MAC / MAD 計算公式及使用範例

油壓緩衝器

決定油壓緩衝器的大小規格之前，我們必須知道下列四個參數

- 移動物體的總合重量 m (kg)
- 撞擊瞬間速度 v (m/s)
- 推進力 F (N)
- 每小時的撞擊次數 C (/hr)

常用的計算公式

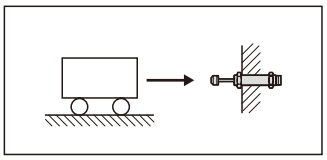
- 動能 : $E_K = mv^2/2$
- 驅動能量 : $E_D = F \times S$
- 自由落體速度 : $v = \sqrt{2g \times h}$
- 氣油壓缸的推進力 : $F = 0.00785\ Pd^2$
- 最大衝擊力 (概估) : $Fm = 1.2\ E_T/S$
- 電動馬達產生的推進力 : $F = 3000\ kW/v$
- 每小時吸收的總能量 : $E_{TC} = E_T \times C$

代號	單位	說明
μ		摩擦係數
α	(rad)	斜面傾斜角
θ	(rad)	撞擊接觸行進角度
ω	(rad/s)	角速度
A	(m)	寬度
B	(m)	厚度
C	(/hr)	每小時支撞擊次數
d	(mm)	氣缸內徑
E_D	(Nm)	驅動能量
E_K	(Nm)	動能
E_T	(Nm)	總合能量
E_{TC}	(Nm)	每小時總合能量
F	(N)	推進力
F_m	(N)	最大衝擊力
g	(m/s^2)	重力加速度
h	(m)	高度
HM		馬達制動係數 (一般等於 2.5)
kW	(kW)	電動馬達功率
m	(kg)	移動物體的總合重量
M_e	(kg)	有效重量
P	(bar)	作動壓力
R	(m)	半徑
R_s	(m)	油壓緩衝器至旋轉中心的距離
S	(m)	行程
T	(Nm)	驅動扭力
t	(s)	減速時間
v	(m/s)	撞擊瞬間速度
v_s	(m/s)	緩衝器撞擊速度

計算例 1. 水平撞擊

使用條件

m = 300 kg
v = 1.0 m/s
S = 0.05 m
C = 300 /hr



公式及計算結果

$$E_K = \frac{mv^2}{2} = \frac{300 \times 1.0^2}{2} = 150\ Nm$$

$$E_T = E_K = 150\ Nm$$

$$E_{TC} = E_T \times C = 150 \times 300 = 45000\ Nm/hr$$

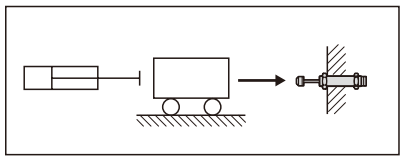
$$M_e = \frac{2E_T}{V^2} = \frac{2 \times 1.5}{1.0^2} = 300\ kg$$

由公式計算結果建議使用 :
MAD-3650 油壓緩衝器一支

計算例 2. 有推進力之水平撞擊

使用條件

m = 300 kg
v = 1.2 m/s
S = 0.05 m
P = 40 N/cm^2
F = 1000 N
C = 500 /hr



公式及計算結果

$$E_K = \frac{mv^2}{2} = \frac{300 \times 1.0^2}{2} = 216\ Nm$$

$$E_D = F \times S = 0.00785\ Pd^2 \times S$$

$$= 0.00785 \times 40 \times 100^2 \times 0.05 = 157\ Nm$$

$$E_T = E_K + E_D = 216+157 = 373\ Nm$$

$$E_{TC} = E_T \times C = 373 \times 300 = 111900\ Nm/hr$$

$$M_e = \frac{2E_T}{V^2} = \frac{2 \times 373}{1.2^2} = 518\ kg$$

由公式計算結果建議使用 :
MAD-4250 油壓緩衝器一支

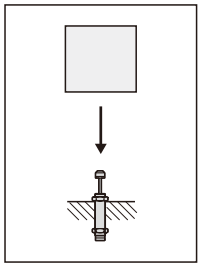
MAC / MAD 計算公式及使用範例

油壓緩衝器

計算例 3. 自由落體

使用條件

m = 40 kg
h = 0.4 m
S = 0.06 m
C = 200 /hr



公式及計算結果

$v = \sqrt{2g \times h} = \sqrt{2 \times 9.81 \times 0.4} = 2.8$ m/sec

$E_K = \frac{mv^2}{2} = \frac{40 \times 2.8^2}{2} = 157$ Nm

$E_D = F \times S = 40 \times 9.81 \times 0.06 = 23.5$ Nm

$E_T = E_K + E_D = 157 + 23.5 = 180.5$ Nm

$E_{TC} = E_T \times C = 180.5 \times 200 = 36100$ Nm/hr

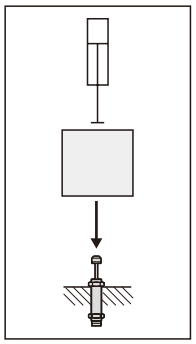
$M_e = \frac{2E_T}{V^2} = \frac{2 \times 180.5}{2.8^2} = 46$ kg

由公式計算結果建議使用 :
MAC-3660-1 油壓緩衝器一支

計算例 4. 有推進力之自由落體

使用條件

m = 40 kg
h = 0.3 m
S = 0.025 m
P = 5 bar
d = 50 mm
C = 200 /hr
v = 1.0 m/sec



公式及計算結果

$E_K = \frac{mv^2}{2} = \frac{40 \times 1.0^2}{2} = 20$ Nm

$E_D = F \times S = (mg+0.0785Pd^2) \times S$

$= (40 \times 9.81+0.0785 \times 5 \times 50^2) \times 0.025 = 34.3$ Nm

$E_T = E_K+E_D = 20+34.3 = 54.3$ Nm

$E_{TC} = E_T \times C = 54.3 \times 200 = 10860$ Nm/hr

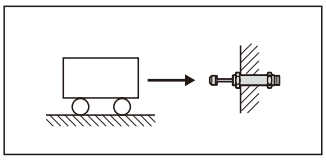
$M_e = \frac{2E_T}{V^2} = \frac{2 \times 54.3}{1.0^2} = 108.6$ kg

由公式計算結果建議使用 :
MAD-2525 油壓緩衝器一支

計算例 5. 馬達驅動之水平撞擊

使用條件

m = 400 kg
v = 1.0 m/s
W = 1.5 kW
HM = 2.5
S = 0.075 m
C = 60 /hr



公式及計算結果

$E_K = \frac{mv^2}{2} = \frac{300 \times 1.0^2}{2} = 150$ Nm

$E_D = F \times S = \frac{kW \times HM}{v} \times S = \frac{1500 \times 2.5}{1.0} \times 0.075 = 281$ Nm

$E_T = E_K+E_D = 200 + 281 = 481$ Nm

$E_{TC} = E_T \times C = 481 \times 60 = 25860$ Nm/hr

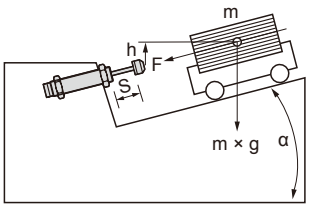
$M_e = \frac{2E_T}{V^2} = \frac{2 \times 481}{1.0^2} = 962$ kg

由公式計算結果建議使用 :
MAD-4275 油壓緩衝器一支

計算例 6. 傾斜撞擊

使用條件

m = 150 kg
h = 0.3 m
S = 0.075 m
α = 30°
C = 200 /hr



公式及計算結果

$v = \sqrt{2g \times h} = \sqrt{2 \times 9.81 \times 0.3} = 2.43$ m/sec

$E_K = \frac{mv^2}{2} = \frac{150 \times 2.43^2}{2} = 443$ Nm

$E_D = F \times S = m \times g \times S \times \sin\alpha$

$= 50 \times 9.81 \times 0.075 \times \sin30° = 55.2$ Nm

$E_T = E_K+E_D = 433+55.2 = 498.2$ Nm

$E_{TC} = E_T \times C = 498.2 \times 200 = 99640$ Nm/hr

$M_e = \frac{2E_T}{V^2} = \frac{2 \times 498.2}{2.43^2} = 168.7$ kg

由公式計算結果建議使用 :
MAD-4275 油壓緩衝器一支

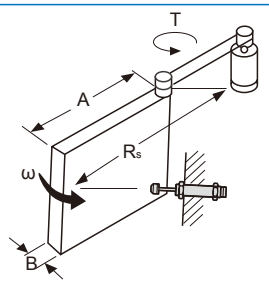
MAC / MAD 計算公式及使用範例

油壓緩衝器

計算例 7. 水平旋轉門

使用條件

m = 20 kg
ω = 2.0 rad/s
T = 20 Nm
R_S= 0.8 m
A = 1.0 m
B = 0.05 m
S = 0.016 m
C = 100 /hr



公式及計算結果

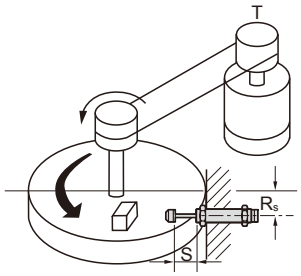
I	=	$\frac{m(4A^2+B^2)}{12}$	=	$\frac{20(4 \times 1.0^2+0.05^2)}{12}$	=	6.67 kg.m^2
E_K	=	$\frac{I\omega^2}{2}$	=	$\frac{6.67 \times 2.0^2}{2}$	=	13.34 Nm
θ	=	$\frac{s}{R_S}$	=	$\frac{0.04}{0.8}$	=	0.05 rad
E_D	=	T × θ	=	20 × 0.05	=	1.0 Nm
E_T	=	E_K+E_D	=	13.34+1.0	=	14.34 Nm
E_{TC}	=	E_T × C	=	14.34 × 100	=	1434 Nm/hr
v	=	ω × R_S	=	2.0 × 0.8	=	1.6 m/s
M_e	=	$\frac{2E_T}{V^2}$	=	$\frac{2 \times 14.34}{1.6^2}$	=	11.20 kg

由公式計算結果建議使用 :
MAD-2016 油壓緩衝器一支

計算例 8. 有推進力之旋轉分度盤

使用條件

m = 200 kg
ω = 1.0 rad/s
T = 100 Nm
R = 0.5 m
R_S= 0.4 m
S = 0.04 m
C = 100 /hr



公式及計算結果

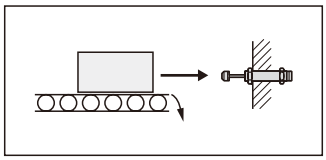
I	=	$\frac{mR^2}{2}$	=	$\frac{200 \times 0.5^2}{2}$	=	25 kg.m^2
E_K	=	$\frac{I\omega^2}{2}$	=	$\frac{25 \times 1.0^2}{2}$	=	12.5 Nm
θ	=	$\frac{s}{R_S}$	=	$\frac{0.04}{0.4}$	=	0.1 rad
E_D	=	T × θ	=	100 × 0.1	=	10 Nm
E_T	=	E_K+E_D	=	12.5+10	=	22.5 Nm
E_{TC}	=	E_T × C	=	22.5 × 50	=	1125 Nm/hr
v	=	ω × R_S	=	1.0 × 0.4	=	0.4 m/s
M_e	=	$\frac{2E_T}{V^2}$	=	$\frac{2 \times 22.5}{0.4^2}$	=	281 kg

由公式計算結果建議使用 :
MAD-2540 油壓緩衝器一支

計算例 9. 水平動力輸送帶

使用條件

m = 150 kg
v = 0.5 m/s
μ = 0.25
S = 0.02 m
C = 120 /hr



公式及計算結果

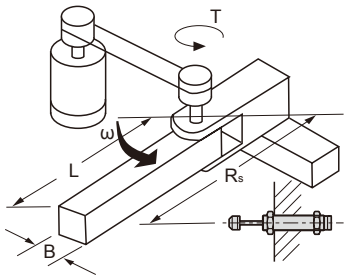
E_K	=	$\frac{mv^2}{2}$	=	$\frac{150 \times 0.5^2}{2}$	=	18.75 Nm
E_D	=	F × S = mgμ × S = 150 × 9.81 × 0.25 × 0.02 = 7.35 Nm				
E_T	=	E_K+E_D =		18.73+7.35	=	26.1 Nm
E_{TC}	=	E_T × C =		26.1 × 120	=	3132 Nm/hr
M_e	=	$\frac{2E_T}{V^2}$	=	$\frac{2 \times 26.1}{0.5^2}$	=	208.8 kg

由公式計算結果建議使用 :
MAC-2020-3 油壓緩衝器一支

計算例 10. 有推動力之旋轉臂

使用條件

m = 40 kg
A = 0.5 m
B = 0.05 m
ω = 2.0 rad/s
T = 10 Nm
R_S= 0.4 m
S = 0.05 m
C = 50 /hr



公式及計算結果

I	=	$\frac{m(4A^2+B^2)}{12}$	=	$\frac{40(4 \times 0.5^2+0.05^2)}{12}$	=	3.34 kg.m^2
E_K	=	$\frac{I\omega^2}{2}$	=	$\frac{3.34 \times 2.0^2}{2}$	=	6.7 Nm
θ	=	$\frac{s}{R_S}$	=	$\frac{0.05}{0.4}$	=	0.125 rad
E_D	=	T × θ	=	10 × 0.125	=	1.25 Nm
E_T	=	E_K+E_D	=	6.7+1.25	=	8 Nm
E_{TC}	=	E_T × C	=	8 × 50	=	400 Nm/hr
v	=	ω × R_S	=	2.0 × 0.4	=	0.8 m/s
M_e	=	$\frac{2E_T}{V^2}$	=	$\frac{2 \times 8}{0.8^2}$	=	25 kg

由公式計算結果建議使用 :
MAD-1416-2 油壓緩衝器一支