Highways to Empire: The Inca Road System

MANY CULTURES have flourished and faded in western South America since prehistoric times, but only the Incas succeeded in building an empire that unified the region. They did so by military prowess, by administrative skill, and by building a road system unlike any other in the preindustrial world.

The Incas (or Inkas, as they are known in the South American language of Quechua) were nothing if not ambitious. After establishing the city of Cusco (Cuzco), in what is now Peru, sometime in the 13th century, they subdued and assimilated the peoples of the surrounding area and beyond. By 1533, when the Spanish arrived, the Incas ruled the Andes. Their empire stretched for 2,500 mi (4,000 km) along the continent's west coast, encompassing most of modern-day Peru and Chile, parts of Ecuador and Bolivia, and northwest Argentina.

What the Incas accomplished is all the more impressive when one considers the fragmented geography of the Andes.

The Incas stitched together their empire with a road system that included paved sections, *above,* and long catenary bridges woven from vines, grass, branches, and other fibrous materials, *below.*

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The region is known for its diverse ecological zones, including coastal deserts, high plateaus, towering peaks, and dense jungles. Human settlements there have historically been confined to intermountain basins, river valleys, and other pockets of arable land separated by mountains or deserts. Unifying these isolated populations required innovation in both infrastructure and politics.

The empire at its height comprised four *suyus,* or provinces. Their boundaries converged at Cusco, the capital, from which four ceremonial streets radiated into the provinces like the spokes of a wheel. In the Inca empire, all roads led to Cusco because, symbolically at least, all roads began there.

Over time, the Incas transformed the entire Cusco basin, building agricultural terraces and urban infrastructure including drainage systems and roads. In recognition of the Incas' mastery of hydrology and irrigation, in 2006 ASCE conferred landmark status on two of their cities: Tipón, which lies just east of Cusco,

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and Machu Picchu, in the mountains 50 mi to the northwest. Inca roads were not limited to urban areas, however. They reached far beyond Cusco to every corner of the empire.

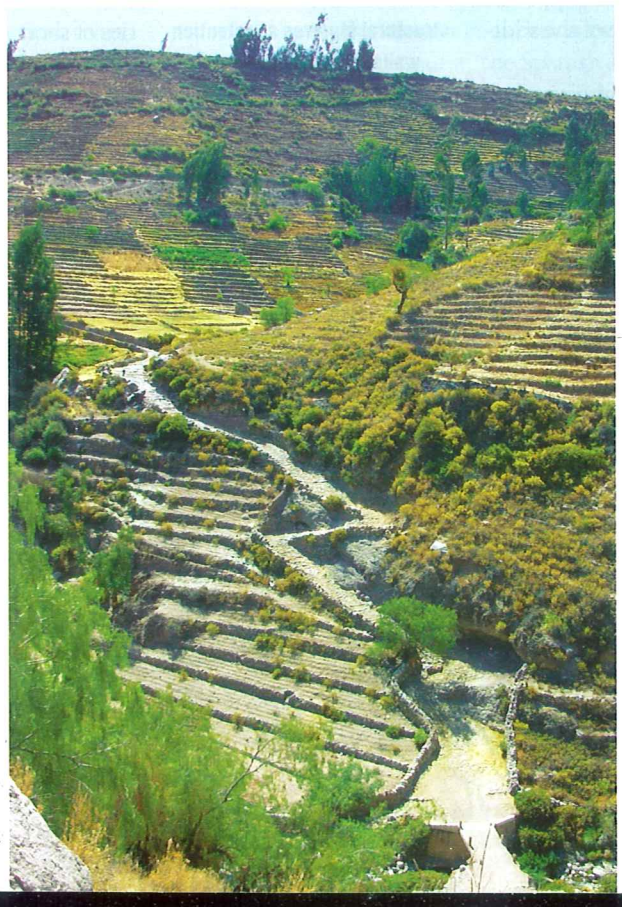
The Inca road system (Qhapaq Ñan in Quechua) included both new roads and roads that other groups had built before the Incas conquered them. The backbone of the system comprised two roughly parallel north–south main routes. One followed the Pacific coast, while the other passed through the Andes. The longer, highland route stretched from north of present-day Quito, Ecuador, to south of Santiago, Chile. Numerous trunk roads connected the two, and others extended outward from the main roads to the edges of the empire.

Although the 20th-century American explorer Victor W. Von Hagen referred to the Qhapaq Ñan as the Highway of the Sun, it was not a highway system in the modern sense. Some sections were wide and smooth, but most were not; in many places, the "road" was only a footpath. The absence of formal structures in places does not indicate a lack of technical sophistication, however. On the contrary, the Inca road builders exercised sound judgment, conserving their resources by constructing walls, steps, and other structural features only when necessary.

Road width varied depending on a number of factors, including the type of terrain and the proximity of settlements that would provide labor for construction and maintenance. A width of approximately 3 m appears to have been considered a minimum for the most important routes. The most heavily traveled road in the empire—the highland segment north of Cusco, which linked the capital to Quito—rarely narrowed to less than 4 m, even in agricultural areas, where land was valuable. In some places, the road widens to 16 m.

Spanish travelers often praised this northern road, not only for its size but also for its stone pavements, steps, retention walls, and well-planned drainage systems.

One Inca bridge type consisted of a flat stone placed over a stone-lined culvert, *above*. In agricultural areas, the Incas often erected 1 to 2 m high walls on both sides of the road to separate it from their crops, *below*. The walls were made of stone or sandy clay depending on the materials available.



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The part of the highland route that continued south of Cusco into Bolivia was probably just as important, but because much of it passed through the relatively flat Andean plain, or Altiplano, it required fewer such structural features. South of central Bolivia, the highland road narrowed as it entered less populated territories.

The Incas' road-building techniques varied depending on the type of terrain through which the road passed. In agricultural areas, they erected 1 to 2 m high walls on both sides. The walls were made of stone or sandy clay depending on the materials available. In the grasslands at higher altitudes, unsuitable for agriculture, sidewalls were unnecessary. Instead, the Incas invested considerable resources in building infrastructure that would withstand the rain and snowmelt. They crafted stone drainage channels and stone pavements to control the flow of water and protect the roadbed from erosion. In many places the edges of the road are clearly marked by rows of stones, retention walls, or hillside cuts.

Where the road passed laterally along the side of a slope, the Incas often built retention walls on the downslope side, sometimes utilizing backfill obtained by excavating the uphill slope. On particularly steep lateral slopes, the retention walls were constructed in two or more benches. On one mountainside in Peru, for example, the road builders used a 2 m high retaining wall with two benches to create a level path on a 35-degree slope.

In swampy areas, the Incas used paving stones to create a solid roadbed. Most paved sections were relatively short, but one stretch on the route between Cusco and Quito boasts a 16 m wide paved surface that stretches for 20 km.

In a few locations, the best available route lay across a floodplain or even a lake. In the absence of an alternative alignment, the Incas built causeways—earthen roadbeds that were elevated above the surface of the water. To cross two shallow bays on the edge of Lake Titicaca, for example, Incan engineers

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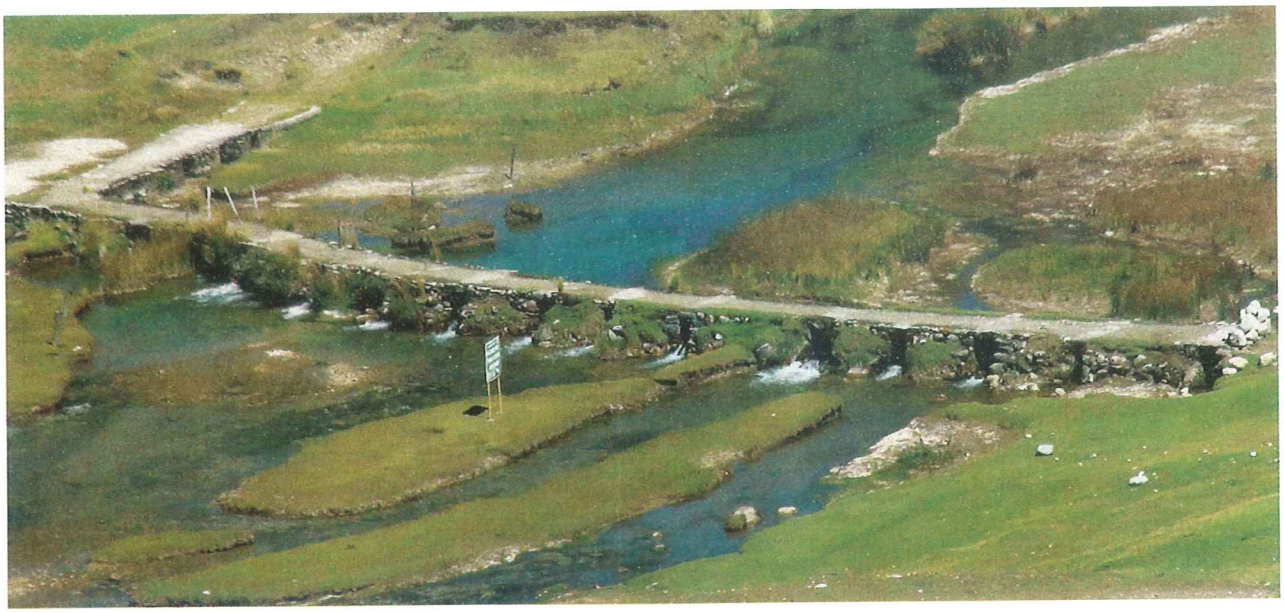


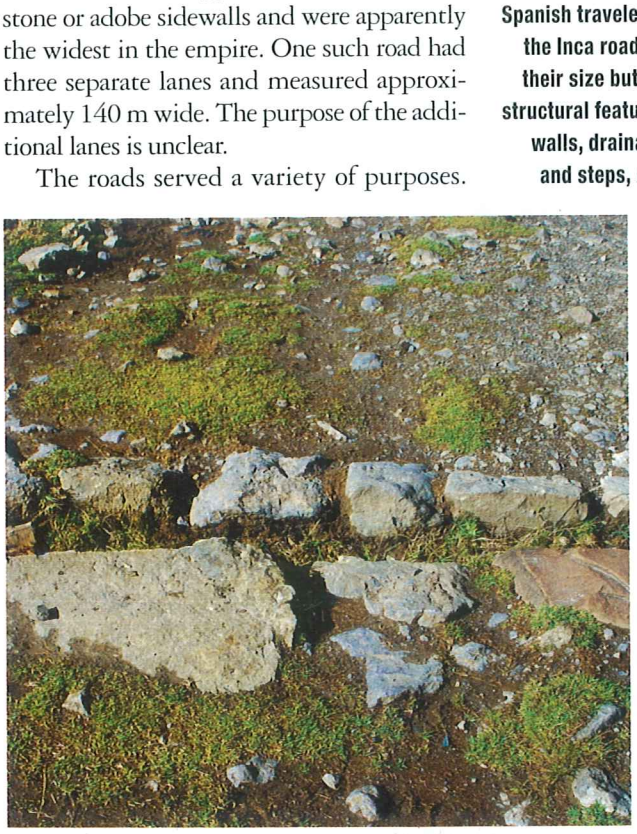
created a causeway 1 to 2 m high, 3 to 6 m wide, and more than 5 km long.

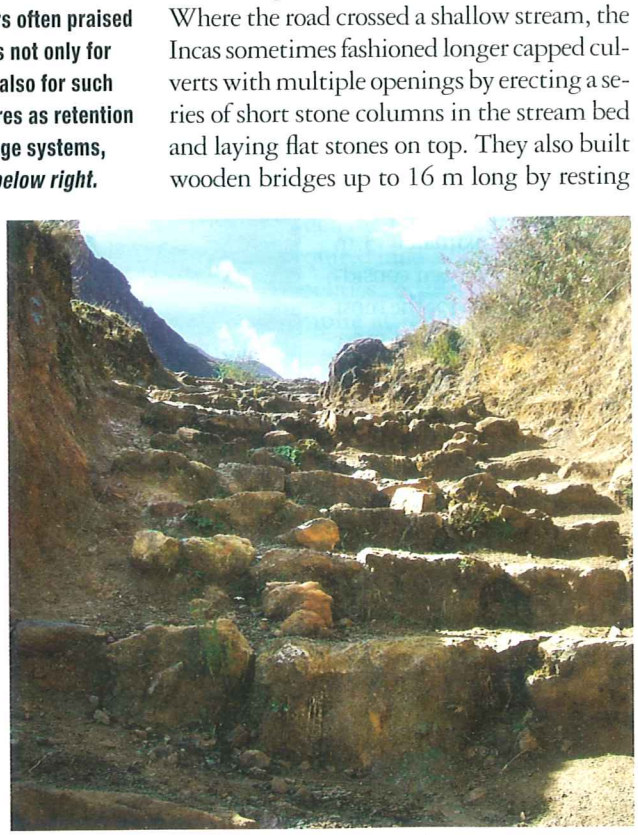
Water was not a problem everywhere. On the coastal highway, the road passed for great distances through sandy desert. These desert roads required few formal structures, although the Incas sometimes marked them with rows of stones or wooden posts to help travelers find their way. Some notable exceptions, however, are the unusually wide approach roads that led from the desert to the entrances of certain irrigated valleys on the north coast. These approach roads usually had stone or adobe sidewalls and were apparently the widest in the empire. One such road had three separate lanes and measured approximately 140 m wide. The purpose of the additional lanes is unclear.

The roads served a variety of purposes. Soldiers traveled them, as did state officials, llama caravans, craftsmen, and the emperor himself, accompanied by his court. Numerous roadside lodgings called *tampus* facilitated long-distance travel. The roads also served as a means of communication. Messengers called *chaskis* were stationed along the main routes at regular intervals in order to relay messages from one end of the empire to the other with maximum efficiency.

Where a road crossed a floodplain or a stream, the Incas sometimes made long capped culverts with multiple openings by erecting a series of short stone columns in the stream bed and laying flat stones on top, *above.* The Incas used paving stones and drainage channels, *below left,* to control the flow of water and protect the roadbed from erosion. In the colonial period, Spanish travelers often praised the Inca roads not only for their size but also for such structural features as retention walls, drainage systems, and steps, *below right.*

The Incas employed a variety of bridge forms. The simplest type consisted of a flat stone placed over a stone-lined culvert. Where the road crossed a shallow stream, the Incas sometimes fashioned longer capped culverts with multiple openings by erecting a series of short stone columns in the stream bed and laying flat stones on top. They also built wooden bridges up to 16 m long by resting





CLIFFORD SCHEXNAYDER, *ALL FOUR*

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rows of logs on masonry abutments, sometimes adding wing walls to protect the abutments from erosion.

By far the most impressive Incan crossings, however, were the catenary bridges that carried the roads across many of Peru's deep gorges. The Spanish conquistadors marveled at these daring structures, which represented a technology entirely new to them. Indeed, many Spaniards were at first afraid to cross the suspended spans, which swayed high above some of the region's largest rivers.

An Incan catenary bridge typically consisted of five thick cables woven from vines, grass, branches, and other fibrous materials. The builders secured the cables to stone abutments on both ends. Three cables bore the load and supported the floor of the structure, while the other two served as handrails. Pieces of wood were attached transversely to form the floor, while woven vertical members connected the handrails to the walkway. The bridges differed from modern suspension spans in that their decks were not horizontal but instead sagged in the middle, following the arc of the load-bearing cables.

Like the road itself, Incan catenary bridges played an important role in the conquest and control of new territories. One chronicler, Garcilaso de la Vega, reported in the early 17th century that the construction of one such bridge "alone sufficed to cause many provinces of the region to submit to the Inca [ruler].... He was welcomed as their lord with a good will because...of the marvelous new work that seemed only possible for men come down from heaven."

The greatest advantage of Incan catenary bridges was their ability to span considerable distances. One celebrated example, documented by the 19th-century American archaeologist Ephraim George Squier, stretched approximately 45 m across the Apurímac River. On the other hand, the structures required continual maintenance and had to be reconstructed frequently. The original bridges are long gone, but locals still rebuild one of them, the 120 ft long Q'eswachaka, each year near Huinchiri, Peru, as a tribute to the ingenuity of their ancestors.

If the road system bound the Incan empire together, it also hastened the empire's demise. When the Spanish arrived, they used the roads to their military advantage as they moved from one area to another. After the conquest, the Spanish appreciated the value of the infrastructure they had acquired. They continued to use the roads, the *tampus,* and even their own version of the *chaski* system for many years.

The Incas never invented the wheel, made iron tools, or developed a writing system, but their road network stands among the greatest achievements of the preindustrial Americas. It is the subject of an exhibition, The Great Inka Road: Engineering an Empire, at the National Museum of the American Indian, in Washington, D.C., through April 2018. A companion book of the same title is available from the Smithsonian Institution. For more information, see also *The Inca Road System,* by John Hyslop (Orlando, Florida: Academic Press, 1984).

The United Nations Educational, Scientific and Cultural Organization (UNESCO) placed the Qhapaq Ñan on the World Heritage List in 2014. —JEFF L. BROWN

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