.163382 CFS R^2 = ~~0.9~~ 0.9937783

A small difference in std err of est of 0.00957

---

simanh4.for

$$\frac{\hat{Q}/\hat{Q}_{a8}}{b\sqrt{g h_e^3}} = \left[\frac{1}{1+d_1 Q_{a8}^{d_2}}\right]\left[\frac{1}{1+d_3(he/b)^{d_4}}\right]\left[\frac{d_5+(hh/he)^{d6}}{1+(hh/he)^{d6}}\right](1+d7)$$

$$\left[\frac{d_8+ms^{d9}}{1+ms^{d9}}\right]\left[\frac{d_{10}+mu^{d11}}{1+mu^{d11}}\right]$$ ~~fi+b3~~

Adapt fic to allow constraints

27 May 07

mg2707a.123

Plot $h_e^2/hh\cdot b$ under $w = \dfrac{h_e^2}{h_e^2 + hh\cdot b}$

$f(w) = 0.20017 - w(2.0328 + w(8.0383 - w(9.115 + 3.2259w)))$

$g(w) = 0.44992 + w(1.5502 - w(7.1752 + w(7.7394 - 2.5628w)))$

from mg2407e data fit of my Hbrawb data to fita8

Produces huge negative numbers $f(w) \to -1.54$

$g(w) \to -8.14$ over $he^2/hh\cdot b$ from 0 to 10

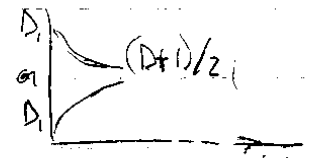
How the hell did that ever work? ~~Must have~~

Seme blows all the results since at least May 23 with fitab in simanh4.for

simanh4.for Modify back towards fita8 & earlier

$$\frac{D_1 + w^{D_2}}{1 + w^{D_2}},\ w = \frac{h_e^2}{h_e^2 + hh\,b} \Rightarrow \frac{D_1 + \dfrac{h_e^{2D_2}}{(h_e^2 + hh\,b)^{D_2}}}{1 + \dfrac{h_e^{2D_2}}{(h_e^2 + hh\,b)^{D_2}}}$$

$$= \frac{D_1(h_e^2 + hh\cdot b)^{D_2} + h_e^{2D_2}}{(h_e^2 + hh\cdot b)^{D_2} + h_e^{2D_2}}$$

$\dfrac{D_1 + w^{D_2}}{1 + w^{D_2}} \to$ 

$\dfrac{D_1}{1 + w^{D_2}} \to$

$$\frac{Q}{b\Delta\sqrt{g h_e^3}} = D_1 + \left(\frac{h_e}{b}\right)\left[D_2 + \frac{D_3}{1 + w^{D_4}} + \frac{D_5 + w^{D_6}}{1 + w^{D_6}}\right] ms$$

$$+ \left(\frac{h_e}{b}\right)^{D_7}\left[D_8 + \frac{D_9}{1 + w^{D_{10}}} + \frac{D_{11} + w^{D_{12}}}{1 + w^{D_{12}}}\right](ms^2 + mu^2)^{D_{13}}$$

F17B3

27 Mar 07

simanh4.for n=13 input: myIgraub

v is used for both variable storage and vm in the top-level subr. calls. Fix. Use FITB3. Use relative error to start.

→ myg2707a1, a2, a3.prn iseed1 = 723 iseed2 = 392

$v(1) = hb(i)$ $v(2) = hch(i) = hh/he$, $V(3) = w(i) = hc^2/(he^2 + hh \cdot b)$

$v(4) = ms(i)$ $v(5) = mu(i)$

xnfit

$c(1) = d(1)$, $c(2) = d(2)$, $c(3) = d(3)/(1 + w^{**}d(4)) +$

$(d(5) + w^{**}d(6))/(1. + w^{**}d(6))$ $c(4) = d(8)$

$c(5) = d(9)/(1 + w^{**}d(10)) + (d(11) + w^{**}d(12))/(1 + w^{**}d(12))$

if $c_i \le 0$ then rel = rel + 2, c_i = 1.d-10

rel = rel + $10^{-6}(c_i - 1)^2$

$q = d(1) + hb * (d(2) + c(3)) * ms$

$+ (hb^{**}d(7)) * (d(8) + c(5)) * (ms * ms + mu * mu)^{**}d(13)$

Initial $D_1 = 0.45$ $D_2 = 0.2$ $D_3 = 0$, $D_4 = 1$, $D_5 = 0$, $D_6 = 1$

$D_7 = 0.4$ $D_8 = 0.8$ $D_9 = 0$, $D_{10} = 1$, $D_{11} = 0$, $D_{12} = 1$, $D_{13} = 0.4$

$lb_1 = lb_2 = lb_7 = lb_8 = 0.0001 = lb_{13}$

$\frac{D_1 w^{D_2}}{1 + w^{D_2}}$ $D_{1/2}$

FINAL: $0.47394 + \left(\frac{he}{b}\right)\left[0.050582 + \frac{3.4709}{1 + w^{-0.47207}} + \frac{-3.9399 + w^{-0.22361}}{1 + w^{-0.22361}}\right] ms$

$+ \left(\frac{he}{b}\right)^{0.92008}\left[0.00010021 + \frac{4.8745}{1 + w^{0.60346}} + \frac{-5.8745 + w^{0.17055}}{1 + w^{0.17055}}\right] \cdot (\ldots)^{0.37743}$

rel = 0.0483656 std = 0.0529523 ← how is this not negative?

Scale rel = 0.171642 std = 0.159022

Possibly because $w \neq 0$ in this dataset ←

28 May 07

START OVER WITH BASICS

fit by: $\frac{Q}{b\sqrt{g}h_e^3} = D_1 + D_2\left(\frac{h_e}{b}\right)^{D_3} ms^{D_4} + D_5\left(\frac{h_e}{b}\right)^{D_6}\left(ms^2 + ub^2\right)^{D_7}$

$\frac{Q}{b\sqrt{g}h_e^3} = D_1 + D_2\left(\frac{h_e}{b}\right)^{D_3} ms^{D_4} + D_5\left(\frac{h_e}{b}\right)^{D_6}\left(ms^2 + ub^2\right)^{D_7}$

FITBY

simanh5.for

Modify simanh4 for to 7 parameters. Constrain all $D_i > 0$ w lb_i = 1.d-6. Use ~~rms error~~ Calculate both rms & mean relative error, but use ~~rms~~ $\frac{1}{n}\sum\left|\frac{\hat{q}-q}{q}\right|$ for the objective function

iseed1 = 268 iseed2 = 936 mg16rawb.prn input

Initial D_i: D_1 = ~~0.47~~ 0.5, D_2 = ~~0.2~~ 0.2, D_3 = 1, D_4 = 1, D_5 = ~~0.5~~ 0.6

D_6 = ~~0.01~~ 0, D_7 = 0.4 Use scaleta0.prn for scaletest input data

Final: ~~obs~~ tst = 0.538726 rms = 0.838140 std ~~error~~ = 0.834097

.ret = 0.234335 std ret = 0.162494

Scaling test didn't work

D_1 = 0.50553 D_2 = 0.12511 D_3 = 0.012007 D_4 = 0.97511

D_5 = 0.12189 D_6 = 0.8e-8 D_7 = 0.22903

scalea3.for

Modify scalea2_for to test subr scale from simanh5.for fix errors & get np = 401 rmserr = 1.183416

std mse = 1.042856 ret = 0.383750 std rel = 0.229597

Copy fixed subr. scale back to simanh5.for

Put mean $\frac{1}{np}\sum(\hat{q}-q)$ error in output of scaletest

28 May 07

simanhs.for (cont'd)

In subroutine fcn set

rel1 = dabs(qh-q(i))

if (rel1 .gt. 1.d0) rel1 = rel1*rel1

rel = rel + rel1 try to improve speed of convergence by making the objective function ∝ error^2 away from immediate optimum

Last time got $0.505 + 0.125\left(\frac{h_e}{b}\right)^{0.01} ms^{0.975} + 0.122\left(\frac{h_e}{b}\right)^{0}(ms^2+mu^2)^{0.229}$

← counter intuitive as Q should be $\propto \sqrt{g h_e^5}$

Rerun w/ improved scale and

Initial $D_1 = 0.505$ $D_2 = 0.125$ $D_3 = 0$, $D_4 = 1$,

$D_5 = 0.25$, $D_6 = 1$, $D_7 = 0.5$ iseed1 = same iseed2 = same

→ my2807b1,b2,b3.prn →

opt = 0.765278, rms-err = 0.812563 std-err = 0.809646

$\overline{\text{rel err}}$ = 0.251523 std $\overline{\text{rel}}$ = 0.167774

Scale mean-err = -0.674165 rms-err = 1.263416

std-error = 1.069849 mean rel error = 0.424873 std rel = 0.273025

$D_1 = 0.47306$ $D_2 = 0.24670$ $D_3 = 0.61e-8$ $D_4 = 0.74559$

$D_5 = 0.079278$ $D_6 = 0.75e-8$ $D_7 = 0.27665$

Try $\frac{Q}{b\sqrt{g h_e^3}} = D_1 + D_2 w^{D_3} ms^{D_4} + D_5 w^{D_6}(ms^2+mu^2)^{D_7}$

$w = h_e^2/(h_e^2 + b \cdot hh)$ FITB5

28 May 07

simanks.for (cont'd)

FITB5 $Q/b\sqrt{he^3} = D_1 + D_2 w^{D_3} ms^{D_4} + D_5 w^{D_6} (ms^2 + mu^2)^{D_7}$

$w = h_e^2/(h_e^2 + hh \cdot b)$ → my2807c1, c2, c3.prn

iseed1 = 322 iseed2 = 24 $D_1 = 0.47$ $D_2 = 0.25$ $D_3 = 0.001$

$D_4 = 1$ $D_5 = 0.5$ $D_6 = .001$ $D_7 = 0.5$

$lb_i = 0.0001$ Final: opt = 0.765359 $D_1 = 0.47311$

$D_2 = 0.24611$ $D_3 = 0.0001$ $D_4 = 0.74566$ $D_5 = 0.079237$

$D_6 = 0.0001$ $D_7 = 0.27611$ again — other answers about the same

$\frac{Q}{b\sqrt{g h_e^3}} = D_1 + D_2 \left(\frac{h_e}{b}\right) w^{D_3} ms + D_4 \left(\frac{h_e}{b}\right)^{D_5} w^{D_6} (ms^2 + mu^2)^{D_7}$ FITB6

my2807 d1, d2, d3.prn ← iseed1 = 481 iseed2 = 565

$D_1 = 0.47$ $D_2 = 0.25$ $D_3 = 1$ $D_4 = 0.5$ $D_5 = 1$, $D_6 = 1$

$D_7 = 0.28$ opt = 0.843688 NG

$D_1 = 0.49756$ $D_2 = 0.29181$ $D_3 = 10^{-4}$ $D_4 = 0.096443$

$D_5 = D_6 = 10^{-4}$ $D_7 = 0.25259$ $D_3 > 0$ $D_6 > 0$

Write over my2807 di files, set $lb_3 = lb_6 = -10$, $D_6 = -1$

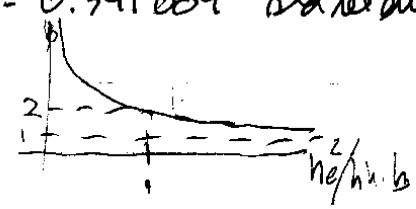
opt = 0.425112 rms-error = 0.557722 stderr = 0.558902

relerr = 0.215104 stdrelerr = 0.257339

Code test error = 0.382686 rmserr = 1.737484 stderr = 1.696933

rel error = 0.341009 stdrelerr = 0.324052

$\frac{h_e^2 + hh \cdot b}{h_e^2}$



$D_1 = 0.45067$ $D_2 = 0.30237$

$D_3 = -0.41149$ $D_4 = 0.084522$

$D_5 = 2.8942$ $D_6 = -1.9679$

$D_7 = 0.37598$

28 May 07

FitB7

$$D_1 + D_2\left(\frac{he}{b}\right)^{D_3} w^{D_4} ms + D_5\left(\frac{he}{b}\right)^{D_6} w^{D_7} (ms^2+mu^2)^{0.375}$$

my2807e ← iseed1 = 536, iseed2 = 562

$D_1 = 0.5$, $D_2 = 0.\overset{30}{\cancel{29}}$, $D_3 = 1$, $D_4 = -0.41$, $D_5 = 0.085$

$D_6 = 2.89$ $D_7 = -1.97$ $D_2 > 0$ $D_5 > 0$ ⇒

opt = 0.421947 rms-error = 0.556476 ~~rel-er~~

relerr = 0.215576 WG on Scalefit

$D_1 = 6.44538$ $D_2 = 0.27508$ $D_3 = 6.24456$

$D_4 = -0.31677$ $D_5 = 0.089189$ $D_6 = 3.1456$ $D_7 = -2.0917$

Rerun Fit BS → my2807c with $-10 = lb_3 = lb_6$

iseed1 = 712 iseed2 = 439

$D_1 = 0.45$ $D_2 = 0.25$ $D_3 = -0.5$ $D_4 = 1$ $D_5 = 0.08$

$D_6 = -2$ $D_7 = 0.38$ $lb_i = 0.0001$ except $lb_3 = lb_6 = -10$

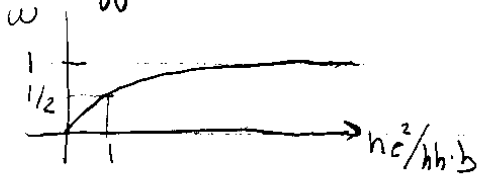
$$D_1 + D_2 w^{D_3} ms^{D_4} + D_5 w^{D_6} (ms^2+mu^2)^{D_7} \quad w = he^2/(he^2+hh\cdot b)$$

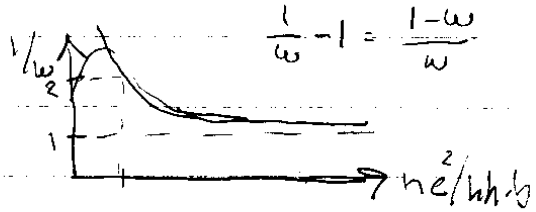
opt = 0.577533 rms er = 0.643216 Scale rms mu = 1.207

$D_1 = 0.40348$ $D_2 = 0.17890$ $D_3 = -0.18811$ $D_4 = 0.72531$

$D_5 = 0.12284$ $D_6 = -0.42697$ $D_7 = 0.21949$

A little worse than using (he/b) instead of w, but the D_i coefficients are close





$$D_1 + \underbrace{\left(D_2 + w^{D_3}\right)^{D_4}}_{>0} ms + \underbrace{\left(D_5 + \left(\frac{1-w}{w}\right)^{D_6}\right)^{D_7}}_{>0} (ms^2+mu^2)^{D_8} \qquad D_2 > 1$$

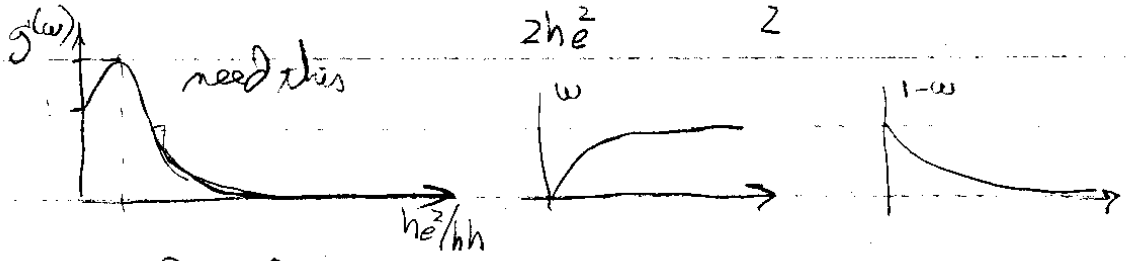
$$\frac{1-w}{w} = \frac{1 - \frac{he^2}{he^2+hh\cdot b}}{\frac{he^2}{he^2+hh\cdot b}} = \frac{hh\cdot b}{he^2} \qquad w^{D_6}(1-w)^{1-D_6}$$

28 May 06

$$\omega^D(1-\omega)^{1-D} = \frac{h_e^{2D}}{(h_e^2+hh\cdot b)^D}\left(1-\frac{h_e^2}{h_e^2+hh\cdot b}\right)^{1-D} = \frac{h_e^{2D}(hh\cdot b)^{1-D}}{h_e^2+hh\cdot b}$$

= harmonic mean of $hh\cdot b = \frac{2hh\cdot b}{hh+b}$ not good if both $hh \pm b = 0$

$h_e^2 = hh\cdot b \rightarrow \omega^D(1-\omega)^{1-D} = \frac{h_e^{2D}(h_e^2)^{1-D}}{2h_e^2} = \frac{1}{2}$



$(D_1+\omega)^{D_2}(1-\omega)^{D_3}$ $(D_1+\omega^{D_2})(1-\omega)^{D_3}$

$D_1 + (D_2+\omega^{D_3})ms + (D_4+\omega^{D_5})(1-\omega)^{D_6}(ms^2+mc^2)^{D_7}$ F17B8

>0 >0 >0 >0 $\omega = h_e^2/h_e^2+hh\cdot b$

my2807f1,f2,f3.prn ← iseed1=9 iseed2=288

$lb_i = -10$ except $lb_1 = 0.0001 = lb_3$ lb_2 Initial D_i:

$D_1 = 0.45$ $D_2 = 0.2$ $D_3 = 0.2 + 0.2$ $D_4 = 0.12$ $D_5 = 0.4$

$D_6 = 1$ $D_7 = 0.3 \Longrightarrow$ opt = 2.44 with $D_2 \rightarrow 0$

Run again with $lb_2 = lb_4 = lb_4 = \epsilon - 1$

$D_1 = 0.45$ $D_2 = -.5$ $D_3 = 2.$ $D_4 = 0.63$ $D_5 = 0.34$ D_6

$D_6 = 0.8$ $D_7 = 0.38 \Longrightarrow$ opt = 0.182684

rms-en = 0.270914 std en = 0.27060 rel-en = 0.10025

std rel en = 0.085645 Solo test mean en = -0.61131

rms en = 1.11790 std en = 0.93711 mean rel en = 0.29255

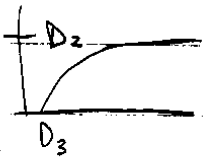
std rel en = 0.21504 | $D_1 = 0.48983$ $D_2 = -0.82476$

$D_3 = 0.040581$ $D_4 = 0.016684$ $D_5 = 0.58655$

$D_6 = 1.9130$ $D_7 = 0.33798$

28 May 07

Problem: $D_2 + \omega^{D_3}$ will go negative if ω small enough – just doesn't happen with this data set
Instead try $D_2 + \omega^{D_3}$ if $D_2 + \omega^{D_3} > 0$ else 0



Or $D_2 (f(\omega))^{D_4}$ $\quad f(\omega) = \begin{cases} \omega - D_3, & \omega > D_3 \\ 0, & \omega \le D_3 \end{cases}$

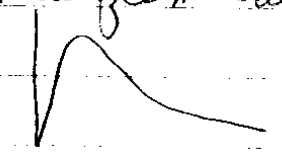
$D_1 + D_2 (f(\omega))^{D_4} ms + (D_5 + \omega^{D_6})(1-\omega)^{D_7} (ms^2 + mu^2)^{D_8}$

$g = (D_5 + \omega^{D_6})(1-\omega)^{D_7}$ $\quad \frac{dg}{d\omega} = D_6 \omega^{D_6 - 1} (1-\omega)^{D_7} - D_7 (1-\omega)^{D_7 - 1} (D_5 + \omega^{D_6})$

$\frac{dg}{d\omega} = 0 \Rightarrow D_6 \omega^{D_6 - 1} (1-\omega)^{D_7} = D_7 (1-\omega)^{D_7 - 1} (D_5 + \omega^{D_6})$

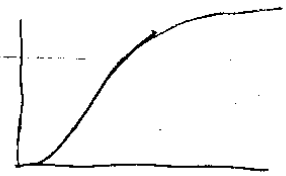
$D_6 \omega^{D_6 - 1} (1-\omega) = D_7 (D_5 + \omega^{D_6})$ no simple soln for ω

Also from TableCurve 2D



$$y = \frac{ab(\exp(-bx) - \exp(-cx))}{c-b}$$

$x>0, b>0, c>0, D \neq C$



$$y = a\left[1 + \frac{b\exp(-cx) - c\exp(-bx)}{c-b}\right]$$

$x>0, b>0, c>0$ $b \neq c$

simanh6.for

Mod by simanh5.for to 8 parameters

FitBQ: $\frac{G_p}{b\sqrt{ghe^3}} = D_1 + D_2 (f(\omega))^{D_4} + (D_5 + \omega^{D_6})(1-\omega)^{D_7} (ms^2 + mu^2)^{D_8}$

FitBQ $\omega = he^2/(he^2 + hh \cdot b)$ $\quad f(\omega) = \begin{cases} \omega - D_3, & \omega > D_3 \\ 0, & \omega \le D_3 \end{cases}$

$D_1 > 0$ $D_2 > 0$ $D_3 > 0$ $D_5 + \omega^{D_6} > 0$ $D_8 > 0$ $\quad D_5 > 0$

→ my2807g 1,2,3., iseed1 = 283 iseed2 = 222

INITIAL D_i: $D_1 = 0.49$ $D_2 = 0.2$, $D_3 = 0$ $D_4 = 0.04$ $D_5 = 0.02$
$D_6 = 0.6$ $D_7 = 1.9$ $D_8 = 0.34$

28 May 07

siman h6.for (cont'd) ~~28 May~~ my2807a files

$$\frac{Q}{b\sqrt{g h_e^3}} = 0.47699 + 0.20096\,(w - 0.0086718)^{0.81966} + (0.0065935 + w^{0.50890})(1-w)^{1.7321}\left(ms^2 + mi^2\right)^{0.32064}$$

qpt = 0.175076 rmserr = 0.25929 $\overline{\text{relerr}}$ = 0.097995

Scaletest $\overline{\text{error}}$ = −0.59664 rmserr = 1.10345

stderr = 0.92940 $\overline{\text{relerr}}$ = 0.28679 stdrelerr = 0.21119

Not very good. A different def of w? $w = \dfrac{h_e^2}{D + h_h \cdot b}$

h_h or $b \to 0$ makes w large and eliminates $(ms^2 : mi^2)$ term in current usage

$w = \dfrac{h_e(h_h + b)}{D + 2h_h \cdot b}$ using a harmonic mean

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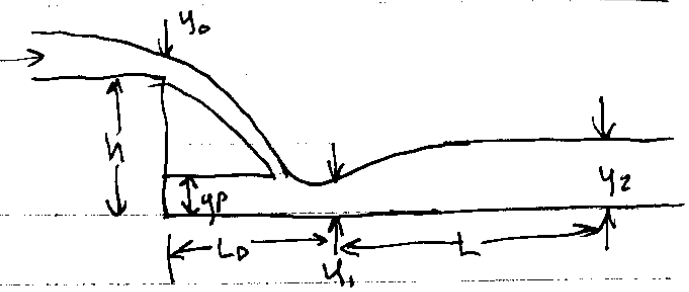
29 May 07

Chow p 423 - Drop ms.



$$D = \frac{q^2}{gh^3}$$

$\frac{y_2}{h} = 1.66 D^{0.27}$ $\quad \frac{L_d}{h} = 4.30 D^{0.27}$ $\quad \frac{y_p}{h} = 1.00 D^{0.22}$ $\quad \frac{y_1}{h} = 0.54 D^{0.425}$

$q < y_2/h$

q = discharge/unit width $\Rightarrow D \simeq \dfrac{q^2}{b^2 g h^3} = \dfrac{Q^2}{(bh)^2 g h}$

$q = Q/b$ $\quad \frac{ft^3}{s} \cdot \frac{1}{ft} = \frac{ft^2}{s}$

$$\frac{Q}{bh} = \sqrt{ghD} \qquad D = (y_p/h)^{\frac{1}{0.22}} \simeq (y_p/h)^{4.55}$$

$y_p = D^{0.22} h$

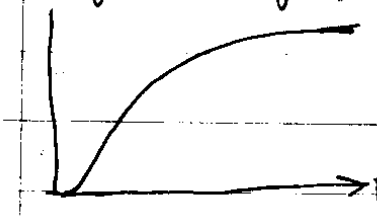
$\dfrac{Q^2}{(bh)^2} = gh\left(\dfrac{y_p}{h}\right)^{4.55}$ when $y_p = h$ $\quad \dfrac{Q^2}{(bh)^2} = gh\,\dfrac{L^4}{s^2}\,\dfrac{1}{L^4} = \dfrac{L}{s^2}, L = \dfrac{L^2}{s^2}$

29 May 07

$\left(\frac{Q}{b \cdot h_h}\right)^2 = g \cdot h_h$ $\qquad \frac{Q}{b\sqrt{g h_e^3}} = f(h_e)$

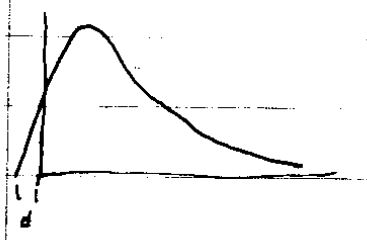
$\frac{Q}{b\sqrt{g h_h^3}} = 1$ $\quad h_e = h_h \Rightarrow f(h_e) \cong 1$ or at least a constant about the point at which Q transforms from gravity dominated drop flow to channel flow

So maybe we should be strictly, or at least mostly, a function of h_e/h_h Let $w = h_e/(h_h + 10^{-10})$?



$$y = a\left[1 + \frac{b\exp(-cx) - c\cdot\exp(-bx)}{b-c}\right]$$

$x>0,\ b>0,\ c>0,\ b\neq c\quad a>0$



$$y = \frac{a\left(\exp(-b(x+d)) - \exp(-c(x+d))\right)}{c-b}$$

$a>0,\ x>0,\ b>0,\ c>0,\ b\neq c$

$$\frac{Q}{b\sqrt{g h_e^3}} = D_1 + D_2\left[1 + \frac{D_3\exp(-D_4 w) - D_4\exp(-D_3 w)}{D_4 - D_3}\right]\frac{h_{e\,rms}}{b} + D_5\frac{\exp(-D_6(w+D_8)) - \exp(-D_7(x+D_8))}{D_7 - D_6}\left[\frac{h_e^2}{b^2}\left(ms^2 + mu^2\right)\right]^{D_9}$$

FITCφ

siman h6_for

Modify to 9 parameters for FITCφ. Define $w = \frac{h_e}{h_h + 10^{-10}}$

my3007a ← iseed1 = 659, iseed2 = 250 30 May 07

$w_{hi} = 10$ $h_{hi} = 0.00001$ Initial D_i: $D_1 = 0.49$, $D_2 = 0.3$ (0.2)

$D_3 = 3$ $D_4 = 6.3$ (4) $D_5 = 5.8$ (0.6), $D_6 = 0.84$ $D_7 = 6.3$ $D_8 = 0.1$ ~~0.0001~~

$D_9 = 0.38$ input mytaraub.prn

30 May 07

simanh6 cont'd

opt = 33.5387 rmseu = 0.159606 std-eu = 0.159633

$\overline{\text{ret eu}}$ = 0.0485634 std rel eu = 0.0516706

Scale $\overline{\text{mean eu}}$ = -0.273769 rms-eu = 0.718926

std eu = 0.66559 $\overline{\text{ret eu}}$ = 0.159054 std rel eu = 0.151775

D_1 = 0.46895 D_2 = 0.32540 D_3 = 2.7038 D_4 = 1.4838

D_5 = 4.9265 D_6 = 0.85970 D_7 = 5.3664 D_8 = 0.10800

D_9 = 0.37348

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31 May 07

simanh6 (cont'd)

my3107a ← my16rawb, Fre C0, set $w(i) = \frac{h_{ei}}{h_{ei} + hh_i}$

iseed1 = 599, iseed2 = 920

D_1 = 0.47, D_2 = 0.33 D_3 = 2.7 D_4 = 1.48 D_5 = 4.9

D_6 = 0.86 D_7 = 5.4 D_8 = 0.11 D_9 = 0.37

→ opt = 0.151 rms eu = 0.2567 $\overline{\text{ret eu}}$ = 0.06825

Scale test error large D_1 = 0.42269 D_2 = 0.28022

D_3 = 8.9313 D_4 = 9.9314 D_5 = 10 D_6 = 5.605

D_7 = 4.605 D_8 = 0.1e-4 D_9 = 0.32784

Reset D_i initial to these values and set $uh_{i=3-7}$ = ~~5~~ 20

Write over old files

opt = 0.140097

⇒ WORSE than $h_0/hh+\epsilon$ rmseu = 0.23074 ~~ret eu~~

$\overline{\text{ret eu}}$ = 0.070335 std rel eu = 0.064007

Scale test mean eu = -0.764 rms-eu = 1.4162

$\overline{\text{ret eu}}$ = 0.350926 std rel eu = 0.30367

31 May 07

$D_1 = 0.43685$ $D_2 = 0.29601$ $D_3 = 6.1708$ $D_4 = 7.1708$

$D_5 = 12.956$ $D_6 = 6.2479$ $D_7 = 5.2479$ $D_8 = 0.1e-4$

$D_9 = 0.37321$

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1 June 07

my 3107a data → my3107a.wk1

Unresolved error. Replace abs-err column in vs with err.% plot in TC-3D $r = \frac{h_e}{h_e + h_h}$

Get discernable surfaces in err(r, mu), err(mu, he), (r, ms)

drop in corner err(mu, ms) → err(0, 0)

much less so in err(mu, hh), err(mu, hu) (ms, he) (mu, Q), (ms, hh)

my3007a.wk4

~~Pat~~ Strong patterns in err(R, Mu) err(He, mu), not err(ms, mu), err(He, ms) with diagonal strings of dots in the vertical organized on He

Bingo: its err(He, $\hat{Q}/Q$) an overall correction that gets stronger for higher He

Seems to be $x = He$ $y = Q_h/Q$ error = z

$z = (y-1)f(x)$ or $Q_h - Q = \left(\frac{Q_h}{Q} - 1\right)(a + bH_e) = \frac{Q_h - Q}{Q} f(H_e)$

$Q = f(H_e)$ done? Not according to TC-2D

~~$Q_h/Q = 1 + F_1 \cdot (Q_h - Q) \rightarrow Q_h = Q + F_1 (Q_h - Q) \cdot Q$~~

For $0 \le H_e \le 0.155$ $(Q_h/Q) = 4(Q_h - Q) + 1$

$Q_h = 4(Q_h - Q)Q + Q \rightarrow Q_h - Q = 4Q(Q_h - Q) \Rightarrow Q = \frac{1}{4} = 0.25$

The "strings" in He-related data apparently come only from the fact that the experiment was set up in discrete values of Q