```
close("all"); clear; clc;
setmadsympath();
```

```
t = sym('t');
N = Frame;
O = Point;
```

```
yaw = DynamicVariable("psi");
x = DynamicVariable("x");
y = DynamicVariable("y");

q = [
    yaw;
    x;
    y
    ];
```

```
m = sym('m');
Izz = sym('I_zz');
```

```
Nb = N.orientNew('z',yaw.state);
Ob = O.locateNew(x.state.*N.x + y.state.*N.y);

I = zeros(3,'sym');
I(3,3) = Izz;

B = Body(Nb,Ob,I,m);
```

```
V = Twist(Pose(Nb,Ob)).vector();
pprint(V)
```

$$\begin{bmatrix} 0 \\ 0 \\ \dot{\psi} \\ c_{\psi}\,\dot{x} + s_{\psi}\,\dot{y} \\ c_{\psi}\,\dot{y} - s_{\psi}\,\dot{x} \\ 0 \end{bmatrix}$$

```
Vd = simplify(expand(diff(V,t)));
pprint(Vd)
```

$$\begin{bmatrix} 0 \\ 0 \\ \ddot{\psi} \\ c_\psi \ddot{x} + s_\psi \ddot{y} + c_\psi \dot{\psi} \dot{y} - \dot{\psi} s_\psi \dot{x} \\ c_\psi \ddot{y} - s_\psi \ddot{x} - c_\psi \dot{\psi} \dot{x} - \dot{\psi} s_\psi \dot{y} \\ 0 \end{bmatrix}$$

```
J = jacobian(V,q.rate);
pprint(J)
```

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & c_\psi & s_\psi \\ 0 & -s_\psi & c_\psi \\ 0 & 0 & 0 \end{bmatrix}$$

```
Jd = diff(J,t);
pprint(Jd)
```

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & -\dot{\psi} s_\psi & c_\psi \dot{\psi} \\ 0 & -c_\psi \dot{\psi} & -\dot{\psi} s_\psi \\ 0 & 0 & 0 \end{bmatrix}$$

```
G = blkdiag(I,m.*eye(3));
pprint(G)
```

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & I_{zz} & 0 & 0 & 0 \\ 0 & 0 & 0 & m & 0 & 0 \\ 0 & 0 & 0 & 0 & m & 0 \\ 0 & 0 & 0 & 0 & 0 & m \end{bmatrix}$$

```
M = simplify(expand(J.'*G*J));
pprint(M)
```

$$\begin{bmatrix} I_{zz} & 0 & 0 \\ 0 & m & 0 \\ 0 & 0 & m \end{bmatrix}$$

```
wm = vec2skew(V(1:3));
vm = vec2skew(V(4:6));

adV = [
    wm,zeros(3);
    vm,wm
    ];

pprint(adV)
```

$$\begin{bmatrix} 0 & -\dot{\psi} & 0 & 0 & 0 & 0 \\ \dot{\psi} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & c_\psi\,\dot{y} - s_\psi\,\dot{x} & 0 & -\dot{\psi} & 0 \\ 0 & 0 & -c_\psi\,\dot{x} - s_\psi\,\dot{y} & \dot{\psi} & 0 & 0 \\ s_\psi\,\dot{x} - c_\psi\,\dot{y} & c_\psi\,\dot{x} + s_\psi\,\dot{y} & 0 & 0 & 0 & 0 \end{bmatrix}$$

```
C = J.'*G*Jd - J.'*adV.'*G*J;
C = simplify(expand(C));
pprint(C)
```

$$\begin{bmatrix} 0 & -m\,\dot{y} & m\,\dot{x} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

```
N = diff(M,t) - 2*C;
N = simplify(expand(N));
pprint(N)
```

$$\begin{bmatrix} 0 & 2\,m\,\dot{y} & -2\,m\,\dot{x} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

As we can see, the result is not skew-symmetric.