Erratum

Analysis of Machining and Machine Tools

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The following corrections have been carried out:

Chapter-3 Multiple Point Cutting Processes

Page 27

In Fig. 3.4, the entry and exit angles, θ_1 and θ_2 , should be marked as following:

Chapter-4 Grinding Process

Page 47

In Equations 4.2 and 4.3, traverse and plunge should be switched. The correct equations are as following:

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$$\begin{aligned} fa_p v_{trav} &= fh_{eff} (\pi D_s n_s \pm v_{trav}) \text{ in traverse} \\ fa_p v_{trav} &= a_p h_{eff} (\pi D_s n_s \pm v_{trav}) \text{ in plunge} \end{aligned} \quad (4.2)$$

$$\begin{aligned} h_{eff} &= \frac{a_p v_{trav}}{(\pi D_s n_s \pm v_{trav})} \text{ in traverse} \\ h_{eff} &= \frac{f v_{trav}}{(\pi D_s n_s \pm v_{trav})} \text{ in plunge} \end{aligned} \quad (4.3)$$

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From Eq. (4.3) h_{eff} should be calculated as the following:

$$h_{eff} = \frac{(0.1)(154)}{\pi(150)(20)} = 0.0016 \text{ mm.}$$

Accordingly,

$$p_s = 10^{0.19-0.46 \log 0.0016} = 29.93 \text{ J/mm}^3 \text{ and } P = (29.93)(2)(0.1)(154) = 921.8 \text{ W.}$$

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Equations 4.26 and 4.27 should be corrected as following:

$$fa_p \pi D_w n_w = fh_{eff} \pi (D_s n_s \pm D_w n_w) \quad (4.26)$$

$$h_{eff} = \frac{a_p D_w n_w}{D_s n_s \pm D_w n_w} \quad (4.27)$$

Chapter-5 Machine Tool Components

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For example, the oval cross section (the 7th in (5.4a) and the 5th in (5.4b)) has a poor resistance to bending but high resistance to torsion, while the I-beam (the 8th in (5.4a) and the 6th in (5.4b)) shows a very good resistance to bending but nearly zero resistance to torsion. Generally speaking, the bending as well as the torsion resistance of machine frame components may be enhanced by the provision of strengthening ribs as shown in Fig. 5.5. The relative bending and torsion resistance of these ribbed frames are summarized in Fig. 5.6.

Has been replaced with:

“For examples, the oval cross section (the 7th in (a) and the 2nd in (b)) has a poor resistance to bending but high resistance to torsion, while the I beam (the 1st in (a)

and the 7th in (b)) shows a very good resistance to bending but nearly zero resistance to torsion. Generally speaking, the bending as well as the torsion resistance of machine frame components may be enhanced by the provision of strengthening ribs.”

New caption for Figure 5.4:

Fig. 5.4 Comparison of the (a) area moments of inertia (b) polar area moments (of inertia for machine tool frame design)

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Figure 5.7 shows the influence of surface finish and contact pressure at a column joint on the damping effect.

Has been replaced with:

The surface finish and contact pressure at a column joint can also influence the damping.

Also, figures 5.5, 5.6, and 5.7 are now deleted, the following figures have been re-numbered accordingly:

- Figure 5.8 is now Figure 5.5
- Figure 5.9 is now Figure 5.6
- Figure 5.10 is now Figure 5.7
- Figure 5.11 is now Figure 5.8
- Figure 5.12 is now Figure 5.9
- Figure 5.13 is now Figure 5.10
- Figure 5.14 is now Figure 5.11
- Figure 5.15 is now Figure 5.12
- Figure 5.16 is now Figure 5.13

Figure 5.17 is now Figure 5.14
 Figure 5.18 is now Figure 5.15
 Figure 5.19 is now Figure 5.16
 Figure 5.20 is now Figure 5.17
 Figure 5.21 is now Figure 5.18
 Figure 5.22 is now Figure 5.19

Chapter-7 Mechanics of Machining

Page 126

Velocities in Equation 7.25 should be expressed in vector form as following:

$$\vec{v}_s = \vec{v} + \vec{v}_c. \quad (7.25)$$

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Last line should read:

$$u_M = \rho v^2 \gamma^2 \sin^2 \varphi = (7.25 \times 10^{-4}) \left(\frac{1186 \times 12}{60} \right)^2 (2.4)^2 (\sin 25^\circ)^2 = 41.96 \text{ psi}$$

Chapter-9 Cutting Temperature and Thermal Analysis

Page 145

In Equation 9.3, R , the dimensionless number should be defined as $\rho cvt/k$, where ρ being the density, k the thermal conductivity, c the specific heat capacity, v the cutting speed, and t the undeformed chip thickness.

Page 150

The Example uses a wrong equation to calculate R . The corrected example and solution is as follows:

Example

The maximum temperature along the tool face and the temperature on the newly machined surface are to be estimated for the following condition during the turning of mild steel at a room temperature of 22 °C:

Rake angle $\alpha = 0$

Cutting force $F_p = 890 \text{ N}$

Thrust force $F_Q = 667 \text{ N}$

Cutting speed $v = 5 \text{ m/s}$

Undeformed chip thickness $t = 0.5 \text{ mm} = \text{feed}$

Width of cut $b = 2.5 \text{ mm}$

Cutting ratio $r = 0.3$

Length of contact between chip and tool face $l_f = 0.75 \text{ mm}$

Ratio of the width of secondary deformation zone to the chip thickness $w_o = 0.2$
 Mild steel density $\rho = 7200 \text{ kg/m}^3$
 Mild steel thermal conductivity $k = 436 \text{ J/smK}$
 Mild steel specific heat capacity $c = 502 \text{ J/kgK}$

Solution

Total heat generation rate $P = F_p v = 890(5) = 4450 \text{ J/s}$

$$\alpha = 0 \rightarrow F_c = -F_p \sin \alpha - F_Q \cos \alpha = -F_Q$$

$$P_F = F_c v_c = F_c v_r = 667(5)(0.3) = 1000 \text{ J/s}$$

In the primary deformation zone: $P_S = P - P_F = 3450 \text{ J/s}$

$$R = \rho c v t / k \quad R = \frac{7200(502)(5)(0.0005)}{436} = 20.7$$

$$\alpha = 0 \rightarrow \tan \phi = \frac{r \cos \alpha}{1 - r \sin \alpha} = r \rightarrow R \tan \phi = 20.7 \quad (0.3) = 6.2$$

Fig of $\Gamma \rightarrow \Gamma = 0.16$

$$T_s = \frac{(1-\Gamma)P_S}{\rho c v t b} = \frac{(1-0.16)3450}{7200(502)5(0.0005)0.0025} = \frac{(1-0.16)3450}{22.6} = 128^\circ \text{C}$$

$$w_o = 0.2 \text{ and } \frac{R}{l_o} = \frac{R}{l_f(r/t)} = \frac{(20.7)}{0.75(0.3/0.5)} = 46$$

$$T_f = \frac{P_F}{\rho c v t b} \quad T_f = \frac{1000}{22.6} = 44.2^\circ \text{C}$$

$$T_m / T_f = 4.2 \rightarrow T_m = 4.2 \times 44.2 + 185.6^\circ \text{C}$$

$$T_{\max} = T_o + T_s + T_m = 22 + 128 + 186 = 336^\circ \text{C}$$

Temperature on the machined surface is:

$$22 + T_w = 22 + \frac{\Gamma P_S}{\rho c v t b} = 22 + \frac{\Gamma}{1-\Gamma} T_s = 22 + \frac{0.16}{0.84} (128) = 46^\circ \text{C}$$

Chapter-12 Electrochemical Machining, Chemical Machining, and Chemical Mechanical Polishing Processes

Page 185

Equation 12.7 missed the valency of work piece material (z) on the denominator and should be corrected as following:

$$\dot{h} + f = \frac{wI}{z\rho FA} \Rightarrow \dot{h} = \frac{wJ}{z\rho F} - f, \quad (12.7)$$

Accordingly, the equations 12.8 and 12.9 should be corrected as following:

$$\frac{dh}{dt} = \frac{wkV}{z\rho Fh} - f. \quad (12.8)$$

$$h^2(t) = h^2(0) + \frac{2wkVt}{z\rho F}, \quad (12.9)$$

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In the below Equation 12.10,

$$h_e \text{ should be corrected as } h_e = \frac{wkV}{z\rho Ff}.$$

Also, example was numbered as 12.2 and other examples were not numbered. For consistency, 12.2 was removed.

In this example, the question was framed as “considering the previous example”. There were two previous examples. This example was based on the first one. To make it precise, the example question was corrected as following:

“Considering the first example in this chapter on ECM of iron work piece, under a feed rate of 0.02 mm/s, what is the time it takes to achieve 90 % of the steady-state value of gap width?”

Based on previous correction on h_e , the example solution was corrected as following:

$$h_e = \frac{wkV}{z\rho Ff} = \frac{(0.028)(0.2)(10)}{(2)(7800)(96,500)(0.02)} = 0.019 \text{ cm.}$$

$$h(0) = 0.0062 \text{ cm, } h(t) = 0.9h_e = 0.017 \text{ cm.}$$

Based on Eq. (12.10),

$$0.017 = 0.0062 - 0.002t + 0.019 \ln \frac{0.0062 - 0.019}{0.017 - 0.019}.$$

Then, the solved time is $t = 12.1 \text{ s}$.

Chapter-13 Laser and Electron Beam Machining

Page 199

In Fig. 13.2, the annotation of the beam divergent angle, θ , was wrong. Fig. 13.2 should be corrected as following:

Fig. 13.2 Focus of laser beam