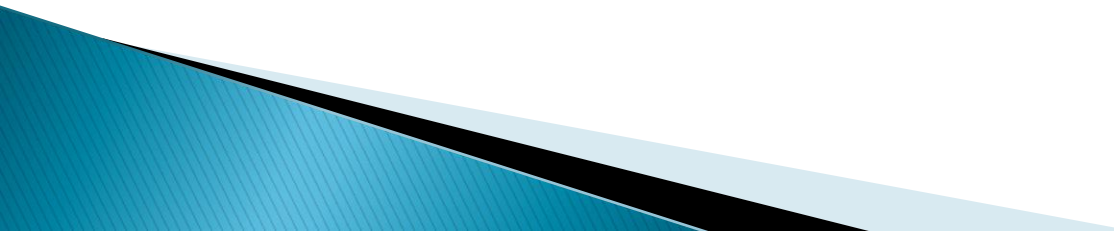


오래쓰는 걸레

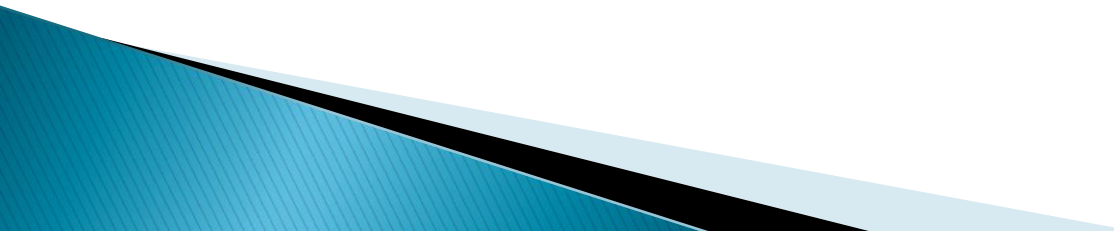
2005006177 이종오
2007006656 주경훈



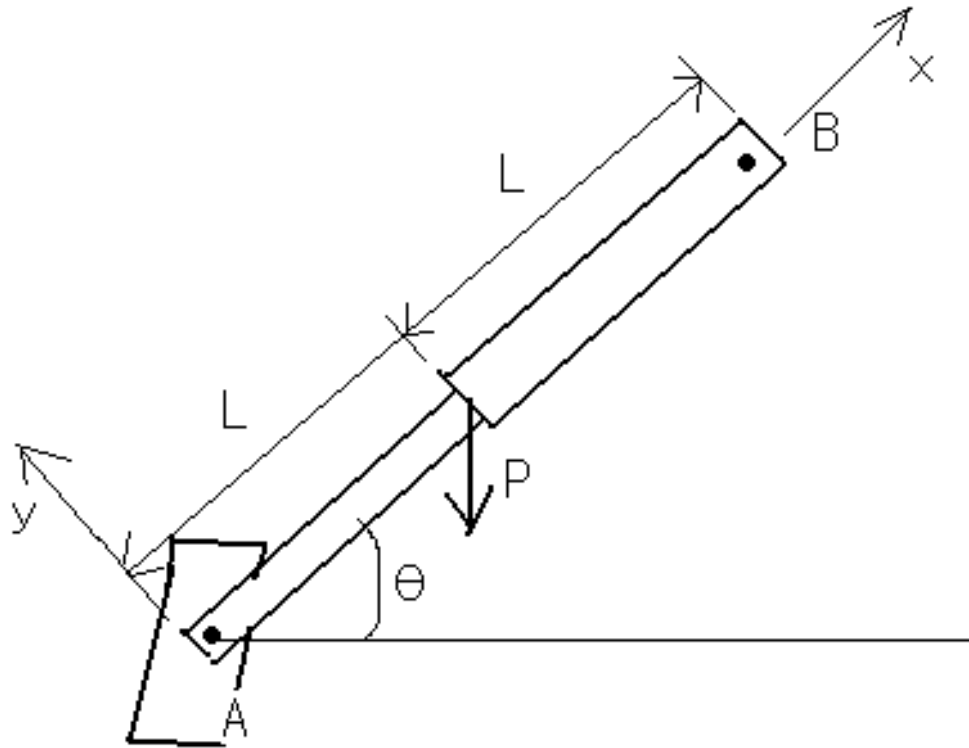
순서

- ▶ Project/ Problem Statement
 - ▶ Data and Information Collection
 - ▶ Definition of Design variables
 - ▶ Identification of a Criterion
 - ▶ Identification of Constraints
- 

Project/ Problem Statement

- ▶ 필요한 재료 값 최소화 -> 단면적 최소화
 - ▶ 변형은 수납 시 문제가 없을 정도로
 - ▶ 봉의 굽기는 손에 쥐기에 불편함이 없을 것
 - ▶ 재료별 크기와 무게 비교 후 적정재료 찾기
- 

Data and Information Collection



Data and Information Collection

▶ 넓이 : $A = 2\pi r t$

▶ 관성모멘트 :

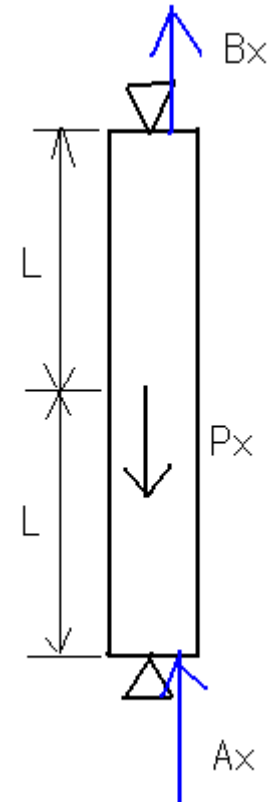
▶ Ax :
$$I = \frac{\pi R^3 t}{4}$$

$$Ax + Bx = Px$$

$$\delta = \delta A + \delta B = \frac{AxL}{AE} - \frac{BxL}{AE} = 0$$

$$Ax = Bx(\text{radius}_a \doteq \text{radius}_b)$$

$$Ax = \frac{1}{2} Px$$



Data and Information Collection

- ▶ $A_y :$ $A_y = \frac{1}{2} P_y$

- ▶ $L = 0.7\text{m}$

- ▶ 하중 $P :$ $P = 200(N)$

$$P_x = P \sin \Theta = 149.02$$

$$P_y = P \cos \Theta = 133.39$$

- ▶ $\Theta = 40^\circ$

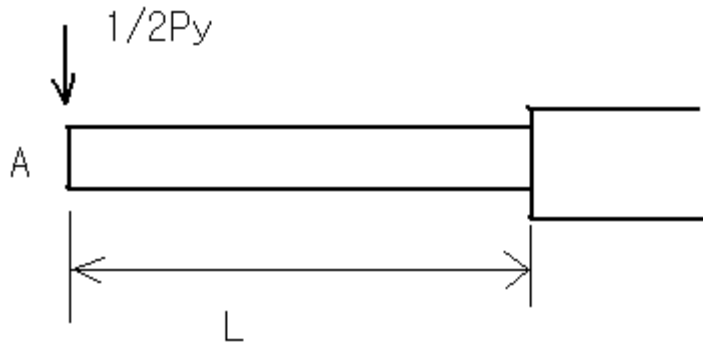
Data and Information Collection

•재료별 물성치

	밀도 (kg/m ³)	σ_a (Mpa)	τ_a (MPa)	E(Gpa)
Steel	7860	250	145	200
Alloy 2014-T6	2800	400	230	75
Yellow brass	8470	410	250	105

Data and Information Collection

•A점에서의 처짐량



$$M = \frac{1}{2} P_y x$$

$$EI \frac{d^2 y}{dx^2} = -\frac{1}{2} P_y x$$

$$EI \frac{dy}{dx} = -\frac{1}{4} P_y^2 x + C_1$$

$$\text{fixed_end_L, at_x} = L$$

$$\frac{dy}{dx} = 0$$

$$C_1 = \frac{1}{4} P_y L^2$$

Data and Information Collection

$$EI \frac{dy}{dx} = -\frac{1}{4} P_y x^2 + \frac{1}{4} P_y L^2$$

$$EI y = -\frac{1}{12} P_y x^3 + \frac{1}{4} P_y L^2 x + C_2$$

$$\text{at } x = L, y = 0$$

$$0 = -\frac{1}{12} P_y L^3 + \frac{1}{4} P_y L^3 + C_2$$

$$C_2 = -\frac{1}{6} P_y L^3$$

$$y = \frac{P_y}{12EI} (-x^3 + 3L^2 x - 2L^3)$$

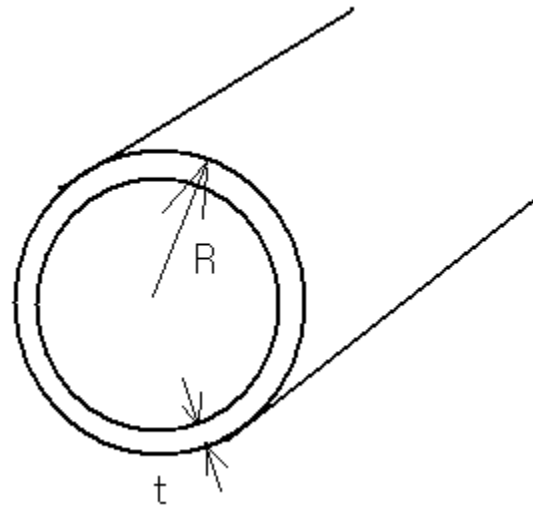
$$\text{at } x = 0$$

$$\text{deflection at } A$$

$$y_A = \frac{P_y}{12EI} \cdot (-L^3) = -\frac{P_y L^3}{6EI}$$

Definition of Design variables

- Radius R
- Thickness t



Identification of a Criterion

- ▶ Mass

$$m = \rho V = \rho 2\pi r t L (kg)$$

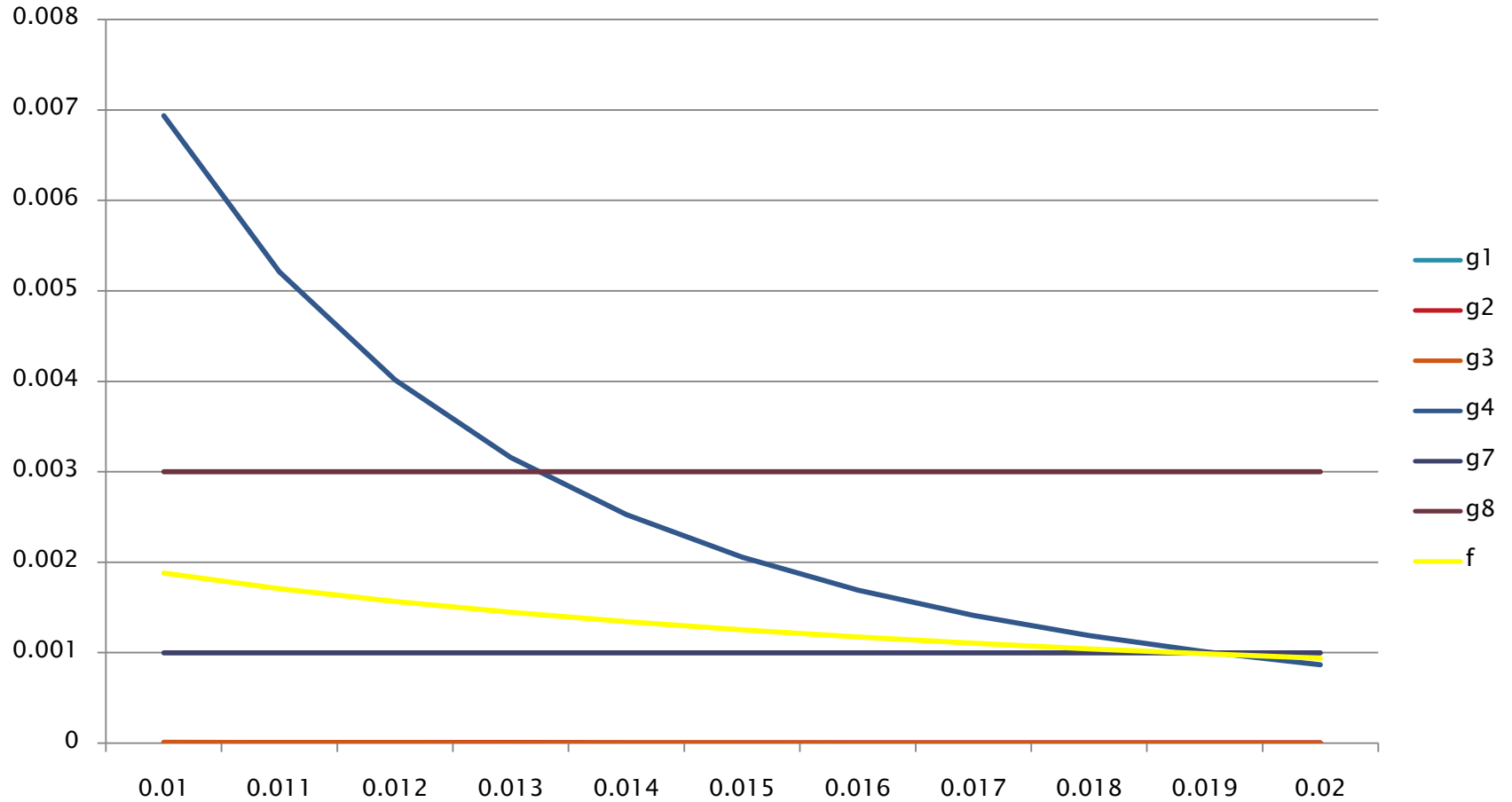
Identification of Constraints

- ▶ g1 : 최대허용응력 : $\frac{Ax}{2\pi rt} - \sigma_a \leq 0$
- ▶ g2 : 최대전단응력 : $\frac{Ay}{2\pi rt} - \tau_a \leq 0$
- ▶ g3 : 좌굴 : $Ax - \frac{\pi^3 Er^3 t}{4(Le)^2} \leq 0, (Le = 0.7L)$

Identification of Constraints

- ▶ g4 : 최대 처짐량 : $\frac{P_y L^3}{6EI} - 7(mm) \leq 0$
- ▶ g5 : $r - 2(cm) \leq 0$
- ▶ g6 : $-r + 1(cm) \leq 0$
- ▶ g7 : $-t + 0.001 \leq 0$
- ▶ g8 : $t - 0.003 \leq 0$

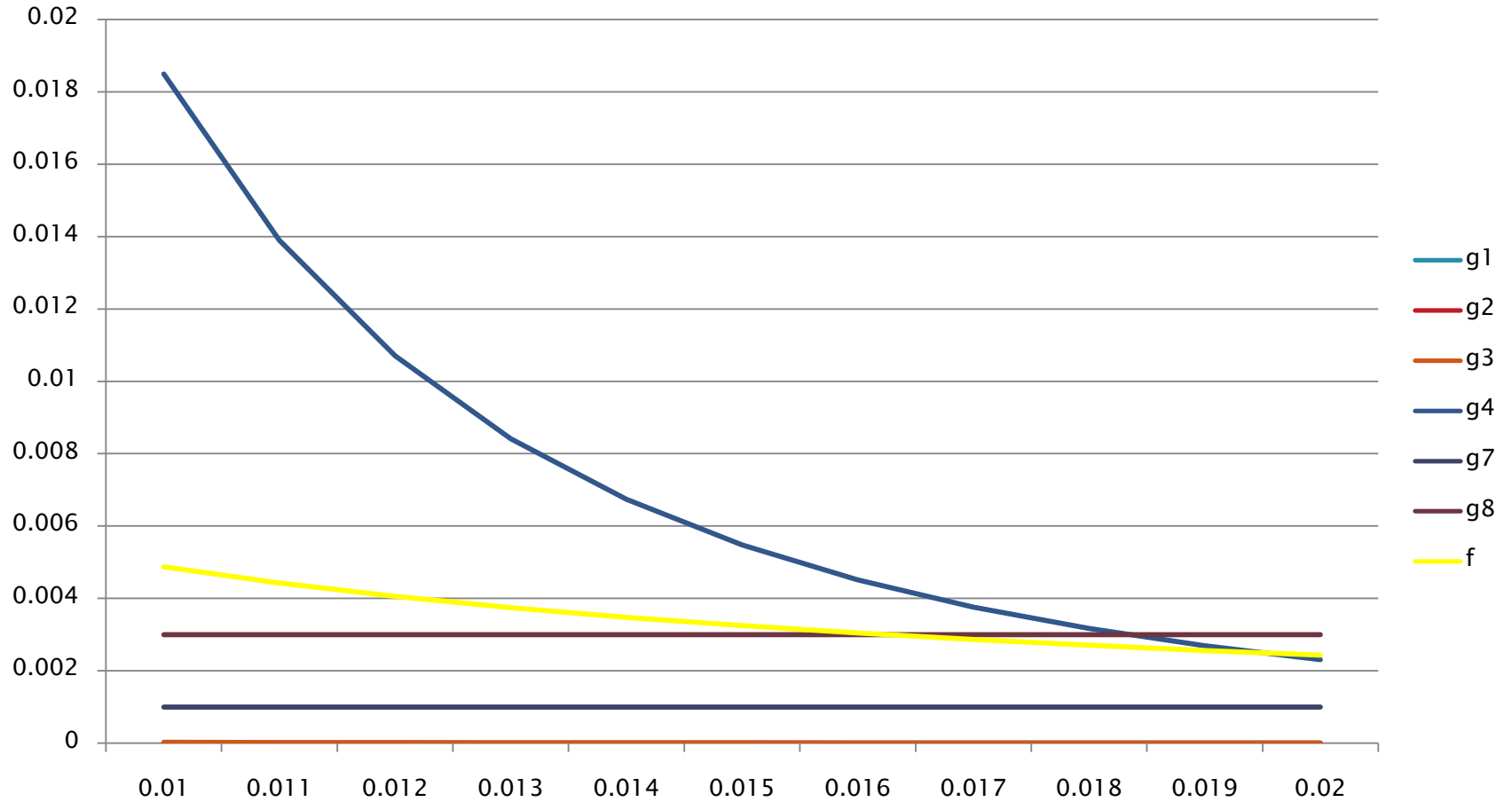
Graphical solution – steel



Excel data – steel

r	g1	g2	g3	g4	g7	g8	F (m=1.3kg)
0.01	4.74354E-06	7.32045E-06	1.15397E-05	0.006934904	0.001	0.003	0.00188
0.011	4.31231E-06	6.65495E-06	8.66995E-06	0.005210296	0.001	0.003	0.001709
0.012	3.95295E-06	6.10037E-06	6.67807E-06	0.004013255	0.001	0.003	0.001567
0.013	3.64888E-06	5.63111E-06	5.25248E-06	0.003156533	0.001	0.003	0.001446
0.014	3.38824E-06	5.22889E-06	4.20543E-06	0.002527297	0.001	0.003	0.001343
0.015	3.16236E-06	4.8803E-06	3.41917E-06	0.002054786	0.001	0.003	0.001253
0.016	2.96471E-06	4.57528E-06	2.81731E-06	0.001693092	0.001	0.003	0.001175
0.017	2.79032E-06	4.30615E-06	2.34881E-06	0.001411542	0.001	0.003	0.001106
0.018	2.6353E-06	4.06692E-06	1.97869E-06	0.001189112	0.001	0.003	0.001045
0.019	2.4966E-06	3.85287E-06	1.68242E-06	0.001011066	0.001	0.003	0.00099
0.02	2.37177E-06	3.66022E-06	1.44246E-06	0.000866863	0.001	0.003	0.00094

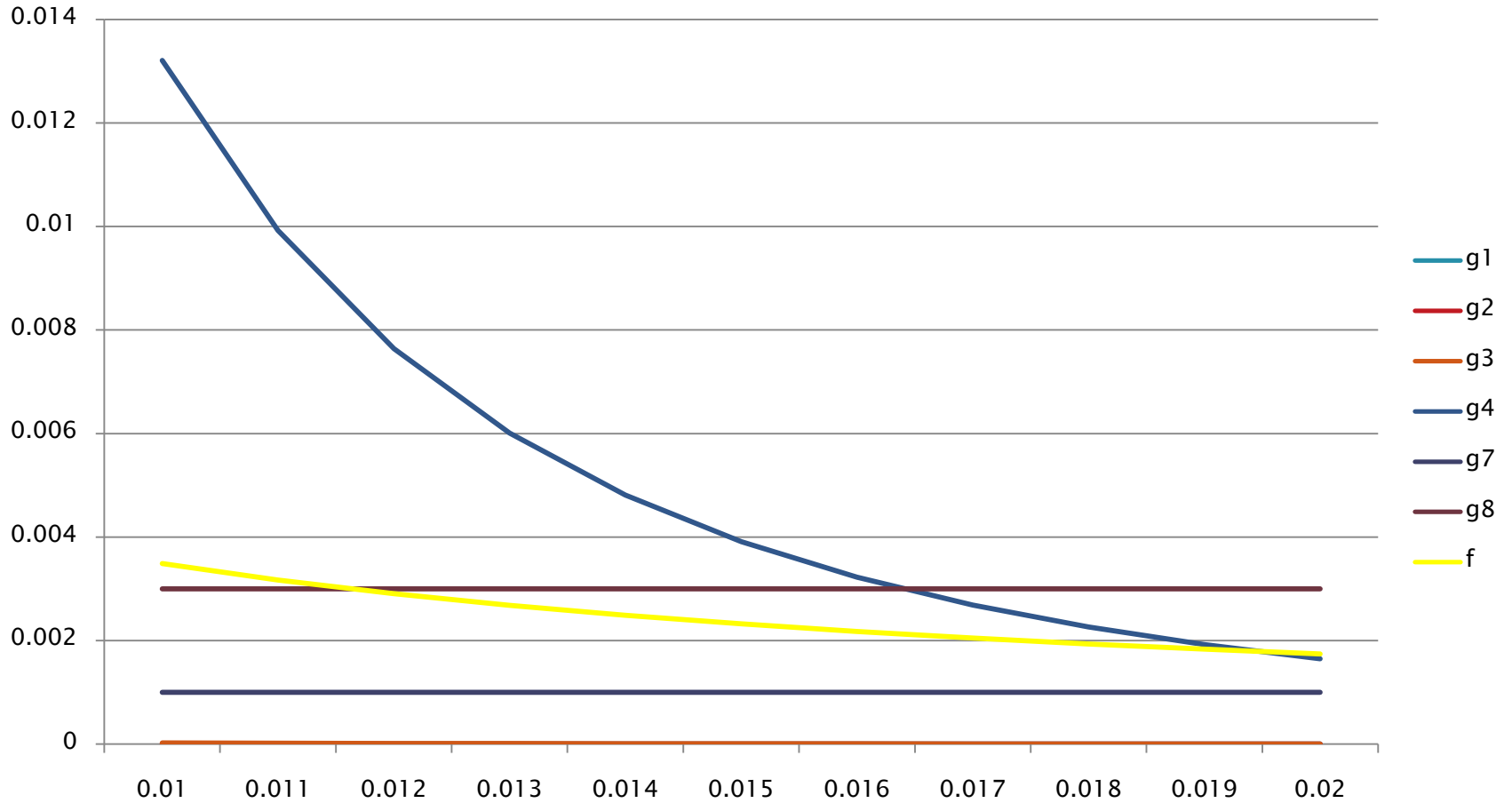
Graphical solution – alloy 2014



Excel data – alloy 2014

r	g1	g2	g3	g4	g7	g8	F (m=0.6kg)
0.01	2.96471E-06	4.61506E-06	3.07726E-05	0.018493	0.001	0.003	0.004872
0.011	2.69519E-06	4.19551E-06	2.31199E-05	0.013894	0.001	0.003	0.004429
0.012	2.47059E-06	3.84589E-06	1.78082E-05	0.010702	0.001	0.003	0.00406
0.013	2.28055E-06	3.55005E-06	1.40066E-05	0.008417	0.001	0.003	0.003748
0.014	2.11765E-06	3.29647E-06	1.12145E-05	0.006739	0.001	0.003	0.00348
0.015	1.97647E-06	3.07671E-06	9.11779E-06	0.005479	0.001	0.003	0.003248
0.016	1.85294E-06	2.88442E-06	7.51283E-06	0.004515	0.001	0.003	0.003045
0.017	1.74395E-06	2.71474E-06	6.2635E-06	0.003764	0.001	0.003	0.002866
0.018	1.64706E-06	2.56392E-06	5.2765E-06	0.003171	0.001	0.003	0.002707
0.019	1.56037E-06	2.42898E-06	4.48645E-06	0.002696	0.001	0.003	0.002564
0.02	1.48236E-06	2.30753E-06	3.84657E-06	0.002312	0.001	0.003	0.002436

Graphical solution – yellow brass



Excal data – yellow brass

r	g1	g2	g3	g4	g7	g8	F (m=1.3kg)
0.01	2.8924E-06	4.24586E-06	2.19804E-05	0.013209	0.001	0.003	0.00349
0.011	2.62946E-06	3.85987E-06	1.65142E-05	0.009924	0.001	0.003	0.003172
0.012	2.41033E-06	3.53822E-06	1.27201E-05	0.007644	0.001	0.003	0.002908
0.013	2.22492E-06	3.26605E-06	1.00047E-05	0.006012	0.001	0.003	0.002684
0.014	2.066E-06	3.03276E-06	8.01035E-06	0.004814	0.001	0.003	0.002493
0.015	1.92827E-06	2.83057E-06	6.51271E-06	0.003914	0.001	0.003	0.002326
0.016	1.80775E-06	2.65366E-06	5.36631E-06	0.003225	0.001	0.003	0.002181
0.017	1.70141E-06	2.49756E-06	4.47393E-06	0.002689	0.001	0.003	0.002053
0.018	1.60689E-06	2.35881E-06	3.76893E-06	0.002265	0.001	0.003	0.001939
0.019	1.52232E-06	2.23466E-06	3.20461E-06	0.001926	0.001	0.003	0.001837
0.02	1.4462E-06	2.12293E-06	2.74755E-06	0.001651	0.001	0.003	0.001745