“Pattern morphology in the elastic sewing machine”

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S1 Dependence on height

In the main text, we noted that the shape parameters (characteristic length, Λ, and loop radius, R_o) of the patterns only depend weakly on the deployment height. To resolve this height dependence of the pattern length scales, we have performed a series of numerical simulations where we have varied the normalized deployment height, $\bar{H}$, while keeping the gravito-bending length fixed at $L_{gb} = 3.3$ cm.

In Fig. S1A, we plot the normalized onset characteristic length, $\bar{\Lambda}_0$, from which the characteristic length at any given ϵ can be calculated through Eq. (3) of the main text, as a function of $\bar{H}$. We observe that the dependence of $\bar{\Lambda}_0$ on $\bar{H}$ is well described by

$$\bar{\Lambda}_0 = D_\Lambda \log(\bar{H}) + \beta_\Lambda, \tag{S1}$$

where D_Λ and β_Λ are numerical constants that are obtained through fitting: $D_\Lambda = 1.124 \pm 0.045$ and $\beta_\Lambda = 5.692 \pm 0.159$.

We now turn to the radius of the coiling loops. In Fig. S1B, we plot the normalized static coiling radius, $\bar{R}_C$, and the normalized onset radius, $\bar{R}_i$, as functions of $\bar{H}$. The loop radius, $\bar{R}_o$, at any value of the dimensionless speed mismatch can be expressed in terms of $\bar{R}_C$ and $\bar{R}_i$ through Eq. (4) of the main text. The relation between the parameters $\bar{R}_C$ and $\bar{R}_i$ and the deployment height, $\bar{H}$, can be expressed as

$$\bar{R}_C = D_C \log(\bar{H}) + \beta_C, \tag{S2a}$$

$$\bar{R}_i = D_i \log(\bar{H}) + \beta_i, \tag{S2b}$$

with $D_C = 0.274 \pm 0.008$, $\beta_C = 1.267 \pm 0.025$, $D_i = 0.133 \pm 0.004$, and $\beta_i = 0.647 \pm 0.012$ as numerical constants that were evaluated by fitting to the data in Fig. S1B.

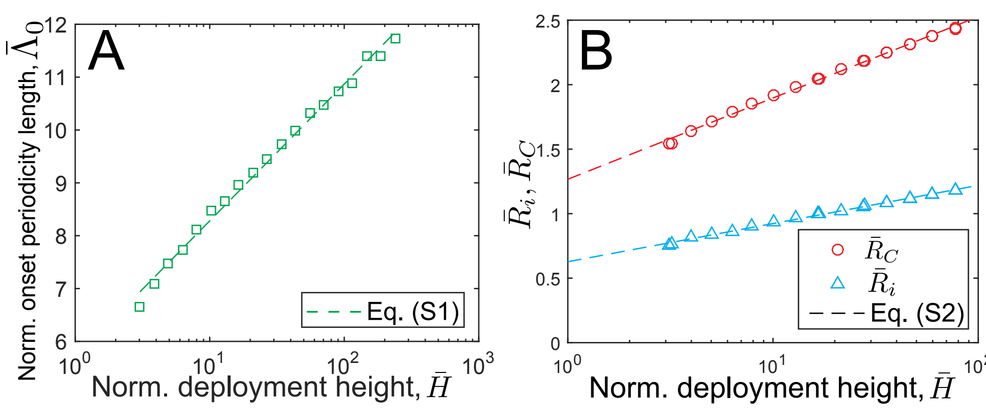

Figure S1: (A) Normalized onset characteristic length, Λ_0, as a function of normalized deployment height, $\bar{H}$, for a rod with $L_{gb} = 3.3$ cm. (B) Normalized static coiling radius, $\bar{R}_C$, and normalized onset radius, $\bar{R}_i$, as functions of $\bar{H}$ for the same rod.

S2 Twisting and bending strain measures in the rod

In §7 of the main text, we discussed the interplay between bending and twist, and evaluated the ratio between twisting and bending energies in both the deposited rod and the suspended heel. To gain further insight and for completeness, we now present the pointwise strain measures in the rod.

In Fig. S2, we plot the traces formed by the rod on the (x, y) plane of the belt, for each of the patterns observed in our elastic sewing machine. The x axis has been normalized by the wavelength, λ, and the y axis by the gravito-bending length, L_{gb}. We now calculate the strain measures along the arc-length of the deposited rod (θ_d', κ_d), as well as the corresponding measures in the suspended heel (θ_h', κ_h), and plot their absolute values in Fig. S3 as functions of the arc-length, s, normalized by the total arc-length in one wavelength, λ_s. We find that the twist in the translated coils is the highest, whereas it is the lowest for meanders. The curvature, on the other hand, remains similar across all of the patterns, to within an order of magnitude estimate. This confirms our finding from the manuscript that the twist to bending energy ratio is substantially higher in the translated coils than in any other pattern, and is close to zero for meanders.

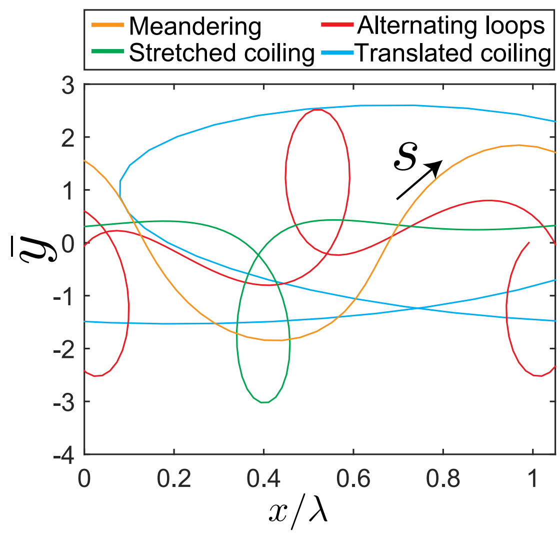

Figure S2: Representative traces of the deposited rod on the belt for the various patterns: meandering ($\epsilon = 0.3$), stretched coiling ($\epsilon = 0.3$), alternating loops ($\epsilon = 0.5$), and translated coiling ($\epsilon = 0.8$).

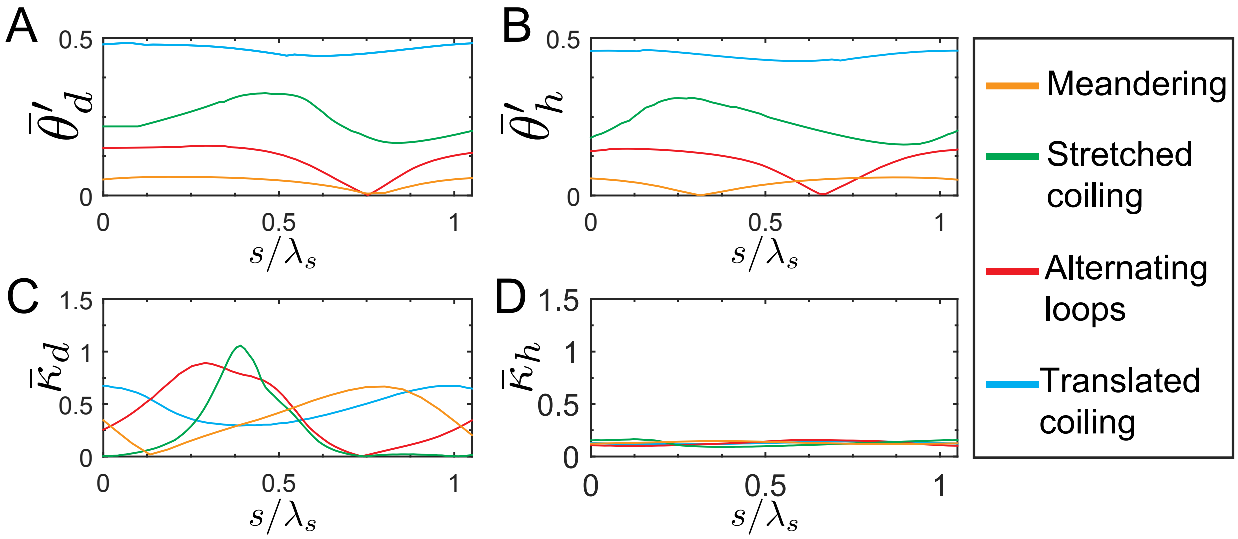

Figure S3: Twisting and bending strain measures (normalized by L_{gb}) as functions of s/λ_s, where λ_s is the arc-length integrated over one wavelength. Normalized twisting strain in (A) the deposited rod, θ_d', and (B) the suspended heel, θ_h'. Normalized bending strain in (C) deposited rod, κ_d, and suspended heel, κ_h. The initial point on the trace in Fig. S2(A) corresponds to $s = 0$.