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How seabirds plunge-dive without injuries BRIAN CHANG, MATTHEW CROSON, Department of Biomedical Engineering and Mechanics, Virginia Tech, LORIAN STRAKER, National Museum of Natural History, Smithsonian Institution, SEAN GART, Department of Biomedical Engineering and Mechanics, Virginia Tech, CARLA DOVE, National Museum of Natural History, Smithsonian Institution, JOHN GERWIN, North Carolina Museum of Natural Sciences, SUNGHWAN JUNG, Department of Biomedical Engineering and Mechanics, Virginia Tech
— In nature, several seabirds (e.g., gannets and boobies) dive into water at up to 24 m/s as a hunting mechanism; furthermore, gannets and boobies have a slender neck, which is potentially the weakest part of the body under compression during high-speed impact. In this work, we investigate the stability of the birds neck during plunge-diving by understanding the interaction between the fluid forces acting on the head and the flexibility of the neck. First, we use a salvaged bird to identify plunge-diving phases. Anatomical features of the skull and neck were acquired to quantify the effect of beak geometry and neck musculature on the stability during a plunge-dive. Second, physical experiments using an elastic beam as a model for the neck attached to a skull-like cone revealed the limits for the stability of the neck during the birds dive as a function of impact velocity and geometric factors. We find that the neck length, neck muscles, and diving speed of the bird predominantly reduce the likelihood of injury during the plunge-dive. Finally, we use our results to discuss maximum diving speeds for humans to avoid injury.

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