

The Evolution of the Warren, or Triangular, Truss

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The adoption of the Warren truss in America, driven by the need to accommodate ever-increasing span and load requirements, produced a wide variety of subdividing patterns and intriguing variations. Although the use of a truss web composed of contiguous triangles, commonly referred to as a “Warren” truss, traces its beginnings from the use of isosceles triangles in continental Europe to the use of equilateral triangles in Great Britain, it became an ubiquitous part of the American landscape by the early-20th century. The chronological evolution of these American forms is presented with the aid of patent drawings and photographs to demonstrate the wide range of ideas and solutions. The web configuration of a basic Warren truss is composed of a series of alternately sloped diagonal members that produce a distinctive image of contiguous “ $\wedge\wedge\wedge$ ” shapes, arrayed between a pair of parallel upper and lower horizontal chords (see figure 1). Because of this visual characteristic, examples are also referred to as “triangular” trusses. Ultimately, variations based on this concept of repetitive triangular forms were developed, created by the insertion of verticals subdividing the triangles. Of the literally hundreds of truss configurations proposed during the 19th century, the original Warren configuration is the only one that did not contain verticals and the only one with a precedent in nature. The hollow bones of dinosaurs and modern birds are braced with the same pattern of equilateral triangles (see figure 2).

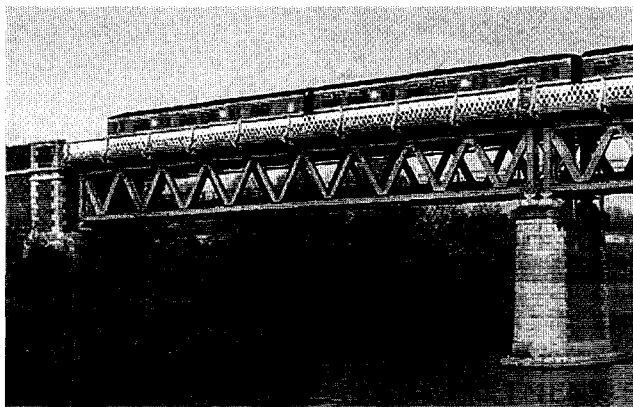


Figure 1. Warren truss with a triangular pattern of diagonal web members, Worcester, England; 1905 railway bridge over the Severn River. Photo courtesy of Derek Locke.

Early History

The exact origin of a truss web composed only of identical repetitive triangles is obscure. Apparently first used in northern Italy, it eventually migrated to England by way of France and Belgium.¹ Alfred Henry Neville, an English entrepreneur and engineer, built several triangular webbed-truss bridges in France and Belgium during the late 1830s and early 1840s, using a configuration of repetitive isosceles triangles that supported a roadbed at midheight.² Neville, Nash et Compagnie, a firm with addresses in Turin and Paris, obtained a French patent for its design in 1838, and in 1839 William Nash obtained a British patent for this same design (see figure 3).³ It was not until 1848 that James Warren and Willoughby Monzani, who may have had input to some of the earlier uses of this form, obtained a British patent for a configuration of repetitive equilateral triangles that could support a roadbed on either its top or bottom chord (see figure 4). Warren's name became synonymous with this form, as the first major spans using this configuration were built in England, and English construction firms built prefabricated versions for use in the British colonies, especially India. In 1851, a 240-foot, 6-inch span iron Warren truss, Newark Dyke Bridge, was built to carry the Great Northern Railroad tracks over England's Trent River (see figures 5a and 5b).⁴

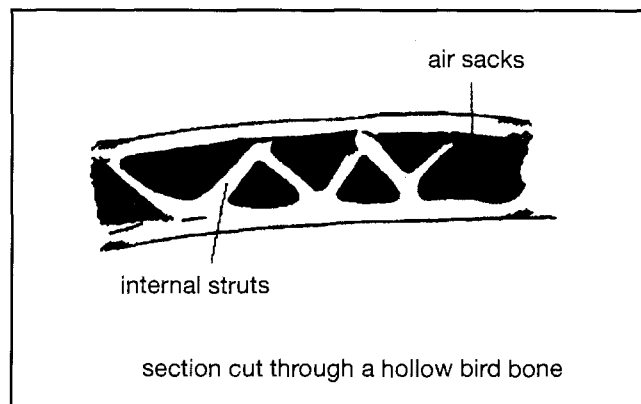


Figure 2. Section cut through a hollow bird bone, showing a configuration of inclined diagonals. Drawing, courtesy of Institute of Biological Science, University of Wales, Aberystwth, UK.