1. Motor and Inertia Load

- The equation to calculate the torque that is required for the motor to make the inertia load start rotating is as follows.

\[ T = J \alpha = J \cdot \frac{d\omega}{dt} = \frac{GD^2}{4g} \cdot \frac{d\omega}{dt} = \frac{2\pi}{60} \cdot \frac{GD^2}{4g} \cdot \frac{dn}{dt} \]

- In case of an induction motor, the starting torque would be changed by rotating speed.
- Thus, the average value of it that from the starting speed to the normal constant speed is called an average acceleration torque, a value commonly used in practice.
- The average acceleration torque \( T_A \) required for the inertia load \( GD^2 \) to be accelerated up to the speed \( n[r/min] \) within \( t[sec] \) is represented by the following equation.

\[ T_A = \frac{GD^2}{37500} \times \frac{n}{t} \text{ [kgf \ \cdot \ cm]} \]

2. Calculation of Flywheel Effect \([GD^2]\)
- In case that a load is acquired through the connection of a gearhead, the motor shaft component of the load inertia should be calculated to select the motor.
- Also, the calculation method of \( GD^2 \) is different depending on the type of a load, and the following table provides \( GD^2 \) calculation method for each shape.

<table>
<thead>
<tr>
<th>Shape</th>
<th>Circular Disk</th>
<th>Hollow</th>
</tr>
</thead>
<tbody>
<tr>
<td>GD^2 Eqn.</td>
<td>( \frac{1}{2} \cdot WD^2 \cdot \text{kg \ \cdot \ m^2} )</td>
<td>( \frac{1}{2} \cdot (\pi D^4)g \cdot \text{kg \ \cdot \ m}^2 )</td>
</tr>
<tr>
<td>W</td>
<td>Mass[kg]</td>
<td>Mass[kg]</td>
</tr>
<tr>
<td>D</td>
<td>Outer Diameter[m]</td>
<td>D : Diameter[m]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shape</th>
<th>Sphere</th>
<th>Hexahedron</th>
</tr>
</thead>
<tbody>
<tr>
<td>GD^2 Eqn.</td>
<td>( \frac{2}{3} \cdot WD^2 \cdot \text{kg \ \cdot \ m^2} )</td>
<td>( \frac{2}{3} \cdot (a \times h)^2 \cdot g \cdot \text{kg \ \cdot \ m}^2 )</td>
</tr>
<tr>
<td>W</td>
<td>Mass[kg]</td>
<td>Mass[kg]</td>
</tr>
<tr>
<td>D</td>
<td>Diameter[m]</td>
<td>a, b : Length of Side [m]</td>
</tr>
</tbody>
</table>
- When the brake motor is used, the inertia moment of a load has a greater impact on stop time, overrun and stop precision. The relationship between the inertia moment J and the flywheel effect GD2 is expressed as the following equation.

\[
GD^2 = 4 J \\text{[kgf} \cdot \text{cm]} \quad \text{GD}^2: \text{FAYWHEEL EFFECT} \quad J: \text{INERTIA MOMENT}
\]

- When the deceleration is applied using a gearhead, the motor shaft component of GD2 is represented by \(1/(\text{gear ratio})^2\). The equation is as follows.

\[
GD^2 = \frac{1}{i^2} \times GDl^2[\text{kgf} \cdot \text{cm}^2]
\]

\[
GDm: \text{MOTOR AXIS COMPONENT OF GD}^2 \\
GDl^2: \text{ASSEMBLED LOAD OF GD'ON GEARHEAD} \\
i: \text{REDUCTION RATIO OF A GEARHEAD}
\]

- For example, if a gearhead with a ratio of 1/18 is used and the inertia of a load (GDL2) is 1000[kgf.cm²], the component of the motor shaft is

\[
GDm^2 = \frac{1}{18^2} \times 1000 = 3.1[\text{kgf} \cdot \text{cm}^2]
\]

- If converted to SI units of the inertia moment, the inertia moment is expressed as I in SI units and this is represented as an equation below.
Explicit Calculation Method of Motor Capacity

- The following explanations describe how the required capacity for a motor can be calculated. We explained here is a basic equation in a general circumstance.
- Hence, when selecting a motor in reality, the following points should be taken into consideration. The acceleration at starting time, the power required for a instantaneously imposing large load, or the safety measures implemented at design and manufacturing levels, and the impact of changing voltage.

(1) In case of rolling up bed

\[ T = \frac{1}{2} D \cdot W [\text{kgf} \cdot \text{m}] \]

\[ D : \text{Drum [m]} \]
\[ W : \text{Weight [kgf]} \]

(2) In case of operation inertia mass

\[ T = \frac{GD^2}{37500} \times \frac{N}{t} [\text{kgf} \cdot \text{cm}] \]

\[ N : \text{Revolutions per minute [m]} \]
\[ GD : \text{Disk wheel effect [kgf} \cdot \text{cm}^2] \]
\[ t : \text{Time [sec]} \]
(3) In case of belt conveyor

\[ T = \frac{1}{2} D(F + \mu W) \text{[kgf} \cdot \text{m]} \]

- \( D \): Drum [m]
- \( W \): Mass of belt in unit length [kgf/m]
- \( \mu \): Coefficient of friction
- \( F \): [kgf]

(4) A case of moving an object horizontally on the surface

\[ T = \frac{1}{2} D \cdot \mu W \text{[kgf} \cdot \text{m]} \]

- \( W \): Weight [kgf]
- \( \mu \): Coefficient of friction
- \( F \): WHEEL

(5) In case of driving a ball screw

1) Moving horizontally

\[ T = \frac{1}{2\pi} P(F + \mu W) \text{[kgf} \cdot \text{m]} \]

- \( F \): Cutting force [kgf]
- \( W \): Work Mass + Table Mass [kgf]
- \( \mu \): Coefficient of sliding friction in the slide guide surface (0.01)
- \( P \): BALL SCREW LEAD [m]