VIRTUAL DISPLACEMENT OF A POINT P

If a body is applied a virtual displacement, how is a point P located in the body reference frame by s'^P going to be displaced?

$$r^P = r + A(\phi)\, s'^P.$$

virtual displacement: $\begin{bmatrix} r \\ \phi \end{bmatrix} \rightarrow \begin{bmatrix} r+\delta r \\ \phi+\delta\phi \end{bmatrix}$.

$$r^P_{nudged} = (r+\delta r) + A(\phi+\delta\phi)\cdot s'^P.$$

Then,

$$\delta r^P = r^P_{nudged} - r^P = (r+\delta r) + A(\phi+\delta\phi)\, s'^P - r - A(\phi)\, s'^P$$

$$= \delta r + \left(A(\phi+\delta\phi) - A(\phi)\right) s'^P$$

Now: $\hat{A} = \hat{\phi} B \Rightarrow \frac{dA}{dt} = \frac{d\phi}{dt} B \Rightarrow dA = d\phi \cdot B$, or, in other words a small change $d\phi$ in angle leads to a small change in A like $dA = d\phi \cdot B$. Therefore

$$\delta A = A(\phi+\delta\phi) - A(\phi) = \delta\phi \cdot B$$

Then,

$$\boxed{\delta r^P = \delta R + \delta\phi \cdot B}$$

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