

• Supplementary File •

## Design, Modelling and Identification of a Fibre-reinforced Bending Pneumatic Muscle

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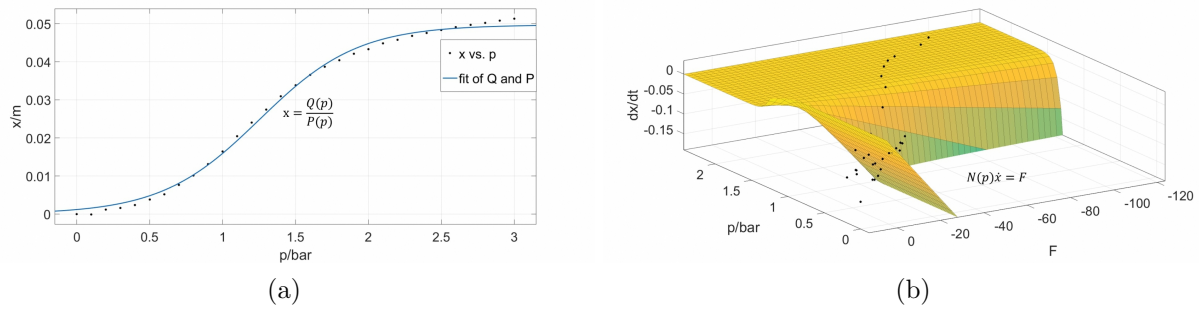
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### Appendix A Detail of Parameters Identification

As is shown in Figure. A1(a), the fitting curve is similar to a sigmoid function, whose common function expression is

$$S(t) = \frac{a}{b + c * e^{-t}} \quad (A1)$$

Replacing the  $S(t)$  and  $t$  with  $x$  and  $p$  in the equation(4), we can derive the equation(5).The index of identification result of  $P$  and  $Q$  was shown in Table. A1.



**Figure A1** (a) Fitting Curve for  $Q$  and  $P$ ; (b) Fitting Surface for  $N$ .

**Table A1** The index of the fit of  $Q$  and  $P$

Index	Value
SSE	3.091e-05
R-square	0.9972
Adjusted R-square	0.997
RMSE	0.001051

According to the statistic of the value of  $M$ , we found that the value is closed to a constant and independent of air pressure  $p$ . After collecting the value of  $N$ , we got the fitting surface, which is shown in Figure. A1(b). In this figure,  $F$  is an intermediate variable and derived from the value of Eq. A2 and Eq. A3, where  $x$ ,  $P$ ,  $Q$  and  $M$  are all known. The index of identification result of  $N$  was shown in Table. A2. And the results of parameters identification were shown in Table. A3.

$$N\dot{x} = P - M\ddot{x} - Q\ddot{x} \quad (A2)$$

$$F = P - M\ddot{x} - Q\ddot{x} \quad (A3)$$

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**Table A2** The index of the fit of  $N$ 

Index	Value
SSE	0.09326
R-square	0.2013
Adjusted R-square	0.1556
RMSE	0.05162

**Table A3** The Value of Parameters

parameter	Value	parameter	Value
$a_1$	20.13	$a_2$	1,491e-08
$b_1$	2.2962	$b_2$	18.8
$c_1$	825.4	$c_2$	147.7
$M$	2.97		

## References

- 1 A. Aggarwal. An improved parameter estimation and comparison for soft tissue constitutive models containing an exponential function. *Biomechanics and Modeling in Mechanobiology*. 2017;16(4):1309-1327.