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Research on Decoupling Performance of Major-motion Mechanism for Forging Manipulators

Abstract

Key words

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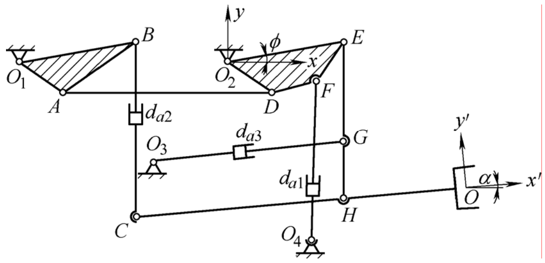
d_a d_a d_a O

x y α d_a d

$\angle EO\ F =$



$$l_{EH} = \left(x - l_{OH}\quad \alpha - l_{O\ E}\quad \phi\right) +$$
$$\left(y - l_{OH}\quad \alpha - l_{O\ E}\quad \phi\right)$$

l_{ij} i j ϕ

$O\ F$ BC $O\ G$

$$\begin{cases} d_a = \sqrt{\left[l_{O\ F}\left(\ -\ \ \phi\right)\right]\ + \left(l_{O\ F}\quad \phi + d\ \right)} \\ d_a = \sqrt{\left[x - l_{OC}\quad \alpha - \left(l_{O\ E}\quad \phi - l_{CH}\right)\right]\ + \left(y - l_{OC}\quad \alpha - l_{O\ E}\quad \phi\right)} \\ d_a = \sqrt{\left[\frac{l_{GH} l_{O\ E}}{l_{EH}}\quad \phi + \frac{l_{EG}}{l_{EH}}\left(x - l_{OH}\quad \alpha\right) - \left(l_{O\ E} - l_{CH}\right)\right]\ + \left[\frac{l_{GH} l_{O\ E}}{l_{EH}}\quad \phi + \frac{l_{EG}}{l_{EH}}\left(y - l_{OH}\quad \alpha\right) + l_{EG}\right]} \end{cases}$$

$$\phi = \quad \left(R \pm \sqrt{R\ \ - \left(P\ \ - Q\ \right)}\ \ P + Q\right)$$

$$\begin{cases} P = \left(x - l_{OH}\quad \alpha\right)\ + \left(y - l_{OH}\quad \alpha\right)\ + l_{O\ E}\ - l_{EH} \\ Q = \ l_{O\ E}\left(x - l_{OH}\quad \alpha\right) \\ R = \ l_{O\ E}\left(y - l_{OH}\quad \alpha\right) \end{cases}$$

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$$\begin{pmatrix} \dot{d}_a \\ \dot{d}_a \\ \dot{d}_a \end{pmatrix} = \begin{pmatrix} f & f & f \\ f & f & f \\ f & f & f \end{pmatrix} \begin{pmatrix} \dot{x} \\ \dot{y} \\ \dot{\alpha} \end{pmatrix}$$

f_{ij} i $j =$ x y α

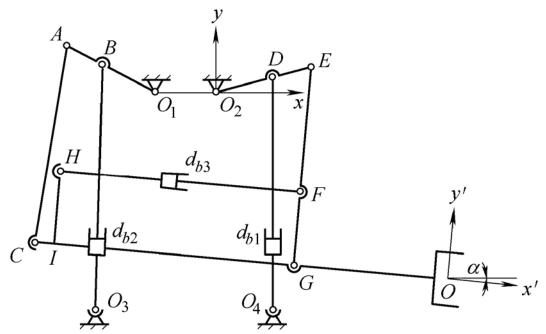
$f_{ij} \equiv$

i $j =$ $i \neq j$

$O\ D$ $O\ B$ HF

d_b d_b d_b O

$(x\ y\ \alpha)$



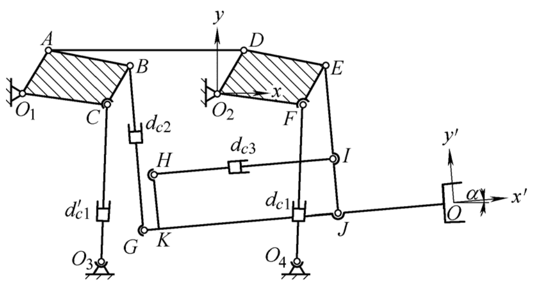
$O\ C$

$O\ F$

$O\ F$ BG HI

d_c d_c d_c O

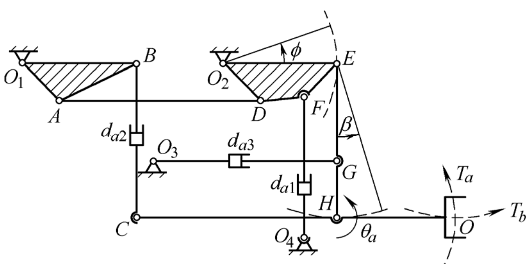
$(x\ y\ \alpha)$

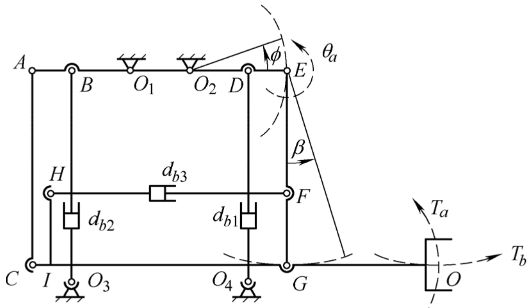


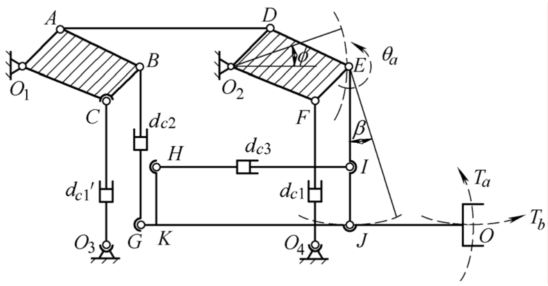
2.1

T_a

T_b θ_α







T_a

E

$$T_a = S\phi$$

S ϕ

T_b

E

H

G J

$$T_b = l_S\beta$$

β E

l_S

R_α

$$\theta_\alpha = \alpha$$

α

$(d\ \ d\ \ d\ )$ T_a

T_b θ_α

2.2

$$\begin{cases} d_a = \sqrt{\left[S(\ -\ \ \phi)\right]\ +(S\ \ \ \phi+d\ \ )} \\ d_a = l_{EH} \\ d_a = \sqrt{\left[l_{CH}-S(\ -\ \ \phi)\right]\ +(S\ \ \ \phi)} \end{cases}$$

$d_a = F(\phi)$ $d_a = F(\phi)$ $\dot{T}_a = S\dot{\phi}$

$$\begin{cases} \dot{d}_a = F' \ \phi \ \dot{\phi} = \frac{}{S} F'\left(\frac{T_a}{S}\right)\dot{T}_a \\ \dot{d}_a = \\ \dot{d}_a = F' \ \phi \ \dot{\phi} = \frac{}{S} F'\left(\frac{T_a}{S}\right)\dot{T}_a \end{cases}$$

$$\begin{cases} d_a = d \\ d_a = l_S \\ d_a = \{ l_{CH} + l_{EG} - l_{EG}\sqrt{l_{CH} + l_{EG}} \times \\ \quad [\beta + (l_{CH} \ l_{EG})]\} \end{cases}$$

$d_a = F(\beta)$ $\dot{T}_b = l_S\dot{\beta}$

$$\begin{cases} \dot{d}_a = \dot{d}_a = \\ \dot{d}_a = F' \ \beta \ \dot{\beta} = \frac{}{l_S} F'\left(\frac{T_b}{l_S}\right)\dot{T}_b \end{cases}$$

$$\begin{cases} d_a = d \\ d_a = \{ l_{CH} + l_{EH} - l_{CH}\sqrt{l_{CH} + l_{EH}} \times \\ \quad [\alpha + (l_{EH} \ l_{CH})]\} \\ d_a = l_{CH} \end{cases}$$

$d_a = F \ \alpha$ $\dot{\theta}_\alpha = \dot{\alpha}$

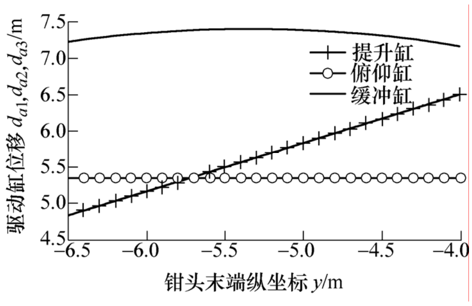
$$\begin{cases} \dot{d}_a = \dot{d}_a = \\ \dot{d}_a = F' \ \alpha \ \dot{\alpha} = F'(\theta_\alpha)\dot{\theta}_\alpha \end{cases}$$

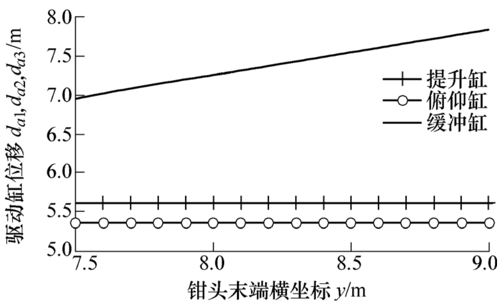
—

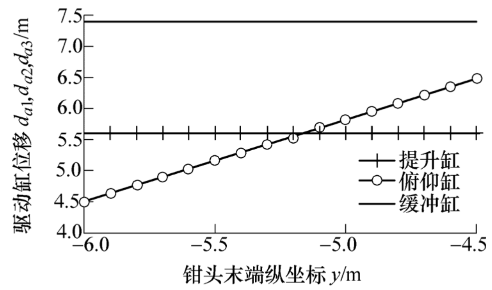
$$\begin{pmatrix} \dot{d}_a \\ \dot{d}_a \\ \dot{d}_a \end{pmatrix} = \begin{pmatrix} \frac{}{S}F'\left(\frac{T_a}{S}\right) & & \\ & & F'(\theta_\alpha) \\ \frac{}{S}F'\left(\frac{T_a}{S}\right) & \frac{}{l}F'\left(\frac{T_b}{l}\right) & \end{pmatrix} \begin{pmatrix} \dot{T}_a \\ \dot{T}_b \\ \dot{\theta}_\alpha \end{pmatrix}$$

1

OE	l_{OE}
OH	l_{OH}
CH	l_{CH}
GH	l_{GH}
EG	l_{EG}
OF	l_{OF}
d_a	d







2.3

$$\begin{cases} d_b = \sqrt{[S(- \ \phi)] + (S \ \phi + d)} \\ d_b = \sqrt{(d + l_{OA} \ \phi) + [l_{OA}(\ \phi)]} \\ d_b = l_{CG} \end{cases}$$

d ϕ

ϕ ϕ

$d_b = G \quad \phi \qquad d_b = G \quad \phi \qquad \dot{T}_a = S\dot{\phi}$

$$\begin{cases} \dot{d}_b = G' \quad \phi\ \dot{\phi} = \frac{}{S} G' \left(\frac{T_a}{S}\right) \dot{T}_a \\ \dot{d}_b = G' \quad \phi\ \dot{\phi} = \frac{}{S} G' \left(\frac{T_a}{S}\right) \dot{T}_a \\ \dot{d}_b = \end{cases}$$

$$\begin{cases} d_b = d_b = d \\ d_b = \sqrt{l_{CG} + l_{EF} - l_{CG} l_{EF} \quad \beta} \end{cases}$$

$d_b = G \quad \beta \qquad \dot{T}_b = l_S \dot{\beta}$

$$\begin{cases} \dot{d}_b = \dot{d}_b = \\ \dot{d}_b = G' \quad \beta\ \dot{\beta} = \frac{}{l_S} G' \left(\frac{T_b}{l}\right) \dot{T}_b \end{cases}$$

$$\begin{cases} d_b = d \\ d_b = \sqrt{\left(d \quad + l_{O A} \quad \phi\right) + \left[l_{O A}\left(\quad \phi\right)\right]} \\ d_b = l \end{cases}$$

$\phi \qquad \phi \qquad d_b = G \quad \phi \qquad \dot{\theta}_\alpha = \dot{\alpha}$

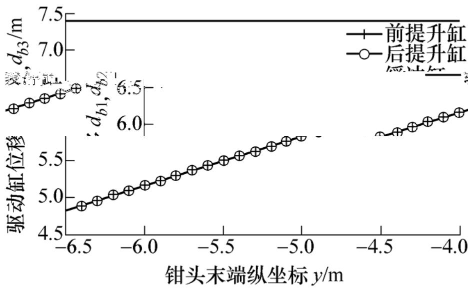
$$\begin{cases} \dot{d}_b = \dot{d}_b = \\ \dot{d}_b = G' \quad \alpha\ \dot{\alpha} = G' \ (\theta_\alpha) \dot{\theta}_\alpha \end{cases}$$

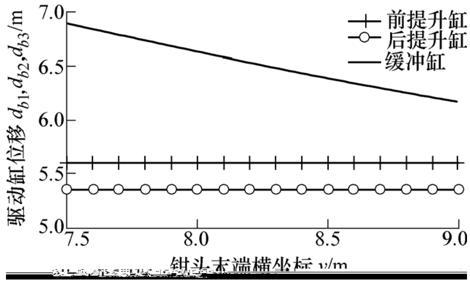
—

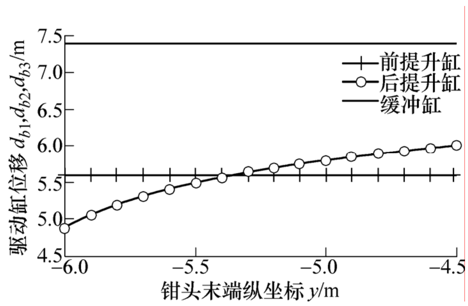
$$\begin{pmatrix} \dot{d}_b \\ \dot{d}_b \\ \dot{d}_b \end{pmatrix} = \begin{pmatrix} \frac{}{S} G' \left(\frac{T_a}{S}\right) & & \\ \frac{}{S} G' \left(\frac{T_a}{S}\right) & & G' \ (\theta_\alpha) \\ & \frac{}{l_S} G' \left(\frac{T_b}{l_S}\right) & \end{pmatrix} \begin{pmatrix} \dot{T}_a \\ \dot{T}_b \\ \dot{\theta}_\alpha \end{pmatrix}$$

2

$O E$	$l_{O E}$
OG	l_{OG}
CG	l_{CG}
FG	l_{FG}
EF	l_{EF}
$O D$	$l_{O D}$
d_b	d







2.4

$$\begin{cases} d_c = \sqrt{\left[S\left(- \quad \phi\right)\right] + \left(S \quad \phi + d \ \right)} \\ d_c = l_{EJ} \\ d_c = l_{GJ} \end{cases}$$

$d_c = H \quad \phi \qquad \dot{T}_a = S\dot{\phi}$

$$\begin{cases} \dot{d}_c = H' \quad \phi \ \dot{\phi} = \frac{}{S} H' \left(\frac{T_a}{S}\right) \dot{T}_a \\ \dot{d}_c = \dot{d}_c = \end{cases}$$

$$d_c = H \quad \beta \qquad \dot{T}_b = l_S \dot{\beta}$$

$$\begin{cases} \dot{d}_c = \dot{d}_c = \\ \dot{d}_c = H' \ (\beta) \dot{\beta} = \frac{}{l_S} H' \left(\frac{T_b}{l_S}\right) \dot{T}_b \end{cases}$$

$$\begin{cases} d_c = d \\ d_c = l_{EJ} \\ d_c = \sqrt{(l_{GJ} - l_{EI} \quad \beta) + (l_{EI} \quad \beta - l_{EI})} \end{cases}$$

$$\sqrt{\quad \sqrt{\quad} \ (\quad) \ \sqrt{\quad} \ (\quad)}$$