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Intricate Multiscale Mechanical Behaviors of Natural Fish-Scale Composites

Chapter - April 2013

DOI: 10.13140/2.1.2868.0643

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Figure 25.5

Figure 25.5 shows the results of the tests. The first two rows show the results of the tests on the 100% virgin material. The first row shows the results of the tests on the 100% virgin material. The second row shows the results of the tests on the 100% virgin material.

The first row shows the results of the tests on the 100% virgin material. The second row shows the results of the tests on the 100% virgin material. The third row shows the results of the tests on the 100% virgin material.

The fourth row shows the results of the tests on the 100% virgin material. The fifth row shows the results of the tests on the 100% virgin material. The sixth row shows the results of the tests on the 100% virgin material.

The seventh row shows the results of the tests on the 100% virgin material. The eighth row shows the results of the tests on the 100% virgin material. The ninth row shows the results of the tests on the 100% virgin material.

The tenth row shows the results of the tests on the 100% virgin material.



Figure 25.6 (a) *Micrograph of a fish scale showing the hierarchical structure of the scale, including the lamellae and the central core.*

(b) *Micrograph of a fish scale showing the hierarchical structure of the scale, including the lamellae and the central core.*

(c) *Micrograph of a fish scale showing the hierarchical structure of the scale, including the lamellae and the central core.*

(d) *Micrograph of a fish scale showing the hierarchical structure of the scale, including the lamellae and the central core.*

(e) *Micrograph of a fish scale showing the hierarchical structure of the scale, including the lamellae and the central core.*

25.5 Analytical Model

The analytical model is a mathematical representation of the physical system. It is used to predict the behavior of the system under various conditions. The model is based on the following assumptions:

- The system is linear and time-invariant.
- The input and output signals are continuous-time signals.
- The system is represented by a transfer function $H(s)$ in the Laplace domain.

The transfer function $H(s)$ is defined as the ratio of the Laplace transform of the output signal $Y(s)$ to the Laplace transform of the input signal $X(s)$. Mathematically, this is expressed as:

$$H(s) = \frac{Y(s)}{X(s)}$$

The transfer function $H(s)$ can be determined by analyzing the system's response to a unit impulse input. The unit impulse input is represented by the Dirac delta function $\delta(t)$. The Laplace transform of the unit impulse is $X(s) = 1$. The output signal $Y(s)$ is then given by:

$$Y(s) = H(s) \cdot X(s) = H(s)$$

The inverse Laplace transform of $Y(s)$ gives the time-domain response $y(t)$ of the system to a unit impulse input. This response is used to determine the system's behavior under various conditions.

The analytical model is used to predict the system's response to a variety of inputs, including step functions, sinusoidal signals, and more complex waveforms. The model is also used to analyze the system's stability and to design control systems.

The first two terms on the right-hand side of (1) are the linear and quadratic components of the interaction between the two scales. The third term is the cubic component. The fourth term is the quartic component. The fifth term is the quintic component. The sixth term is the sextic component. The seventh term is the septic component. The eighth term is the octic component. The ninth term is the nonic component. The tenth term is the decic component. The eleventh term is the undecic component. The twelfth term is the duodecic component. The thirteenth term is the tridecic component. The fourteenth term is the quattuordecic component. The fifteenth term is the quindecim component. The sixteenth term is the sexdecim component. The seventeenth term is the septemdecim component. The eighteenth term is the octodecim component. The nineteenth term is the novemdecim component. The twentieth term is the viginti component. The twenty-first term is the viginti component. The twenty-second term is the viginti component. The twenty-third term is the viginti component. The twenty-fourth term is the viginti component. The twenty-fifth term is the viginti component. The twenty-sixth term is the viginti component. The twenty-seventh term is the viginti component. The twenty-eighth term is the viginti component. The twenty-ninth term is the viginti component. The thirtieth term is the viginti component.

where U is the total potential energy, E is the Young's modulus, I is the moment of inertia, s is the arc length, g is the gravity, w is the weight, F is the force, P is the pressure, m is the mass, $w_x F_y - w_y F_x$ is the moment, f^R is the reaction force, f^L is the load force, m^D is the distributed mass, m is the mass, x is the coordinate, E is the Young's modulus, A is the cross-sectional area, G is the shear modulus, x^s is the coordinate, y^s is the coordinate, x^s is the coordinate, q is the load, d is the distance.

$$U = EI \frac{1}{s} - \dots + g s =$$

where E is the Young's modulus, I is the moment of inertia, s is the arc length, g is the gravity, w is the weight, F is the force, P is the pressure, m is the mass, $w_x F_y - w_y F_x$ is the moment, f^R is the reaction force, f^L is the load force, m^D is the distributed mass, m is the mass, x is the coordinate, E is the Young's modulus, A is the cross-sectional area, G is the shear modulus, x^s is the coordinate, y^s is the coordinate, x^s is the coordinate, q is the load, d is the distance.

$$g s = w F + F \cdot P - m$$

where $w F = w_x F_y - w_y F_x$ is the moment, $P = \dots$ is the pressure, F is the force, f^R is the reaction force, f^L is the load force, m^D is the distributed mass, m is the mass, x is the coordinate, E is the Young's modulus, A is the cross-sectional area, G is the shear modulus, x^s is the coordinate, y^s is the coordinate, x^s is the coordinate, q is the load, d is the distance.

$$m = m^D \quad m = \dots \quad x =$$

where E is the Young's modulus, A is the cross-sectional area, G is the shear modulus, x^s is the coordinate, y^s is the coordinate, x^s is the coordinate, q is the load, d is the distance.

$$= - \frac{EA}{GA}$$

where x^s is the coordinate, y^s is the coordinate, x^s is the coordinate, q is the load, d is the distance.

$$x^s = x + \frac{s}{q} \quad d$$

$$m^D = K^D s - D = K^D s$$

25.6.2 Results

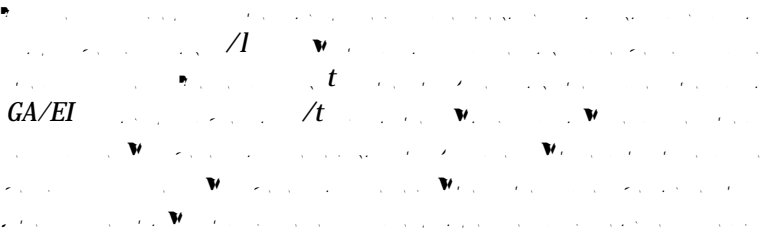
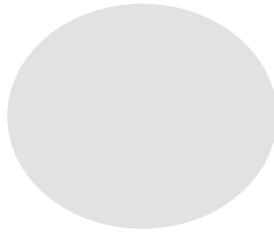


Figure 25.9

Attachment scale stiffness ratio \uparrow K^d



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