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Contents

Unit 1 Road

A *road* is an identifiable route or path between two or more places. Roads are typically smoothed, paved, or otherwise prepared to allow easy travel; though they need not be, and historically many roads were simply recognizable routes without any formal construction or maintenance. In urban areas roads may pass along and be named as streets, serving a dual function as urban space and route.

Usage and Etymology

In original usage, a ñroadò was simply any pathway fit for riding (ñroadò is cognate with ñrideò). The word ñstreet,ò whose origin is the Latin *strata*, was kept for paved pathways that had been prepared to ease travel in some way. Thus, many ñRoman Roadsò have the word "street" as part of their name. However, modern usage does not usually make this distinction and it is only important since place names often hold the earlier usage in them; these days, roads are also prepared in some way. This includes, at least, the removal of trees and smoothing the ground. In some dialects, lower grade roads are called *trails* and *tracks* and it is uncertain where ñroadò begins and ñtrailò ends. Roads are a prerequisite for road transport of goods on wheeled vehicles. The word ñroadò emphasizes its function of transportation along its length, while a ñstreetò may be considered to have activity and commerce taking place on it.

History

A cobblestone Roman road in Pompeii.

The first pathways were the trails made by migrating animals. By about 10,000 BC these rough pathways were used by human hunter nomads following these herds.

Street paving has been found in the first human settlements around 4000 BC in Indiaôs Indus Valley city Harrapa.

The oldest engineered road discovered is the Sweet Track causeway in England, dating from around 3800 BC.

The ancient Egyptians constructed a stone paved road to help move materials for the building of the Great Pyramid in about 3000 BC.

The ancient Chinese constructed an extensive system of roads, some paved, from about 1100 BC onwards. By 20 AD the Chinese road network extended over 40,000 kilometres.

The Incas built fine highways, the Inca road system, for couriers through the Andes, and the Mayans built an extensive network of paved roads in Mexico before the European discovery of the New World.

In ancient times transport by river was far easier and faster than transport by road, especially considering the cost of road construction and the difference in carrying capacity between carts and river barges. A hybrid of road transport and ship transport is the horse-drawn boat in which the horse follows a cleared path along the river bank.

In 500 BC Darius I the Great started an extensive road system for Persia (Iran), including the famous Royal Road which was one of the finest highways of its time. The road was used even after the Roman times. Because of the roadôs superior quality, mail couriers could travel 2,699 km in seven days.

From about 300 BC the Roman Empire built straight strong stone Roman roads throughout Europe and North Africa in support of its military campaigns. By the 1st century the Roman Empire was connected by 85,000 kilometers of paved roads.

Road construction and maintenance in Britain was traditionally done on a local parish basis. This resulted in a poor and variable state of roads. To remedy this, the first of the ñTurnpike Trustsò was organized in around 1706 to build good roads and collect tolls from passing vehicles. Eventually there were approximately 1,100 Trusts in Britain and some 38,000 km of engineered roads.

Engineered roads in the age of horse-drawn transport aimed for a maximum gradient of 1 in 30 on a macadamized surface, since this was the steepest a horse could exert to pull a load up hill, which it could manage easily on the flat. Notable road engineers from this period are Pierre Marie Jérôme Trésaguet (1716-1796) in France and John Loudon McAdam (1756-1836) in England.

During the industrial revolution the railway developed as a solution to the problem of rutting of the road surface by heavy carts. Instead of trying to build a strong surface across the whole road, the cart was constrained to run either on rails or grooves which could be made of much stronger, wear resistant material.

Today roads are almost exclusively built to enable travel by automobile and other wheeled vehicles. In most countries road transport is the most utilized

way to move goods. Also in most developed countries roads are formally divided into lanes to ensure the safe and smooth movement of traffic.

Driving on the Right or on the Left

In India, driving is on the left side of the road.

Traffic drives on the right or on the left side of the road depending on the country. In countries where traffic drives on the right, traffic signs are mostly on the right side of the road, roundabouts and traffic circles go counter-clockwise, and pedestrians crossing a two-way road should watch out for traffic from the left first. In countries where traffic drives on the left, the reverse is true. Traffic flow and road design in both cases are each others mirror image.

Construction

A major road near Sibiu, Romania.

Road construction requires the creation of a continuous right-of-way, overcoming geographic obstacles and having grades low enough to permit vehicle or foot travel. Removal of earth and rock by digging or blasting, construction of embankments, bridges and tunnels, and removal of vegetation (this may involve deforestation) are often needed. A variety of road building equipment is employed in road building.

Once these activities are completed, construction of the pavement can begin. First the native soil, known as the subgrade, is compacted. Weak soils

may also be stabilized with additives such as portland cement and quicklime, or dug out and replaced with imported soils.

Then a base course consisting of gravel or crushed stone is usually placed on the subgrade and compacted. On top of the base course is placed a surface course which typically consists of asphalt concrete or portland cement concrete. This surface course strengthens the pavement structure by spreading out the vehicle loads applied to the subgrade. It also provides a smooth and high-friction surface for vehicles to drive on.

Modern roads, and indeed many ancient ones, such as those built by the Romans, feature a convex transverse profile known as superelevation or camber. This is designed to allow water to drain away from the road to its edges. Water is then carried away by gutters to drains placed at intervals. Some roads don't have gutters and water simply drains away to a naturally porous verge, or into ditches. Modern roads that carry motor traffic also employ camber in curves to aid traffic stability by allowing them to ñbank intoò the bend to some extent.

On the side of the road there may be retroreflectors on pegs, rocks or crash barriers, white toward the direction of the traffic on that side of the road, and red toward the other direction. In the road surface there may be catôs eyes: retroreflectors that protrude slightly, but which can be driven over without damage.

Road signs are often also made retroreflective or even illuminated in rare circumstances. For greater visibility of road signs at daytime, sometimes fluorescence is applied to get very bright colors.

Maintenance

A typical rural county road in Indiana, USA, where traffic drives on the right. The yellow lines indicate that passing is allowed in the ongoing direction but not in the oncoming direction.

Like all structures, roads deteriorate over time. Deterioration is primarily due to accumulated damage from vehicles; however environmental effects such as frost heaves, thermal cracking and oxidation often contribute.

According to a series of experiments carried out in the late 1950s it was empirically determined that the effective damage done to the road is roughly proportional to the 4th power of axle weight. A typical tractor-trailer weighing 80,000 pounds with 8,000 pounds on the steer axle and 36,000 pounds on both of the tandem axle groups is expected to do 7,800 times more damage than a passenger vehicle with 2,000 pounds on each axle. In most pavement design methodologies trucks are considered to be the sole cause of pavement deterioration.

Pavements are designed for an expected service life. Most European countries have strict standards for road construction that require that most roads should be able to go 30 years or longer between major resurfacings. In the United States new pavements are typically designed for a service life of between 15 and 25 years, depending on the importance of the road. Service life predictions are inherently unreliable due to the difficulty of predicting future traffic and environmental conditions.

Unit 2 Sweet Track

The Sweet Track, an ancient causeway in the Somerset Levels, England, is the oldest known engineered roadway.

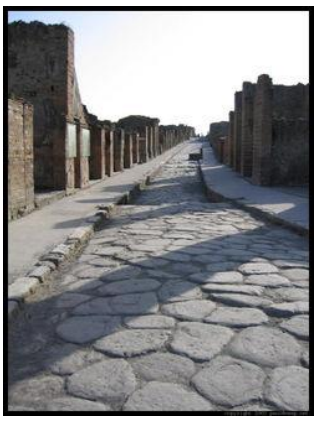
The track was discovered in the course of peat digging in 1970, and is named after its discoverer, Ray Sweet. It extended across the marsh between what was then an island at Westhay, and a ridge of high ground at Shapwick, a distance close to 2,000 meters (over a mile).

Built in the spring of 3806 BC during the Neolithic period, the track consisted of crossed poles of ash, oak and lime which was driven into the waterlogged soil to support a walkway that mainly consists of oak planks laid end-to-end. Due to the wetland setting, the components must also have been prefabricated.

Most of the Track remains in its original location, and several hundred meters of it are now actively conserved using a pumped water distribution system. Portions are stored at the British Museum, London.

Since the discovery of the Sweet Track it has been determined that the track was actually built along the route of an even earlier abandoned track, the Post Track, dating from 3838 BC and so 32 years older.

Unit 3 Roman Road



A Roman road in Pompeii

The Roman roads were essential for the growth of their empire, by enabling them to move armies. A proverb says that ñall roads lead to Romeò Roman roads were designed that way to hinder provinces organizing resistance against the Empire. At its peak, the Roman road system spanned 53,000 miles (85,300 km) and contained about 372 links.

The Romans, for military, commercial and political reasons, became adept at constructing roads, which they called *viae* (plural of singular *via*). The word is related to the English ñwayò

These long highways were very important in maintaining both the stability and expansion of the empire. The legions made good time on them, and some are still used millennia later. In late Antiquity these roads played an important part in Roman military reverses by offering avenues of invasion to the barbarians.

Types of Roads

Roman roads vary from simple corduroy roads to paved roads using deep roadbeds of tamped rubble as an underlying layer to ensure that they kept dry, as the water would flow out from between the stones and fragments of rubble, instead of becoming mud in clay soils.

Prepared *viae* began in history as the streets of Rome. The laws of the Twelve Tables, dated to approximately 450 BC, specify that a road should be 8 feet wide where straight and 16 where curved. The Tables commanded the Romans to build roads and give wayfarers the right to pass over private land where the road is in disrepair. Building roads that would not need frequent repair therefore became an ideological objective. Roman law defined the right to use a road. The ñright of goingò established a right to use a footpath, across private land; the ñright of drivingò ï a carriage track. A *via* combined both types of rights, provided it was of the proper width, which was determined as 8 feet. In these rather dry laws we can see the prevalence of the public domain over the private, which characterized the republic.

A *via* connected two cities. Some links in the network were as long as 55 miles. The builders aimed at directional straightness. Many long sections are

ruler-straight, but it should not be thought that all of them were. The Roman emphasis on constructing straight roads often resulted in steep grades relatively impractical for most economic traffic: over the years the Romans themselves realized it and built longer, but more manageable, alternatives to existing roads. *Viae* were generally centrally placed in the countryside. Either main or secondary roads might be paved, or they might be left unpaved, with a gravel surface, as they were in North Africa. These prepared but unpaved roads were *viae sternendae* (ñto be strewnò). Beyond the secondary roads were the *viae terrenae*, ñdirt roadsò A road map of the empire reveals that it was laced fairly completely with a network of prepared *viae*. Beyond the borders are no roads; however, one might presume that footpaths and dirt roads allowed some transport.

Milestones

Miliarium (milestone)

Potaissa Napoca Miliarium

After 124 BC most *viae* were divided into numbered miles by *milestones*. The words we translate as mile are *milia passuum*, ñone thousand of pacesò, which amounted to about 1620 yards, 1480 meters. A milestone, or *miliarium*, was a circular column on a solid rectangular base, set two feet into the ground, standing several feet high, 20" in diameter, weighing about 2 tons. At the base was inscribed the number of the mile relative to the road it was on. In a panel at eye-height was the distance to the Roman Forum and other information about the officials who made or repaired the road.

Remains of the *miliarium aureum* in the Roman Forum.

The Romans had a preference for standardization whenever they could, and so Augustus, after becoming permanent commissioner of roads in 20 BC, set up the golden milestone near the temple of Saturn. All roads were considered to begin from this gilded bronze monument. On it were listed all the major cities in the empire and distances to them. Constantine called it the navel of Rome.

Milestones permitted distances and locations to be known and recorded exactly. It wasn't long before historians began to refer to the milestone at which an event occurred.

Way Stations

A legion on the march didn't need a way station, as it brought its own baggage train and constructed its own camp (*castra*) every evening at the side of the road. Other officials or people on official business, however, had no legion at their service, and so the government maintained way stations, or *mansiones* ("staying places"), for their use. Passports were required for identification.

Carts could travel about 8 miles per day, pedestrians a little more, and so each *mansio* was about 15 to 18 miles from the next one. There the official traveller found a complete villa dedicated to his refreshment. Oftentimes a permanent military camp or a town grew up around the mansio.

Non-official travellers needed refreshment too, and at the same locations along the road. A private system of *cauponae* were placed near the mansiones. They performed the same functions but were somewhat disreputable, as they were frequented by thieves. Graffiti decorate the walls of the few whose ruins have been found.

Genteel travellers needed something better than cauponae. In the early days of the viae, when little unofficial existed, houses placed near the road were required by law to offer hospitality on demand. Frequented houses no doubt became the first *tabernae*, which were hostels, rather than the "taverns" we know today. As Rome grew, so did its tabernae, becoming more luxurious and acquiring good or bad reputations as the case may be. One of the best hotels was on the Via Appia. It had a large storage room containing barrels of wine, cheese and ham.

A third system of way stations serviced vehicles and animals: the *mutationes* ("changing stations"). They were located every 12-18 miles. In these complexes, the driver could purchase the services of wheelrights, cartwrights, and veterinarians. Using these stations in chariot relays, the emperor Tiberius hastened 500 miles in 24 hours to join his brother, Drusus Germanicus, who was dying of gangrene as a result of a fall from a horse.

Vehicles

Roman law and tradition forbade the use of vehicles in urban areas, except in certain cases. Married women and government officials on business could ride. The law restricted commercial carts to night-time access to the city within the walls and within a mile outside the walls. Outside the cities, Romans were avid riders and rode on or drove quite a number of vehicle types, some of which are mentioned here.

For purposes of description, Roman vehicles can be divided into the car, the coach and the cart. Cars were used to transport one or two individuals, coaches were used to transport parties, and carts to transport cargo.

Of the cars, the most popular was the *currus* (ñcarò), a standard chariot form descending to the Romans from a greater antiquity. The top was open, the front closed. One survives in the Vatican. It carried a driver and a passenger. A currus of two horses was a *biga*; of three horses, a *triga*; and of four horses a *quadriga*. The tyres were of iron. When not in use, its wheels were removed for easier storage.

A more luxurious version, the *carpentum*, transported women and officials. It had an arched overhead covering of cloth and was drawn by mules. A lighter version, the *cisium*, equivalent to our gig, was open above and in front and had a seat. Drawn by one or two mules or horses, it was used for cab work, the cab drivers being called *cisiani*.

The coach had 4 wheels. The high sides formed a sort of box in which seats were placed, with a notch on each side for entry. It carried several people with baggage up to the legal limit of 1000 pounds. It was drawn by teams of oxen, horses or mules. A cloth top could be put on for weather, in which case it resembled a covered wagon. It was probably the main vehicle for travel on the viae.

Of the carts, the main one was the *plaustrum* or *plostrum*. This was simply a platform of boards attached to wheels and a cross-tree. The wheels were solid and were several inches thick. The sides could be built up with boards or rails. A large wicker basket was sometimes placed on it. A two- and a four-wheel version existed.

The itinerary

The Romans and ancient travellers in general did not use maps. They may have existed as special items in some of the libraries, but they were hard to copy and were not in general use. On the Roman road system, however, the traveller needed some idea of where he was going, how to get there, and how long it would take. The itinerary filled this need. In origin it was simply a list of cities along a road. It was only a short step from lists to a master list. To sort out the lists, the Romans drew diagrams of parallel lines showing the branches of the roads. Parts of these were copied and sold on the streets. The very best featured symbols for cities, way stations, water courses, and so on. They cannot be considered maps, as they did not represent landforms.

The Roman government from time to time undertook to produce a master itinerary of all Roman roads. Julius Caesar and Mark Antony commissioned the first known such effort in 44 BC. Zenodoxus, Theodotus and Polyclitus, three Greek geographers, were hired to survey the system and compile a master itinerary. This task required over 25 years. The result was a stone engraved master itinerarium set up near the Pantheon, from which travelers and itinerary sellers could make copies.

Construction of a Road

The Romans are believed to have inherited the art of road construction from the Etruscans. No doubt the art grew as it went along and also incorporated good ideas from other cultures.

After the architect looked over the site of the proposed road and determined roughly where it should go, the *agrimensores* went to work surveying the road bed. They used two main devices, the rod and one called the *groma*, which helped them obtain right angles. The *gromatici*, the Roman equivalent of rod men, placed rods and put down a line called the *rigor*. As they did not possess anything like a transit, an architect tried to achieve straightness by looking along the rods and commanding the gromatici to move them as required. Using the gromae they then laid out a grid on the plan of the road.

The *libratores* began their work. Using ploughs and legionaries with spades, they excavated the road bed down to bed rock or at least to the firmest ground they could find. The excavation was called the *fossa*, ñditchò The depth varied according to terrain.

The road was constructed by filling the ditch. The method varied according to geographic locality, materials available and terrain, but the plan, or ideal at which the architect aimed was always the same. The roadbed was layered.

Into the fossa was dumped large amounts of rubble, gravel and stone, whatever fill was available. Sometimes a layer of sand was put down, if it could be found. When it came to within a few feet of the surface it was covered with gravel and tamped down, a process called *pavire*, or *pavimentare*. The flat surface was then the *pavimentum*. It could be used as the road, or additional layers could be constructed. A *statumen* or ñfoundationò of flat stones set in cement might support the additional layers.

The final steps utilized concrete, which the Romans had exclusively rediscovered. They seem to have mixed the mortar and the stones in the fossa. First a several-inch layer of coarse concrete, the *rudus*, then a several-inch layer of fine concrete, the *nucleus*, went onto the pavement or *statumen*. Into or onto the nucleus went a course of polygonal or square paving stones called the *summa crusta*. The crusta was crowned for drainage.

It is unclear that any standard terminology was used; the words for the different elements perhaps varied from region to region. Today the concrete

has worn from the spaces around the stones, giving the impression of a very bumpy road, but the original surface was no doubt much closer to being flat. These remarkable roads are resistant to rain, freezing and flooding. They needed little repair.

River crossings were achieved by bridges. Single slabs went over rills. A bridge could be of wood, stone, or both. Wooden bridges were constructed on pilings sunk into the river, or on stone piers. Larger or more permanent bridges required arches. Roman bridges were so well constructed that many are in use today.

Causeways were built over marshy ground. The road was first marked out with pilings. Between them were sunk large quantities of stone so as to raise the causeway 6 feet above the marsh. In the provinces, the Romans often did not bother with a stone causeway, but used log roads.

Outcroppings of stone, ravines, or hilly or mountainous terrain called for cuttings and tunnels. Roman roads generally went straight up and down hills, rather than in a serpentine pattern. Grades of 10%-12% are known in ordinary terrain, 15%-20% in mountainous country.

Financing

Financing road building was a Roman government responsibility. Maintenance, however, was generally left to the province. The officials tasked with fund raising were the *curatores viarum*, in which you can see the English word, curator. They had a number of methods available to them. Private citizens with an interest in the road could contribute to its repair. High officials might distribute largesse to be used for roads. *Censors*, who were in charge of public morals and public works, were expected to fund repairs with their own money. Beyond those means, taxes were required.

The beauty and grandeur of the roads might tempt us to believe that any Roman citizen could use them for free, but this was not the case. Tolls abounded, especially at bridges. Often they were collected at the city gate. Freight was made heavier still by import and export taxes. These were only the charges for using the roads. Costs of services on the journey went up from there.

Unit 4 Roman Roads in Britain

Map of Roman Britain

The Roman roads in Britain were constructed between approximately AD 50 and AD 400, in order to facilitate trade and military traffic between the different regions of Roman Britain (Britannia). There were no proper roads in Britannia prior to the arrival of the Romans. Instead, the native Brythons used trackways which were often located along hilltop ridges, such as the Ridgeway in southern England. Some of these trackways were later adapted by the Romans, but most of the road network was wholly new.

In southern Great Britain, Roman roads fell into disrepair in the Early Middle Ages, during which time they gained their present names. In some places, the origins of the roads were forgotten and they were ascribed to mythical Anglo-Saxon giants and divinities: for instance, Wade's Causeway in North Yorkshire owes its name to Woden, the supreme god of Germanic and Norse mythology.

The roads continued to be used for centuries thereafter. Chaucer's pilgrims in the Canterbury Tales almost certainly used Watling Street to travel from Southwark to Canterbury. However, the roads were mostly destroyed in the 18th and 19th century when toll roads were constructed on top of the Roman originals. Very few Roman roads have survived in anything like their original condition, and even then only for very short stretches - Wade's Causeway is widely regarded as the best-preserved in Britain. Many modern roads continue to use the old Roman alignments. Much of Watling Street, for example, is now under the A2 and A5.

The Roman engineers who constructed Britainôs first roads built them to a standard pattern replicated across the empire. Military roads tended to follow

long, straight alignments between major towns and garrisons, while civil routes tended to follow the contours of the land in order to link farms and estates to their markets. The road was carried on an embankment (the agger), sometimes as much as 5 feet (1.5 m) high and 50 feet (15 m) wide, built up from soil excavated from drainage ditches on either side of the road. The road was surfaced with gravel wherever possible, but small broken stones or larger blocks or slabs were used if gravel was in short supply.

Many English place names derive from a position on or near a Roman road, usually denoted by the element -street (also strat-, strait-, streat- and other variants). Thus, for example, Stretham means ñhomestead or village on a Roman roadò and likewise Stretford means ñford on a Roman roadò

Unit 5 Silk Road

The Silk Road or Silk Route is an interconnected series of routes through Southern Asia traversed by caravan and ocean vessel, and connecting eastern China with Asia Minor, as well as other points. It extends over 8,000 km (5,000 miles). Its influence carried over into Japan and Korea.

The Silk Road in the 1st century.

These exchanges were significant not only for the development and flowering of the great civilizations of China, ancient Egypt, Mesopotamia, Persia, India and Rome but also helped to lay the foundations of the modern world.

The continental Silk Road diverges into northern and southern routes as it extends from the commercial centers of North China, the northern route passing through the Bulgarï Kypchak zone to Eastern Europe and the Crimean peninsula, and from there across the Black Sea, Marmara Sea and the Balkans to Venice; the southern route passing through Turkestanï Khorasan into Mesopotamia and Anatolia, and then through Antioch in Southern Anatolia into the Mediterranean Sea or through the Levant into Egypt and North Africa.

The Silk Road on the Sea extends from South China, to present-day Philippines, Brunei, Siam, Malacca, Ceylon, India, Iran, Egypt, Italy, Portugal and Sweden. On August 7, 2005 it was reported that the Antiquity and Monument Office of Hong Kong was planning to propose the Silk Road on the Sea as a UNESCO World Heritage Site.

Silk road is a translation from the German *Seidenstraße*. The first person who used the term was the German geographer Ferdinand von Richthofen during 1877.

Origin: Cross-continental Travel

As water-born shipping and domestication of efficient pack animals both increased the capacity for prehistoric peoples to carry heavier loads over greater distances, cultural exchanges and trade developed rapidly. For example, shipping in predynastic Egypt was already established by the 4th millennium BC along with domestication of the donkey, with the dromedary possibly having been domesticated as well. Domestication of the Bactrian camel and use of the horse for transport then followed.

Just as waterways provide easy means of transport, broad stretches of grasslands ð all the way from the shores of the Pacific to Africa and deep into the heart of Europe ð provide fertile passage for grazing, plus water and fuel for caravans. These water and land routes allowed passage that avoided trespassing on agricultural lands, presenting ideal conditions for caravans, merchants to travel immense distances without arousing the hostility of settled peoples.

Ancient Transport

The ancient peoples of the Sahara had already imported domesticated animals from Asia between 7500 and 4000 BC. Foreign artifacts dating to the 5th millennium BC in the culture of Egypt indicate contact with distant Syria. By the beginning of the 4th millennium BC, ancient Egyptians in Maadi were importing pottery as well as construction ideas from Canaan.

Routes along the Persian Royal Road (constructed 5th century BC) may have been in use as early as 3500 BC. Between 1979 and 1985, charcoal samples found in the tombs of Nekhen, which were dated to the Naqada I and II periods, were identified as cedar from Lebanon.

Egyptian Maritime Trade

The Palermo stone mentions King Sneferu of the 4th Dynasty sending ship to import high-quality cedar from Lebanon. In one scene in the pyramid of Pharaoh Sahure of the Fifth Dynasty, Egyptians are returning with huge cedar trees. Sahureôs name is found stamped on a thin piece of gold on a Lebanon

chair, and 5th dynasty cartouches were found in Lebanon stone vessels. Other scenes in his temple depict Syrian bears.

The oldest known expedition to the Land of Punt was organized by Sahure, which apparently yielded a quantity of myrrh, along with malachite and electrum. The 12th-Dynasty Pharaoh Senusret III had a ñSuezò canal constructed linking the Nile River with the Red Sea for direct trade with Punt. Around 1950 BC, in the reign of Mentuhotep III, an officer named Hennu made one or more voyages to Punt. A very famous expedition was conducted by Nehsi for Queen Hatshepsut in the 15th century BC to obtain myrrh; a report of that voyage survives on a relief in Hatshepsutôs funerary temple. Several of her successors, including Thutmoses III, also organized expeditions to Punt.

Persian Royal Road

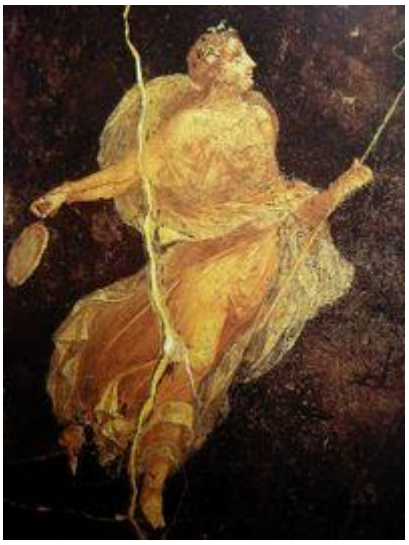
By the time of Herodotus (475 BC) the Persian Royal Road ran some 2,857 km from the city of Susa on the lower Tigris to the port of Smyrna (modern Izmir in Turkey) on the Aegean Sea. It was maintained and protected by the Achaemenid empire (700-330 BC) and had postal stations and relays at regular intervals. By having fresh horses and riders ready at each relay, royal couriers could carry messages the entire distance in 9 days, though normal travellers took about three months. This Royal Road linked into many other routes. Some of these, such as the routes to India and Central Asia, were also protected by the Achaemenids, encouraging regular contact between India, Mesopotamia and the Mediterranean.

Hellenistic Conquests

The first major step in opening the Silk Road between the East and the West came with the expansion of Alexander the Great deep into Central Asia, as far as Ferghana at the borders of the modern-day Xinjiang region of China, where he founded in 329 BC a Greek settlement in the city of Alexandria ñAlexandria The Furthestò, Khujand (formerly Leninabad), in the state of Tajikistan.

When Alexander the Greatôs successors took control of Egypt in 323 BC, they began to actively promote trade with Mesopotamia, India, and East Africa through their ports on the Red Sea coast, as well as overland. The Greeks were to remain in Central Asia for the next three centuries. They kept expanding eastward reaching and going beyond the city of ñAlexandria The Furthestò. There are indications that he may have led expeditions as far as Kashgar in Chinese Turkestan, leading to the first known contacts between China and the West around 200 BC.

The Roman Empire and Silk



Menade in silk dress, Naples National Museum.

Soon after the Roman conquest of Egypt in 30 BC, regular communications and trade between India, Southeast Asia, Sri Lanka, China, the Middle East, Africa and Europe blossomed on an unprecedented scale. Land and maritime routes were closely linked, and novel products, technologies and ideas began to spread across the continents of Europe, Asia and Africa. Intercontinental trade and communication became regular, organized, and protected. Intense trade with the Roman Empire followed soon, confirmed by the Roman craze for Chinese silk even though the Romans thought silk was obtained from trees:

ñThe Seres (Chinese), are famous for the woolen substance obtained from their forests; after a soaking in water they comb off the white down of the leavesé So manifold is the labour employed, and so distant is the region of the globe drawn upon, to enable the Roman maiden to flaunt transparent clothing in publicò(Pliny the Elder (23ï 79, The Natural History).

The Senate issued, in vain, several edicts to prohibit the wearing of silk, on economic and moral grounds: the importation of Chinese silk caused a huge outflow of gold, and silk clothes were considered to be decadent and immoral.

The Hou Hanshu records that the first Roman envoy arrived in China by this maritime route in 166, initiating a series of Roman embassies to China.

Central Asian Commercial & Cultural Exchanges

The heyday of the Silk Road corresponds to that of the Byzantine Empire in its west end, Sassanid Empire Period to Il Khanate Period in the Nile-Oxus section and Three Kingdoms to Yuan Dynasty in the Sinitic zone in its east end. Trade between East and West also developed on the sea, between Alexandria in Egypt and Guangzhou in China, fostering the expansion of Roman trading posts in India. Historians also talk of a ñPorcelain Routeò or ñSilk Routeò across the Indian Ocean. The Silk Road represents an early phenomenon of political and cultural integration due to inter-regional trade.

Under its strong integrating dynamics on the one hand and the impacts of change it transmitted on the other, tribal societies previously living in isolation along the Silk Road or pastoralists who were of barbarian cultural development were drawn to the riches and opportunities of the civilizations connected by the Silk Road, taking on the trades of marauders or mercenaries. Many barbarian tribes became skilled warriors able to conquer rich cities and fertile lands, and forge strong military empires.

The Silk Road gave rise to the clusters of military states of nomadic origins in North China, invited the Nestorian, Manichaean, Buddhist, and later Islamic religions into Central Asia and China, created the influential Khazar Federation and at the end of its glory, brought about the largest continental empire ever: the Mongol Empire, with its political centers strung along the Silk Road realizing the political unification of zones previously loosely and intermittently connected by material and cultural goods.

Mongol Era

The Mongol expansion throughout the Asian continent from around 1215 to 1360 helped bring political stability and re-establish the Silk Road. In the late 13th century, a Venetian explorer named Marco Polo became one of the first Europeans to travel the Silk Road to China. Westerners became more aware of the Far East when Polo documented his travels in Il Milione. He was followed by numerous Christian missionnaries to the East. Luxury goods were traded from one middleman to another, from China to the West, resulting in high prices for the trade goods.

Many technological innovations from the East seem to have filtered into Europe around that time. The period of the High Middle Ages in Europe saw major technological advances, including the adoption through the Silk Road of printing, gunpowder, the astrolabe, and the compass.

Chinese maps and Islamic mapmaking seem to have influenced the emergence of the first practical world maps. Large Chinese junks were also observed by these travelers and may have provided impetus to develop larger ships in Europe.

However, with the disintegration of the Mongol Empire also came discontinuation of the Silk Roadôs political, cultural and economic unity. Turkmeni marching lords seized the western end of the Silk Road ð the decaying Byzantine Empire. After the Mongol Empire, the great political powers along the Silk Road became economically and culturally separated. Accompanying the crystallization of regional states was the decline of nomad power, partly due to the devastation of the Black Death and partly due to the encroachment of sedentary civilizations equipped with gunpowder.

The Silk Road stopped serving as a shipping route for silk around 1400.

The Great Explorers: Europe Reaching for Asia

The disappearance of the Silk Road following the end of the Mongols was one of the main factors that stimulated the Europeans to reach the prosperous Chinese empire through another route, especially by the sea. Tremendous profits were to be obtained for anyone who could achieve a direct trade connection with Asia.

When he went West in 1492, Christopher Columbus reportedly wished to create yet another Silk Route to China. It was allegedly one of the great disappointments of western nations to have found a continent ñin-betweenò before recognizing the potential of a ñNew World.ò In 1594 Willem Barents left Amsterdam with two ships to search for the Northeast passage north of Siberia, on to eastern Asia. He reached the west coast of Novaya Zemlya, and followed it northward, being finally forced to turn back when confronted with its northern extremity.

The wish to trade directly with China was also the main drive behind the expansion of the Portuguese beyond Africa after 1480, followed by the powers of the Netherlands and Great Britain from the 17th century. As late as the 18th century, China was usually still considered the most prosperous and sophisticated of any civilization on earth, however its per capita income was low relative to western Europe at that time. Leibniz, echoing the prevaling perception in Europe until the Industrial Revolution, wrote in the 17th century: ***ñ****Everything exquisite and admirable comes from the East Indies****é*** *Learned people have remarked that in the whole world there is no commerce comparable to that of China****ò****.*

In the 18th century, Adam Smith, declared that China had been one of the most prosperous nations in the world, but that it had remained stagnant for a long time and its wages always were low and the lower classes were particularly poor:

ñ*China has been long one of the richest, that is, one of the most fertile, best cultivated, most industrious, and most populous countries in the world. It seems, however, to have been long stationary. Marco Polo, who visited it more than five hundred years ago, describes its cultivation, industry, and populousness, almost in the same terms in which they are described by travellers in the present times. It had perhaps, even long before his time, acquired that full complement of riches which the nature of its laws and institutions permits it to acquire.****ò*** (Adam Smith, The Wealth of Nations, 1776).

In effect, the spirit of the Silk Road and the will to foster exchange between the East and West, and the lure of the huge profits attached to it, has affected much of the history of the world during these last three millennia.

Unit 6 Royal Road

The map of Achaemenid Empire and the Royal Road.

The Persian Royal Road was an ancient highway built by the Persian king Darius I of Achaemenid Empire in the 5th Century BC. Darius built the road to facilitate rapid communication throughout his very large empire from Susa to Sardis. His couriers could travel 1,677 miles (2,699 km) in seven days. The Greek historian Herodotus wrote, ñ*There is nothing in the world that travels faster than these Persian couriers.*ò Herodotusô praise for these messengers ð ñ*Neither snow nor rain nor heat nor darkness of night prevents them from accomplishing the task proposed to them with the very utmost speed*òð is the inspiration for the unofficial motto of postal carriers.

Course of the Royal Road

The course of the road has been reconstructed from the writings of Herodotus, archeological research, and other historical records. It began in the west in Sardis (about 60 miles east of Izmir in present-day Turkey), traveled east through what is now the middle northern section of Turkey to the old Assyrian capital Nineveh (present-day Mosul, Iraq), then traveled south to Babylon (present-day Baghdad, Iraq). From near Babylon, it is believed to have split into two routes, one traveling northwest then west through Ecbatana and on along the Silk Road, the other continuing east through the future Persian capital Susa (in present-day Iran) and then southeast to Persepolis.

History of the Royal Road

Because the road did not follow the shortest nor the easiest route between the important cities of the Persian Empire, archeologists believe the western-most sections of the road may have originally been built by the Assyrian kings, as the road plunges through the heart of their old empire. More eastern segments of the road (in present-day northern Iran) are coincident with the major trade route known as the Silk Road.

However, Darius I made the Royal Road as it is recognized today by improving the road bed and connecting the parts together in a unified whole,

primarily as a quick mode of communication using the kingdom's messengers.

The construction of the road as improved by Darius was of such quality that the road continued to be used into Roman times. A bridge at Diyarbakir, Turkey still stands from this period of the roadôs use.

Unit 7 Inca Road System

Among the many roads and trails constructed in pre-columbian South America, the Inca road system of Peru was the most extensive. Traversing the Andes Mountains and reaching heights of over 5,000 m (16,500 feet) above sea level, the trails connected the regions of the Inca Empire from the northern provincial capital in Quito (Ecuador) past the modern city of Santiago (Chile) in the south. The Inca road system covered approximately 22,500 km (14,000 mi) and provided access to over three million km² of territory.

Major highways of the Inca Empire

A chasqui playing a conch shell

Chaski

Since the Incas did not make use of the wheel for transportation, and did not have horses until the arrival of the Spanish in Peru in the 16th century, the trails were used almost exclusively by people walking, sometimes accompanied by pack animals, usually the llama.

The trails were used by the Inca people as a means of relaying messages, carried via knotted-cord *quipu* (A quipu usually consists of colored spun and

plied thread from llama or alpaca hair or cotton cords with numeric and other values encoded by knots in a base 10 positional system. Quipus may have just a few strands, but some have up to 2,000 strands), books, and by memory; and for transporting goods. Messages could be carried by *chasqui* runners covering as much as 240 km (150 mi) per day.

Each chasqui carried a trumpet made of a conch shell or animal's horn, a quipu in which information was stored, and a rucksack on his back to hold objects to be delivered. Chasquis worked using a relay system which allowed them to convey messages over very long distances within a short period of time.

There were approximately 2,000 inns placed at even intervals along the trails. The inns provided food, shelter and military supplies to the tens of thousands who traveled the roads. There were corrals for llamas and stored provisions such as corn, lima beans, dried potatoes, and llama jerky. Along the roads, local villagers would plant fruit trees that were watered by irrigation ditches. This enabled chasqui runners and other travelers to be refreshed while on their journeys. Inca rope bridges provided access across valleys.

Many of the trails converge on the center of the empire, the Inca capital city of Cusco. Therefore, it was easy for the Spanish conquistadors to locate the city. Traversing the trails on horseback proved to be difficult and treacherous for the Spanish in their attempts to conquer the Inca Empire.

Main Routes

The most important Inca road was the Camino Real, as it is known in Spanish, with a length of 5,200 km (3,230 mi). It began in Quito, Ecuador, passed through Cusco, and ended in what is now Tucumán, Argentina. The Camino Real traversed the mountain ranges of the Andes, with peak altitudes of more than 5,000 m. El Camino de la Costa, the coastal trail, with a length of 4,000 km (2,420 mi), ran parallel to the sea and was linked with the Camino Real by many smaller routes.


Inca trail to Machu Picchu.

By far the most popular of the Inca trails for trekking is the Capaq Nan trail, which leads from the village of Ollantaytambo to Machu Picchu, the so-called ñLost City of the Incasò There are many well-preserved ruins along the way, and hundreds of thousands of tourists from around the world make the three- or four-day trek each year, accompanied by guides.

Inca Rope Bridges

Inca Rope bridges were simple suspension bridges over canyons and gorges to provide access for the Inca Empire. Bridges of this type were suitable for use since the Inca people did not use wheeled transport - traffic was limited to pedestrians and livestock. These bridges were an intrinsic part on the Inca road system and are an excellent example of Inca innovation in engineering. They were frequently used by chasqui runners delivering messages throughout the Inca Empire.

The construction of these bridges amounted to a pair of stone anchors on each side of the canyon with massive cables of woven grass linking these two pylons together. Adding to this construction, two additional cables acted as guardrails. The cables which supported the foot-path were reinforced with plaited branches. This multi-structure system made these bridges strong enough to even carry the Spaniards while riding horses after they arrived. However, these massive bridges were so heavy that they tended to sag in the middle, and this caused them to swing in high winds.

Part of the bridgeôs strength and reliability came from the fact that each cable was replaced every year by local villagers as part of their public service or obligation. In some instances, these local peasants had the sole task of maintaining and repairing these bridges so that the Inca highways or road systems could continue to function.

Renewing the Last Bridge

After a full year of use the last Inca grass-rope bridge sags and must be replaced for safety. Even though there is a modern bridge nearby the folk in the region keep the ancient tradition and skills alive by renewing the bridge. Several family groups have each prepared a number of grass-ropes to be

formed into cables at the site, others have prepared mats for decking, and the reconstruction is a communal effort. In ancient times the effort would have been a form of tax, with participants coerced to perform the rebuilding; nowadays the builders have indicated that effort is performed to honor their ancestors and the Pachamama (Earth Mother). The event has also been supported by video productions for the BBC and is becoming a minor tourist attraction, with some small tolls charged for tourists use the road during the festival to walk the newly completed bridge.

Unit 8 Types of Road

Various types of roads are in use around the world. They range from private access to the stereotypical two-lane highway, to high capacity dual carriageway routes, such as freeways and motorways. The names associated with a particular type of road vary around the world. As a result, the name given to a road in one country could apply to a different type of road in another country.

Definition

A *road* is an identifiable route or path between two or more places. Roads are typically smoothed, paved, or otherwise prepared to allow easy travel; though they need not be, and historically many roads were simply recognizable routes without any formal construction or maintenance. In urban areas roads may pass along and be named as streets, serving a dual function as urban space and route.

A *street* is a public parcel of land adjoining buildings in an urban context, on which people may freely assemble, interact, and move about. A street can be as simple as a level patch of dirt, but is more often paved with a hard, durable surface such as cobblestone or brick. Portions may also be smoothed with asphalt, embedded with rails, or otherwise prepared to accommodate non-pedestrian traffic. Examples of streets include pedestrian streets, alleys, and center-city streets too crowded for road vehicles to pass, none of which are usually considered roads.

Medium Capacity

Most countries have major roads of medium capacity designed for automobile travel that connect cities, places, other routes, or other significant points of interest. These routes are usually known by the name given to an official class of road, specific to a country. The term *highway* is used generically in some parts of the world, including the United States of America. Designs of such routes vary widely. They can include some characteristics of freeways and motorways such as multiple lanes of traffic, a median between

lanes of opposing traffic, and access control (ramps and grade separation). They can also be as simple as a two-lane shoulderless road.

2+1 roads are an innovation used in Denmark and Sweden since the 1990s. They are being constructed in other countries, such as Ireland. They involve a road with a single divided carriageway, with two lanes in one direction, and one lane in the other. The format switches every few kilometres to have the two lane section on the other side of the road.

High Capacity Restricted Access Roads

Most high capacity roads are built to a higher standard than general purpose roads. In order to provide for higher traffic volumes, such routes may be operated with limited access points, and to particular types of motorized vehicles. Usually these high capacity routes are dual carriageway. Concepts that adhere to these qualities include; freeways, motorways, autobahns and autostrada.

United Kingdom

The M25, a typical motorway in the United Kingdom

In the UK the term *motorway* is used almost unanimously to refer to a specific type of road in the UK and the Republic of Ireland. Although the terms *expressway*, or *parkway* are sometimes used, they amount to little more than street names, with *motorway* the only term officially recognized. The UK motorways are engineered so that they are among the safest such roads in the world, with almost all motorways having a full-width hard shoulder (breakdown lane), full grade-separated interchanges with long on/off ramps and a barriered central reservation which is a compulsory requirement for a motorway (the term ñmedian stripò is unknown in British English). Without a barried central reservation, or if a multilane road fails to meet any of the other requirements to become a motorway, it is simply referred to as a *dual carriageway*.

All UK motorways have an ñMò prefix (e.g. M1) or, where an ñAò road has been upgraded to motorway status, an ñMò suffix in brackets (e.g. A1(M)).

United States Freeways

Interstate 80 (Eastshore Freeway) in Berkeley, a typical American freeway

In the United States of America, a *freeway* is a divided highway with full control of access. This means two things. First, adjoining property owners do not have a legal right of access, meaning that they cannot connect their lands to the highway by constructing driveways. When an existing road is converted into a freeway, all existing driveways must be removed and access to adjacent private lands must be blocked with fences or walls. Second, traffic on the highway is ñfree-flowingò, although many non-engineers misapprehend the ñfreeòin ñfreewayòto mean that such a highway must be free of charge to use. All cross-traffic (and left-turning traffic) has been relegated to overpasses or underpasses, so that there are no traffic conflicts on the main line of the highway which must be regulated by a traffic light, stop signs, or other traffic control devices. Achieving such free flow requires the construction of many bridges, tunnels, and ramp systems. The advantage of grade-separated interchanges is that freeway drivers can almost always maintain their speed at junctions since they do not need to yield to crossing traffic.

Expressways

In contrast, an expressway is defined as a divided highway with partial control of access. Expressways may have driveways connecting to adjacent properties, although the trend over time has been to minimize driveways when possible. Expressways also may have at-grade intersections, though these tend to be spaced farther apart than on most arterial roads. In urban areas, expressway intersections are usually controlled by traffic lights, but in many rural areas, cross-traffic is governed only by stop signs, and there are no restrictions on through traffic. Vehicles crossing an expressway at rural intersections must cross four lanes with vehicles coming at them at prevailing speeds. Thus, expressways are more dangerous than freeways and cannot carry traffic as efficiently as a freeway.

Unit 9 Highway

Highway in Pennsylvania, USA

Highway SP-160 in Brasil

Highway is a term commonly used in the United States to designate major roads intended for travel by the public between important destinations, such as cities.

Highway designs vary widely. They can include some characteristics of freeways and motorways such as multiple lanes of traffic, a median between lanes of opposing traffic, and access control (ramps and grade separation). Highways can also be as simple as a two-lane, shoulderless road. The United States has the largest network of national highways, including Interstate highways and United States Numbered Highways. This network is present in every state and connects all major cities. China has the fastest expanding and second largest highway system in the world.

Some highways, like the Pan-American Highway or the European routes, connect multiple countries. Australiaôs Highway 1 connects all state capitals and runs almost the entire way around the country.

The longest single national highway in the world is the Trans-Canada Highway, which runs from Victoria, British Columbia, on the Pacific Coast, through ten provinces to the Atlantic Coast, at St. Johnôs, Newfoundland.

Highways are not always continuous stretches of pavement. For example, some highways are interrupted by bodies of water, and ferry routes may serve as sections of the highway.

Nomenclature

The terms used for various types of highways (such as autobahn, autoroute, expressway, freeway, and motorway) vary between countries or even regions within a country. In some places a *highway* is a specific type of major road that is distinct from *freeway* or *expressway*; in other places the terms may overlap. In law, *highway* may mean any public road or canal. However, in some countries, the term *highway* is not generally used at all.

Social and Environmental Effects

By reducing travel times relative to arterial streets, highways have a positive effect upon balance of leisure or productive time through reduced commute and other travel time. However, highways have criticisms, partially due to being an extended linear source of pollution:

- Community cohesion: Where highways are created through existing communities, there can be reduced community cohesion and more difficult local access.
- Roadway noise: Highways generate more roadway noise than arterial streets due to the higher operating speeds. Therefore, considerable noise health effects are expected from highway systems. Noise mitigation strategies exist to reduce sound levels at nearby sensitive receptors. The idea that highway design could be influenced by acoustical engineering considerations first arose about 1973.
- Air quality issues: Highways may contribute fewer emissions than arterials carrying the same vehicle volumes. This is because high, constant-speed operation creates an emission reduction compared to vehicular flows with stops and starts. However, concentrations of air pollutants near highways may be higher due to increased traffic volumes. Therefore, the risk of exposure to elevated levels of air pollutants from a highway may be considerable, and further magnified when highways have traffic congestion.
- New highways can cause habitat fragmentation and allow human intrusion into previously untouched areas.

Unit 10 Motorway

Motorway symbol in the UK, France and Ireland.

A *motorway* (in the United Kingdom, New Zealand, Pakistan, some other Commonwealth nations and Ireland) is both a type of road and a classification or designation. Motorways are highways designed to carry a large volume of traffic where a normal road would not suffice or would be unsafe, usually between cities. In the UK they are predominantly dual-carriageway roads, usually with three lanes in each direction, although four-lane and two-lane carriageways are also common, and all have grade-separated access.

Equivalent terms in other countries include autoroute, autobahn, freeway, autostrada, autopista, motorvej, autópálya, motorväg and autoput. In North America, the English terms freeway and expressway (including autoroutes) are used as a type of road, not necessarily as a classification type. Many

highways are maintained throughout the United States as part of the Interstate Highway System. These highways are generally similar to motorways in purpose and quality.

Regulations and Features

A Sunday in April 2004 at 5 p.m. on Britain's busy M25

In Ireland and the UK, motorways are denoted by blue signage and an M-prefixed or suffixed road number.

The construction and surfacing of motorways is generally of a higher standard than conventional roads, and maintenance is carried out more frequently; in particular, motorways drain water very quickly to reduce hydroplaning. The road surface is generally tarmac (ñblack topò) or concrete (ñwhite topò). Other features are crash barriers, catôs eyes and, increasingly, textured road markings (a similar concept to rumble-strips).

Common Criteria

For a road to be classified as motorway a number of conditions must be fulfilled. The following conditions generally apply:

- Accessed at junctions by slip roads off the sides of the main carriageway;
- Joined by link-roads at an interchange, the object of which is to allow traffic to change route without stopping or slowing significantly;
- Traffic lights are not permitted (except at toll booths and certain interchanges);
- Have signposted entry and exit points at the start and end;
- Certain types of transport are banned, typically pedestrians, bicycles, learner drivers, horses, agricultural vehicles, underpowered vehicles (e.g. small scooters, invalid carriages).
- Emergency telephones (which connect directly to the police) must be provided at a regular distance (in the UK emergency telephones are situated at intervals of 1 mile)

Speed Limits

Speed limits are generally higher than on ordinary roads. Some types of vehicle may be subject to a lower limit, while often sections of motorway are subject to lower speed limits due to local driving conditions.

In the UK the majority of motorways and dual carriageways have a maximum speed limit of 70 mph (113 km/h) for cars. In 2004 the Conservative Party proposed increasing the motorway speed limit to 80 mph (129 km/h) on some stretches. Some road safety groups feel this would be a good idea, as it more closely represents the normal (and, they claim, safe) driving practice of the majority of motorway users.

Many other roads are of near-motorway quality, but are not classified as such (generally for breaking one or more of the above rules). These are referred to as dual carriageways, which in Britain usually have the same 70 mph (113 km/h) limit.

Lane Usage

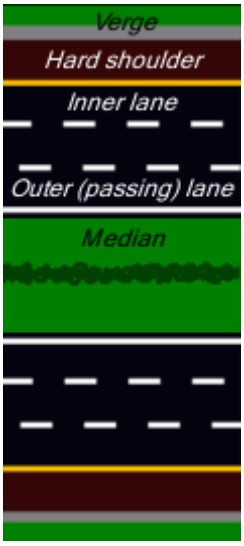


Diagram showing lanes and road layout

White dashed lines denote the lane separation, while an unbroken white line is painted alongside the median (usually known as the "central reservation"). A white line on the edge of the slow lane marks the edge of the hard shoulder. The hard shoulder is not used for traffic and is reserved for breakdowns or emergency maneuvers. Pedestrians should *only* use the hard shoulder to walk to emergency telephones and not for any other reason. Vehicles on the hard shoulder should activate their hazard warning lights.

Lanes closest to the edge of the road are intended for general driving – these are hence the "inside" lanes, while the lanes closest to the median are intended for overtaking (passing) slower-moving vehicles – hence they are termed "outside" lanes. Generally lanes closer to the centre of the road (outer lanes) are used for overtaking, while lanes near the edge of the road (inner

lanes) are used for slower traffic. Under the Highway Code in the UK, it is not permitted to overtake on the left, except in emergencies, when signs indicate drivers may do so, or when traffic is moving slowly. Similar rules apply in Germany and some other countries.

Traffic should always use the left-hand-most lane as much as possible. Generally this means a vehicle should use the left-hand lane next to the hard shoulder, and use the other two lanes only for overtaking maneuvers, moving back into the left lane once they have passed the slower vehicle(s). In heavy traffic, it is acceptable to cruise in the middle lane to pass slower vehicles to avoid constant lane changes.

A significant problem on motorways is the ñmiddle lane hogò, a driver who drives in the middle lane when there is no reason to do so. This can be very frustrating for other drivers. Faster vehicles approaching in the left hand lane have to maneuver across four lanes of the motorway rather than two to overtake such a vehicle, since undertaking is deemed dangerous. Drivers of heavy goods vehicles can be especially frustrated by a middle lane hog, as their vehicles are not permitted to use the right-hand-most lane on a three (or more) lane motorway under normal circumstances. Some vehicles try to convince a ñright lane hogò to move to the slower lane by keeping a very close distance, which is also considered dangerous.

In the UK lanes in a given direction are numbered from left to right as lane 1, lane 2, lane 3, etc. Lane 1 is the lane next to the hard shoulder.

Junctions

The most basic motorway junction is a two-lane flyover with four slip-roads, two on each side of the motorway, to exit or enter. A simple crossroads or roundabout is present on either end of the flyover. A rather large version of a roundabout, using two curved flyovers is sometimes used to present a single large junction for users of the slip-roads or crossing road. The slip roads leading off the motorway are known as ñexit slip roadsò, those leading onto the motorway as ñentry slip roadsò. The precise slip road at any junction may be identified by reference to the direction of the carriageway, for example ñnorthbound entry slipò.

The signal-controlled roundabout is often used in these situations and has become very common in Ireland. A far greater degree of complexity is present in Britain with varying types of Spaghetti Junction-style interchanges.

Location and Construction

Major intercity or national routes are often built or upgraded to motorway standard. Motorways are also commonly used for ring roads around cities or bypasses of built-up areas.

In Britain there are plans to improve many motorways as well as to upgrade some roads to motorway status. In Ireland, the National Roads Authority has been connecting main cities with motorways as part of a six-year National Development Plan. The European Union has part-funded many motorway projects in the past, as part of a Trans-European Transport Networks, and there are plans to invest billions of euros in such projects in the next ten years.

One of the most recently constructed motorways in the UK is the M6 Toll, bypassing Birmingham and Wolverhampton, which opened in 2004 and is the only completely toll motorway in England. There are tolled sections of motorway on the M4 and M48, where they cross the River Severn at the Severn crossings. Although the crossing of the River Thames east of London is tolled, the bridge and tunnels themselves are officially designated to permit usage by non-motorway traffic.

Unit 11 Freeway

This stylized drawing of an overpass is used to represent a freeway in many countries.

A freeway (also motorway or expressway) is a type of highway that is designed for safer high-speed operation of motor vehicles through the elimination of at-grade intersections. This is accomplished by imposing full control of access from adjacent properties and eliminating all cross traffic with grade separations and interchanges, and no railroad crossings. Such highways are usually divided with at least two lanes in each direction. Because traffic never crosses at-grade, there are generally no traffic lights or stop signs. The word *freeway* is also used to describe a highway without tolls.

Note: Expressway has other meanings, and motorway typically applies only to those roads designated as motorways by the national highway agency. Thus this article will primarily use the term freeway for clarity and conciseness. The terms ñcontrolled accessò and ñlimited accessò are also used, but both terms can also apply to arterial roads with partial control of access.

Despite the name, a freeway can be a toll road.

General Characteristics

High-capacity freeway interchange in Los Angeles, California.

Freeways, by definition, have no cross traffic in the form of other roads and railroads. Elimination of cross traffic is typically achieved with grade separation using underpasses and overpasses. In addition to sidewalks attached to roads that cross a freeway, specialized pedestrian bridges or tunnels may also be provided. These structures enable pedestrians and cyclists to cross the freeway without a long detour to the nearest motor vehicle crossing. Movable bridges are occasionally present on freeways, requiring drivers to yield to river traffic.

Access is typically provided only at interchanges, though lower-standard right-in/right-out access can be used for direct connections to side roads or driveways to adjacent property. In ideal cases, sophisticated interchanges allow for smooth, uninterrupted transitions between intersecting freeways. However, sometimes it is necessary to exit onto a surface road to transfer from one freeway to another. Exits are sometimes numbered to help drivers identify their exit.

Two-lane freeways, often undivided, are sometimes built when traffic volumes are low or right-of-way is limited; they may be designed for easy conversion to one side of a four-lane freeway. Otherwise, freeways typically have at least two lanes in each direction; some busy ones can have as many as 16 lanes or up to 18 for short distances. These wide freeways may use separate collector and express lanes to separate through traffic from local traffic, or special high-occupancy vehicle lanes, either as a special restriction on the innermost lane or a separate roadway, to encourage carpooling. These HOV lanes, or roadways open to all traffic, can be reversible lanes, providing more capacity in the direction of heavy traffic, and reversing direction before traffic switches. Sometimes a collector/distributor road, a shorter version of a local lane, shifts weaving between closely-spaced interchanges to a separate roadway or altogether eliminates it.

Freeways can have frontage roads, normal surface roads parallel to and on either side of the freeway, to provide access to adjacent properties. Frontage roads typically have one-way traffic flow in urban areas and two-way traffic flow in rural areas.

Except on some two-lane freeways (and very rarely on wider freeways), a median separates the opposite directions of traffic. This strip may be as

simple as a grassy area, or may include a crash barrier such as a Jersey barrier to prevent head-on collisions. On some freeways, the two carriageways are built on different alignments; this may be done to make use of available corridors in a mountainous area or to provide narrower corridors through dense urban areas.

Speed limits are generally higher than on similar non-freeways, and are sometimes nonexistent. Because the high speeds reduce decision time, freeways are usually equipped with a larger number of guide signs than other roads, and the signs themselves are physically larger. In major cities, guide signs are often mounted on overpasses or overhead gantries so that drivers can see where each lane goes.

In most parts of the world, there are public rest areas or service areas on freeways. Many countries also provide emergency phones alongside freeways at regular intervals.

To reduce the probability that high-speed freeway traffic will have to slow down for slower same-direction traffic, access to freeways is usually limited to classes of motor vehicles that are powerful enough to maintain a certain minimum speed. Some countries partially restrict the use of motorcycles or ban them completely from freeways.

Effects and Controversy

Rush hour on I-45, downtown Houston.

Freeways have been constructed both between urban centres and within them, making common the style of sprawling suburban development found near most modern cities. As well as reducing travel times, the ease of driving on them reduces accident rates, though the speeds involved also tend to increase the severity and death rate of the collisions that do still happen.

Freeways have been heavily criticized by environmentalists and preservationists for the noise, pollution, and economic shifts they bring. Additionally, they have also been criticized by the driving public for the inefficiency with which they handle peak hour traffic.

Often, rural freeways open up vast areas to economic development, generally raising property values. But mature freeways in urban areas are quite often a source of lowered property values, contributing to the

deleterious effects of urban blight. One major problem is that even with overpasses and underpasses, freeways tend to divide neighborhoods ð especially impoverished ones where residents are less likely to own a car that could easily take them around the freeway. For these reasons, almost no new urban freeways have been built in the U.S. since 1970.

Some have even been demolished and reclaimed as boulevards, notably in Portland (Harbor Drive), San Francisco (Embarcadero Freeway) and Milwaukee (Park East Freeway). Growing anti-urban freeway sentiment has resulted in some significant policy changes; the most noteworthy was an FHWA case study involving the West Side Highway in Manhattan, a quintessential urban freeway in need of expansion and reconstruction. The outcome of the study basically concluded that the current elevated highway should be replaced with a new, at-grade boulevard with integrated pedestrian facilities. This case study may be a precedent for areas where a typical, elevated urban freeway is not desirable and/or may not be effective at handling impacted traffic. In Boston, Massachusetts, the elevated Central Artery, originally built in the 1950s, was demolished in 2005 when new tunnels were built for an expanded Central Artery directly beneath the pre-existing elevated highway. Completion of the project, referred to as the Big Dig allowed Boston to reunite its business district with the waterfront, severed by the original elevated Central Artery, while maintaining the expressway through downtown, now located underground.

Freeway opponents argue that freeway expansion is self-defeating, in that expansion will just generate more traffic. That is, even if traffic congestion is initially shifted from local streets to a new or widened freeway, people will begin to run errands and commutes to more remote locations which took too long to reach in the past. Over time, the freeway and its environs will become congested again as both the average number and distance of trips increase.

Freeway advocates argue that properly designed and maintained freeways are aesthetically pleasing, convenient, and safe, at least in comparison to the uncontrolled roads they replace or supplement, and that they expand recreation, employment and education opportunities for individuals and open new markets to small businesses. And for many, uncongested freeways are fun to drive.

At present, freeway expansion has largely stalled in the United States, due to a multitude of factors that converged in the 1970s: higher due process requirements prior to taking of private property, increasing land values, increasing costs for construction materials, local opposition to new freeways in urban cores, the passage of the National Environmental Policy Act which imposed the requirement that each new project must have an environmental impact statement or report.

History

The concept of limited-access automobile highways dates back to the New York City area Parkway system, whose construction began in 1907ï 1908; but parkways are traditionally distinguished from freeways by lower design speeds and a ban on commercial traffic. Designers elsewhere also researched similar ideas, especially in Germany, where the Autobahn would become the first national freeway system.

However, in 1925, Italy was technically the first country to build a freeway, which linked Milan to Lake Como. It is known in Italy as the Autostrada dei Laghi.

Meanwhile, in England, the related concept of the motorway was first proposed by Sidney Webb in a 1910 book ñThe King's Highwayò but was not formally embraced by the government until the passage of the *Special Roads Act 1949*. In 1926, the English intellectual Hillarie Belloc recognized the necessity of grade-separated roads for ñrapid and heavy trafficò, but thought they would be the exception rather than the rule: ñThe creation of a great network of local highways suitable for rapid and heavy traffic is impossible. Even if the wealth of the community increases, the thing would be impossible, because it would mean the destruction of such a proportion of buildings as would dislocate all social life.ò

The word ñfreewayò first surfaced in the mid-1930s in proposals for the improvement of the New York City parkway network.

The first long-distance rural freeway in the United States is generally considered to be the Pennsylvania Turnpike, which opened on October 1, 1940. The Turnpike was so advanced for its time that tourists even had picnics in the median (that is, after it was already open to traffic) and local entrepreneurs did a brisk business in souvenirs. It was designed so that straightaways could handle maximum speeds of 102 miles per hour, and curves could be taken as fast as 90.

Shortly thereafter, on December 30, 1940, California opened its first freeway, the Arroyo Seco Parkway (now called the Pasadena Freeway) which connected Pasadena with Los Angeles. And in 1942, Detroit, Michigan opened the world's first urban depressed freeway, the Davison Freeway. Meanwhile, traffic in Los Angeles continued to deteriorate and local officials began planning the huge freeway network for which the city is now famous.

Recent Developments

Outside the U.S., many countries continue to rapidly expand their freeway networks. Examples include: Australia, Canada, Chile, China, Croatia, France, India, Israel, Mexico, Malaysia, Pakistan, the Philippines, Spain and Taiwan. Australia and France in particular have been innovative in using the newest tunneling technologies to bring freeways into high-density downtowns (Sydney and Melbourne) and historic rural areas (Versailles). China already

has the world's second largest freeway network in terms of total kilometers and will probably overtake the U.S. well before 2025.

In Australia, the city of Adelaide pioneered the concept of a dedicated reversible freeway. The M2 expressway runs toward the city in the morning and out of the city in the evening. Its ramps are designed so that they can double as on- or off-ramps, depending upon the time of day. Gates and electronic signage prevent motorists from driving in the wrong direction.

Meanwhile, major progress has been made in making existing U.S. freeways and expressways more efficient. Experiments include the addition of high-occupancy vehicle lanes (HOV lanes) to discourage driving solo, and building new roads with train tracks down the median (or overhead). Californiaôs Caltrans has been very innovative in squeezing HOVs into limited right-of-way (by elevating them), and in building special HOV-only ramps so that HOVs can switch freeways or exit the freeway without having to merge across regular traffic. Many states have added truck-only ramps or lanes on heavily congested routes, so that cars need not weave around slow-moving big rigs.

Intelligent transportation systems (ITS) are also increasingly used, with cameras to monitor and direct traffic, so that police, fire, ambulance, tow, or other assistance vehicles can be dispatched as soon as there is a problem, and to warn drivers via variable message signs, radio, television, and the web to avoid problem areas. Research has been underway for many years on how to partly automate cars by making smart roads with such things as buried magnets to guide sensor-equipped vehicles, with on-board GPS to determine location, direction, and destination. While these systems may eventually be used on surface streets as well, they are most practical in a freeway setting.

Unit 12 Autobahn

The German autobahn sign

Autobahn is the German word for a major high-speed road restricted to motor vehicles and having full control of access, similar to a motorway or freeway in English-speaking countries.

In most countries, it usually refers to the German Autobahn specifically. German autobahns have no general speed limit, but the ñrecommended speedò is 130 km/h (80 mph). Austrian and Swiss autobahns have general speed limits of 130 km/h and 120 km/h (75 mph), respectively. In German, the word is pronounced as described above, and its plural is Autobahnen; in English, however, the segment ñautoò is typically pronounced as in other

English words such as ñautomobileò. The official name of the Autobahn in Germany is Bundesautobahn (BAB) (federal motorway).

Construction

Similar to such freeways in other countries, autobahns have multiple lanes of traffic in each direction, separated by a central barrier with grade-separated junctions and access restricted to certain types of motor vehicles only. The first German Autobahn was completed in 1932 between Cologne and Bonn (it was the worldôs very first motorway!). Each carriageway was flanked by bankettes about 60 cm (2 ft) in width, constructed of varying materials; right-hand bankettes on many autobahns were later retrofitted to 120 cm (4 ft) in width when it was realized cars needed the additional space to pull off the autobahn safely. In the postwar years, a thicker asphaltic concrete cross-section with full paved hard shoulders came into general use. The top design speed was approximately 160 km/h (100 mph) in flat country but lower design speeds could be used in hilly or mountainous terrain. A flat-country autobahn constructed to published design standards in use during the Nazi period could support hands-off speeds on curves of about 150 km/h (95 mph).

The number signet for the ñA 8ò as it appears on all traffic signs

The current autobahn numbering system in use in Germany was introduced in 1974. All autobahns are named by using the capital letter ñAò followed by a blank and a number (for example ñA 8ò). The ñmain autobahnsò going all across Germany have a single digit number usually even-numbered for east-west routes and odd-numbered for north-south routes. Some roads may not be as easily distinguished as strictly either as it would be, for example, in the United States whose major roads follow routes that are clearly horizontal or vertical when viewed on a conventional map. Shorter autobahns that are of regional importance (e.g. connecting two major cities or regions within Germany) have a double digit number (e.g. A 24, connecting Berlin and Hamburg).

There are also very short autobahns of just local importance (e.g. beltways or the A 555 from Cologne to Bonn) that usually have three numbers the first one of which is similar to the system above, depending on the region.

History

A German autobahn in the 1930s

The two-lane autobahn, with no emergency lane (Germany)

The idea for the construction of the Autobahn was first conceived during the days of the Weimar Republic, but apart from the AVUS in Berlin, construction was slow, and most projected sections did not progress much beyond the planning stage due to economic problems and a lack of political support. One project was the private initiative HaFraBa which planned a "car-only road" (the name autobahn was created in 1929) crossing Germany from Hamburg in the North via central Frankfurt am Main to Basel in Switzerland. Parts of the HaFraBa were completed in the 1930s and early 1940s, but construction eventually was halted by World War II.

Just days after the 1933 Nazi takeover, Adolf Hitler enthusiastically embraced an ambitious autobahn construction project and appointed Fritz Todt the Inspector General of German Road Construction. Soon, over 100,000 laborers worked at construction sites all over Germany. As well as providing employment and improved infrastructure, necessary for economic recovery efforts, the project was also a great success for propaganda purposes. It has been said that another aim of the autobahn project, beyond creating national unity and strengthening centralized rule, was to provide mobility for the movement of military forces. This, however, overlooks the fact that gradients on autobahns built before the war were far too steep for the goods vehicles of the time. The autobahn's main purpose, then, was to enable a large proportion of the population to drive long distances in their own cars, enjoying the countryside along the way. This explains some of the autobahn's routing which offers spectacular views but is impractical for today's heavy goods traffic.

The autobahns formed the first limited-access, high-speed road network in the world, with the first section from Frankfurt am Main to Darmstadt opening in 1935. This straight section was used for high speed record attempts by the Grand Prix racing teams of Mercedes-Benz and Auto Union until a fatal accident involving popular German race driver Bernd Rosemeyer in early 1938. A similar high speed section was built between Dessau and Halle.

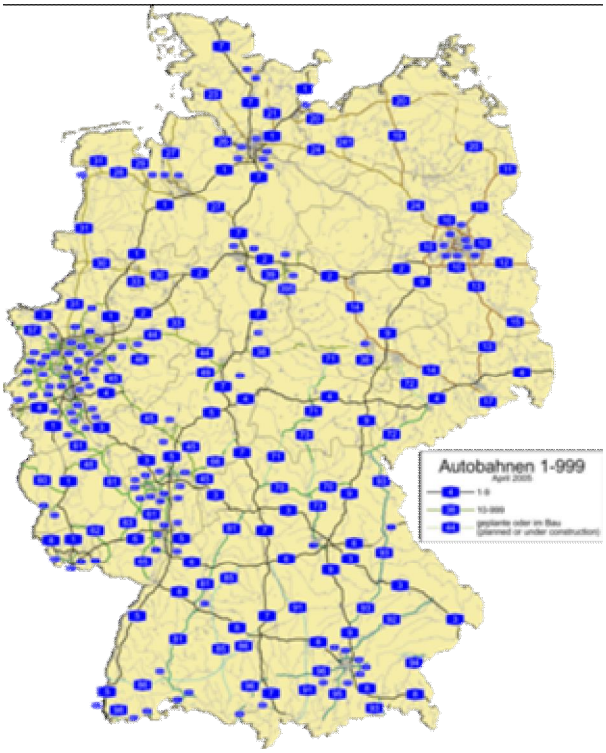
During World War II, the central reservations of some autobahns were paved to allow their conversion into auxiliary airports. Aircraft were either stashed in numerous tunnels or camouflaged in nearby woods. However, for

the most part, the autobahns were not militarily significant. Motor vehicles could not carry goods as quickly or in as much bulk as trains could, and the autobahns could not be used by tanks as their weight and caterpillar tracks tore up the roadsô delicate surfaces. Furthermore, the general shortage of gasoline which Germany experienced during much of the war, as well as the relatively low number of trucks and motor vehicles badly needed for direct support of military operations, further decreased the attractiveness of autobahns for significant transport. As a result, most military and economic freight continued to be carried by rail. After the war, numerous sections of the autobahns were in bad shape, severely damaged by heavy Allied bombing and military demolition. As well, thousands of kilometers of autobahns remained unfinished, their construction brought to a halt by 1943 due to the increasing demands of the war effort.

In West Germany, following the war, most existing autobahns were soon repaired. During the 1950s, the West German government restarted the construction program; it continuously invested in new sections and in improvements to older ones. The finishing of the incomplete sections took longer, with some stretches being opened to traffic only in the 1980s. Some sections cut by the Iron Curtain in 1945 were only completed after German reunification in 1990. Finally, certain sections were never completed, as more advantageous routes were found. Some of these sections stretch across the landscape forming a unique type of modern ruin, often easily visible on satellite photographs.

The autobahns in East Germany (GDR) and the former German provinces of East Prussia, eastern Pomerania and Silesia in Poland and the Soviet Union after 1945 were grossly neglected in comparison to those in West Germany and Western Europe in general. They received minimal maintenance during the years of the Cold War. The speed limit on the GDR autobahns was 100 km/h (62 mph), however lower speed limits were frequently encountered due to the poor condition of the road surface, changing quickly in some instances. The speed limits on the GDR autobahns were rigorously enforced by the Volkspolizei, whose patrol cars were frequently encountered hiding under camouflage waiting for speeders. In the 1970s and 80s, the West German government paid millions of Deutsche Marks to the GDR for construction and maintenance of the transit autobahns between West Germany and West Berlin, although there were indications that the GDR diverted some of the earmarked maintenance funds for other purposes.

Current Density



Map of the German autobahn network

Today, Germanyôs autobahn network has a total length of about 11,980 km. Many sections of Germanyôs autobahns are modern, containing three lanes in addition to an emergency lane. Some other sections remain in their original state, with two lanes, no emergency lane, short ramps, etc. Such a combination of the two types of autobahn can be seen on the A 9 autobahn (Munich-Berlin). Heading out from Munich, the autobahn starts off as a modern, four-lane in each direction + emergency lane autobahn. However, after heading into Thuringia, which was formerly part of East Germany, parts of the autobahn are no wider than two lanes and no emergency lane exists (only rare emergency bays with a telephone post in orange-yellow). Ongoing roadworks will eventually bring the entire A 9 to three-lane standard.

Speed limits

The German autobahns are famous for being some of the few public roads in the world without blanket speed limits for cars and motorcycles. Lack of blanket speed limits does not appear to negatively impact the road safety of autobahns compared with motorways in other countries; motorways are safer than other road types. Certainly, speed limits do apply at junctions and other danger points, like sections under construction or in need of repair. Certain stretches have separate, and lower, speed limits used in cases of wet lanes.

Some limits were imposed to reduce pollution and noise. Limits can also be put into place temporarily through dynamic traffic guidance systems that display the according traffic signs. If there is no speed limit, the recommended speed limit is 130 km/h (81 mph); this speed is not a binding

limit, but being involved in an accident at higher speeds can lead to being deemed at least partially responsible due to ñincreased operating dangerò The average rate of speed traveled on the autobahn in unregulated areas by automobiles not regulated by other laws is about 150 Km/h (93 mph). On average, about half of the total length of the German autobahn network has no speed limit, about one third has a permanent limit, and the remaining parts have a temporary limit for a number of reasons.

In places without a general limit, there are mostly also no restrictions on overtaking. Therefore, those traveling at high speeds may regularily encounter trucks running side-by-side at only about 80 km/h (50 mph). In theory, trucks are not allowed to overtake others unless they drive 20 km/h (12 mph) faster than whomever they are overtaking, but truck drivers are generally under pressure to arrive in time, and such laws are rarely enforced for economic and political reasons, as many trucks are from foreign countries. The right lane of a typical autobahn is often crowded with trucks, and too often, trucks pull out to overtake. Due to size and speed this is often referred to as ñElephant Raceò In some zones with only two lanes in both directions there is no speed limit, but a special overtaking restriction for trucks and/or cars pulling trailers.

Modern cars easily reach well over 200 km/h (124 mph), and most large car manufacturers follow a gentlemenôs agreement by artificially limiting the top speed of their cars to 250 km/h (155 mph) for safety reasons (inexperienced drivers and risk of tires failing, especially when underinflated). Yet, these limiters can easily be defeated, so speeds exceeding 300 km/h (186 mph) are not unheard of, although due to common speed limits and other traffic, such speeds are rarely attainable.

Vehicles unable to attain speeds in excess of 60 km/h (37 mph) are not allowed to use the autobahn. Though this limit is not high for most modern vehicles, it prevents very small cars (e.g. Quads) and motor-scooters (e.g. Mofas) from using autobahns. To comply with this limit, several heavy-duty trucks in Germany (e.g. for carrying tanks or cranes) have a design speed of 62 km/h (usually denoted by a round black-on-white sign with ñ62òon it).

Since the mid-1980s, when environmental issues gained importance and recognition among lawmakers, interest groups and the general public, there has been an ongoing debate on whether or not a nationwide general speed limit should be imposed for Autobahns. Obviously, a carôs fuel consumption increases with speed, and fuel conservation is a key factor in reducing pollution. Safety issues have been cited as well with regards to speed-related fatalities. Opposers of a general speed limit maintain that such regulation is unnecessary because only two percent of all German roads would be affected and because better fuel economy even at high speeds has been achieved in most modern cars. Moreover, recent accident statistics supposedly don't lend proof that traveling at high speeds is that much more dangerous.

Twenty years after the beginning of this debate, there are still no definite plans by the federal government concerning such a speed limit.

Traffic laws and enforcement

The German autobahn network is patrolled by unmarked police cars and motorcycles equipped with video cameras; this allows the enforcement of laws (tailgating, for example) which are often viewed in other countries as difficult to prove in court. Notable laws include the following:

- Autobahns in Austria and Germany may only be used by powered vehicles that are designed to achieve a maximum speed exceeding 60 km/h (Switzerland: 80 km/h).
- The right lane must be used when it is free and the left lane is generally intended for passing maneuvers only; drivers using the left lane for prolonged periods of time when the other lanes are free may be fined by Autobahn police.
- Overtaking on the right (Undertaking) is forbidden, except in traffic jams where it may be practiced with caution. The fact that the car overtaken is illegally occupying the left-hand lane is not an acceptable excuse; in such cases the police will routinely stop and fine both drivers.
- In a case of a traffic jam, the drivers must form an emergency lane to guarantee that emergency services can reach the scene of the accident. This lane has to be formed between the left lane and the lane next to the left lane.
- It is unlawful for a driver to stop their vehicle on the road for any reason except in an emergency and/or situations where stopping is unavoidable, such as being in a traffic jam or being involved in a collision. This includes stopping on emergency lanes. Running out of fuel is considered preventable and is consequently fined. In some cases, it can also be deemed a crime, and the driver can be given a prison sentence.
- The distance between vehicles (in meters) should be at least half the speed (in km/h) at all times (e.g. at least 60 meters at 120 km/h). This corresponds to a ñead timeò of just under 2 seconds. As a reference: the white-and-black reflection posts to the right have a distance of 50 m to each other. Again, the fact that the car in front is illegally occupying the left-hand lane when the right-hand lane is free does not excuse following too closely.

Fines for tailgating were increased in May 2006. At speeds over 100 km/h, keeping less than 30 percent of the recommended distance now results in a suspension of ones driver's license for one to three months.

- Due to legal regulations it is allowed to honk and flash headlights in order to indicate the intention of overtaking, but a proper distance to the vehicle in front must be maintained. Driving at insufficient distances--even when flashing ones headlights--is illegal.
- The tires must be approved for the vehicleôs top speed (winter tires (mud- and snow-tires) for lower speeds (i.e. cheaper than high-speed tires) are allowed, but the driver must have a sticker in the cockpit reminding of the maximum speed).

Unit 13 Causeway

The rail causeway
across the Wadden Sea to
the island of Sylt in Germany

The causeway to Antelope Island in
the Great Salt Lake, Utah, USA

In modern usage, a *causeway* is a road or railway elevated by a bank, usually across a broad body of water or wetland. A transport corridor that is carried instead on a series of arches, perhaps approaching a bridge, is a viaduct. The distinction between the terms *causeway* and *viaduct* becomes blurred when flood-relief culverts are incorporated. Many causeways are tidal, being covered for a period surrounding high tide.

Derivation of the word

When first used, the word appeared in a form such as ñcausey wayò making clear its derivation from the earlier form ñcauseyò. This word seems to have come from the same source by two different routes. It derives ultimately, from the Latin for heel, *calx* and as near certainly as may be, comes from the trampling technique for consolidating earthworks. In antiquity, the construction was trodden down, one layer at a time, by people such as slaves. Alternatively, a flock of sheep might be used. Today, a machine does the job. The same technique would have been used for road embankments, raised river banks, sea banks and fortification earthworks.

The second derivation route is simply the hard, trodden surface of a path. The name by this route came to be applied to a firmly-surfaced road. It is now little-used except in dialect and in the names of roads which were originally notable for their solidly-made surface. The word is comparable in both meanings with the French *chaussée*, from a form of which it reached English by way of Norman French. The French adjective, *chaussée*, carries the meaning of having been given a hardened surface, and is used to mean either paved or shod. As a noun *chaussée* is used on the one hand for a metalled carriageway, and on the other for an embankment with or without a road.

Engineering

The modern embankment may be constructed within a *cofferdam*: two parallel steel sheet pile or concrete retaining walls, anchored to each other with steel cables or rods. This construction may also serve as a dyke that keeps two bodies of water apart, such as bodies with a different water level on each side, or with salt water on one side and fresh water on the other. This may also be the primary purpose of a structure, the road providing a hardened crest for the dike, slowing erosion in the event of an overflow. It also provides access for maintenance as well perhaps, as a public service.

Examples of Use

The Causeway Section of the still under-construction Cebu South Coastal Road in Cebu, The Philippines

Notable causeways include those that connect Singapore and Malaysia (the Johor-Singapore Causeway), Bahrain and Saudi Arabia (25-Km long King Fahd Causeway) and Venice to the mainland, all of which carry roadways and railways. In the Netherlands there are a number of prominent dykes which double as causeways, including the Afsluitdijk, Brouwersdam, and Markerwaarddijk. In Louisiana, two very long bridges, called the Lake Pontchartrain Causeway, stretch across Lake Pontchartrain for almost 38 km, making them the world's longest bridges (if total length is considered instead of span length). In the Republic of Panama a causeway connects the islands of Perico, Flamenco, and Naos to Panama City on the mainland. It also serves as a breakwater for ships entering the Panama Canal.

Causeways are also common in Florida, where low bridges may connect several man-made islands, often with a much higher bridge (or part of a single bridge) in the middle so that taller boats may pass underneath safely. Causeways are most often used to connect the barrier islands with the mainland.

The Churchill Barriers in Orkney are of the most notable sets of causeways in Europe. Constructed in waters up to 18 metres deep, the four barriers link five islands on the eastern side of the natural harbour at Scapa Flow. They were built during World War II as military defences for the harbour, on the orders of Winston Churchill.

Precautions in Use

Causeways affect currents and may therefore be involved in beach erosion or changed deposition patterns. This, for instance, has been a problem at the Hindenburgdamm in northern Germany. Causeways are often a problem with an approaching hurricane or strong tropical storm, because the high winds and waves make them dangerous. Along with traffic jams, this is a major reason for the early emergency evacuation of island residents during a weather emergency.

Unit 14 Street

A *street* is a public parcel of land adjoining buildings in an urban context, on which people may freely assemble, interact, and move about. A street can be as simple as a level patch of dirt, but is more often paved with a hard, durable surface such as cobblestone or brick. Portions may also be smoothed with asphalt, embedded with rails, or otherwise prepared to accommodate non-pedestrian traffic.

The word ñstreetò is sometimes used colloquially as a synonym for ñroad,ò but city residents and urban planners draw a crucial distinction: a roadôs main function is transportation, while streets facilitate public interaction. Examples of streets include pedestrian streets, alleys, and city-centre streets too crowded for road vehicles to pass. Conversely, highways and motorways are types of roads, but few would refer to them as streets.

Role in the Built Environment

The street is a public environment shared between all sorts of people. As a component of the built environment as ancient as human habitation, the street sustains a range of activities vital to civilization. Its roles are as numerous and diverse as its ever-changing cast of characters.

Streets can be loosely categorized as main streets and side streets. Main streets are usually broad with a relatively high level of activity. Commerce and public interaction are more visible on main streets, and vehicles may use them for longer-distance travel. Side streets are quieter, often residential in use and character, and may be used for vehicular parking.

Circulation

Rue Saint-Jacques, a street in Montreal, 1910

Circulation, or less broadly, transportation, is perhaps a streetôs most visible use, and certainly among the most important. The unrestricted movement of people and goods within a city is essential to its commerce and vitality, and streets provide the physical space for this activity.

In the interest of order and efficiency, an effort may be made to segregate different types of traffic. This is usually done by carving a road through the middle for motorists, reserving sidewalks on either side for pedestrians; other arrangements allow for streetcars, trolleys, and even wastewater and rainfall runoff ditches (common in Japan and India). In the mid-20th century, as the automobile threatened to overwhelm city streets with pollution and ghastly accidents, many urban theorists came to see this segregation as not only helpful but necessary in order to maintain mobility. Le Corbusier perceived an ever-stricter segregation of traffic as an essential affirmation of social order--a desirable, and ultimately inevitable, expression of modernity. To this end, proposals were advanced to build ñvertical streetsò where road vehicles, pedestrians, and trains would each occupy their own levels. Such an arrangement, it was said, would allow for even denser development in the future. These plans were never implemented on a large scale, a fact which todayôs urban theorists regard as fortunate for vitality and diversity.

Transportation is often misunderstood to be the defining characteristic, or even the sole purpose, of a street. This has never been the case, and even in the automobile age, is still demonstrably false. A street may be temporarily blocked to all through traffic in order to secure the space for other uses, such as a street fair, a flea market, or children at play. Many streets are bracketed by bollards or Jersey barriers so as to prevent passage unless on foot. These

measures are often taken in a city's busiest areas, the "destination" districts, when the volume of activity outgrows the capacity of private passenger vehicles to support it. A feature universal to all streets is a human-scale design that gives its users the space and security to feel engaged in their surroundings, whatever through traffic may pass.

Vehicular Traffic

A street full of vehicles in Shanghai

Despite this, the operator of a motor vehicle may regard a street as merely a thoroughfare for vehicular travel or parking. As far as concerns the driver, a street can be *one-way* or *two-way*: vehicles on one-way streets may travel in only one direction, while on two-way streets may travel both ways. One way streets typically have signs reading "ONE WAY" and an arrow showing the direction of allowed travel. Two-way streets are wide enough for at least two lanes of traffic.

Which lane is for which direction of traffic depends on what country the street is located in. On broader two-way streets, there is often a *center line* marked down the middle of the street separating those lanes on which vehicular traffic goes in one direction from other lanes in which traffic goes in the opposite direction. Occasionally, there may be a median strip separating lanes of opposing traffic. If there is more than one lane going in one direction on a main street, these lanes may be separated by intermittent *lane lines* marked on the street pavement. Side streets often do not have center lines or lane lines.

Parking for Vehicles

Many streets, especially side streets in residential areas, have an extra laneôs width on either or both sides for parallel parking vehicles. Most minor side streets allowing free parallel parking do not have pavement markings designating the parking lane. A somewhat recent trend has been to start marking off parking lanes on more important streets. Some streets are too busy or not wide enough to allow parking on the side. Sometimes parking on the sides of streets is allowed only at certain times. Signs off to the side of the street often state regulations about parking. On the side of some streets, particularly in business areas, there may be parking meters into which coins must be paid to allow parking in the adjacent space for a limited time. There may be parking lane markings on the pavement effectively designating which meter a parking space corresponds to. Occasionally, a street may have enough width on the side that there is *angle parking*.

Pedestrian Traffic and Vehicular Amenities

Where vehicular traffic is allowed on a street, traffic and parking regulatory signs are often placed near the sides. Bordering the driving/parking sides of many urban streets, there are curbs. Usually, there are strips of land beyond the driving/parking parts of the streets owned by the government entity owning the streets. Sidewalks are often located on these public land strips beyond the curbs on one or usually both sides of the street. There may be an unpaved strip of land between the vehicle-drivable part of the street and the sidewalk on either side of the street, which can be called the *parkway* or tree lawn. Grass and trees are often grown there for landscaping the sides of the street. Alternatively, there may be openings in wider sidewalks in which trees grow. Streets are often lighted at night with streetlights, which are typically located far overhead on tall poles. Beyond these public strips of land are bordered the front of lots commonly owned by private parties.

Practically all public streets are given a name or at least a number to identify them and any addresses located along the streets. Alleys typically do not have names. The length of a lot of land along a street is referred to as the *frontage* of the lot.

Identity

Streets assume the role of a town square for its regulars. The interaction among the people who live and work on a particular streetð ñeyes on the streetò-can reduce crime, encourage the exchange of ideas, and generally make the world a better place.

Much as a string in a jar can precipitate a beautiful, delicate crystal, a street can serve as the catalyst for neighborhood culture and solidarity. New

OrleansôBourbon Street is famous not only for its active nightlife but also for its role as the center of the cityôs French Quarter. Similarly, the Bowery in New York City was once known as the center of the nationôs underground punk scene. Other streets have marked divisions between neighborhoods of a city. For example, Yonge Street divides Toronto into east and west sides, and East Capitol Street divides Washington, D.C. into north and south.

Streets also tend to aggregate establishments of similar nature and character. East 9th Street in Manhattan, for example, offers a cluster of Japanese restaurants, clothing stores, and cultural venues. This phenomenon is the subject of urban location theory in economics.

A road, like a street, is often paved and used for travel. However, a street is characterized by the degree and quality of street life it facilitates, whereas a road serves primarily as a through passage for road vehicles or (less frequently) pedestrians. Street performers, beggars, patrons of sidewalk cafés, people-watchers, and a diversity of other characters are habitual users of a street; the same people would not typically be found on a road.

In rural and suburban environments where street life is rare, the terms ñstreetò and ñroadò are frequently considered interchangeable. Still, even here, what is called a ñstreetò is usually a smaller thoroughfare, such as a road within a housing development feeding directly into individual driveways.

If a road connects places, then a street connects people. One may ñhit the roadò to see the wonders of the worldð Jack Kerouac famously chronicled one such journeyð but the latest bling will ñhit the streetsò before it ever appears on a road. It is ñon the streetòwhere one hears an interesting rumor, where one bumps into an old acquaintance, where one acquires smarts. Nobody has ever seen a ñroadòvendor or a ñroadòperformer, and youôll never find yourself on a long ñstreetòto nowhere. The street, not the road, is home to the homeless, and even Kerouacôs hero finally returned to find his friends on a New York street.

A town square is a little more like a street, but a town square is rarely paved with asphalt and may not make any concessions for through traffic at all.

Nomenclature

Abbey Road, London

There is a haphazard relationship, at best, between a thoroughfare's function and its name. For example, London's Abbey Road serves all the vital functions of a street, despite its name, and locals are more apt to refer to the "street" outside than the "road". A desolate road in rural Montana, on the other hand, may bear a sign proclaiming it "Davidson Street", but this does not make it a "street".

In the United Kingdom many towns will refer to their main thoroughfare as the High Street (in the United States it would be called the Main Street -- however, occasionally "Main Street" in a city or town is a street other than the *de facto* main thoroughfare), and many of the ways leading off it will be named "Road" despite the urban setting. Thus the town's so-called "Roads" will actually be more streetlike than a road.

Streets have existed for as long as humans have lived in permanent settlements. However, modern civilization in much of the New World developed around transportation provided by motor vehicles. In some parts of the English-speaking world, such as North America, many think of the street as a thoroughfare for vehicular traffic first and foremost. In this view, pedestrian traffic is incidental to the street's purpose; a street consists of a thoroughfare running through the middle (in essence, a road), and may or may not have sidewalks along the sides.

In an even narrower sense, some may think of a street as only the vehicle-driven and parking part of the thoroughfare. Thus, sidewalks and tree lawns would not be thought of as part of the street. A mother may tell her toddlers "Don't go out into the street, so you don't get hit by a car."

Among urban residents of the English-speaking world, the word appears to carry its original connotations (i.e. the facilitation of vehicular traffic as an incidental benefit). For instance, a *New York Times* writer lets casually slip the observation that automobile-laden Houston Street is "a street that can hardly be called 'street' anymore, transformed years ago into an eight-lane raceway that alternately resembles a Nascar event and a parking lot." Published in the paper's Metro section, the article evidently presumes an audience with an innate grasp of the full urban role of the street. To the readers of the Metro section, vehicular traffic does not reinforce, but rather detracts from, the essential "street-ness" of a street.

At least one map has been made to illustrate the geography of naming conventions for thoroughfares; street, avenue, boulevard, circle, and other suffixes are contrasted against one another.

Unit 15 Trail

A country trail.

A mountain trail.

A *trail* is a pedestrian path or road mainly used for walking, but often also for cycling, cross-country skiing or other activities. Some trails are off-limits to everyone other than hikers, and few trails allow motorized vehicles.

In the United States, the word *footpath* is also used to mean a trail; however in Australian English, this word means ñsidewalkò (American English) or ñpavementò(British English).

Walking Trails

The Sendero de los quetzales in Panamá

Trail use has become very popular for a wide variety of users. Some trails are designated as *nature trails*, and are used by people learning about the natural world. Many trails are designated *day trails*, meaning that they are generally used by people out for a short hike, less than a day. Some trails are designated *backpacking trails*, or long-distance trails, and are used by both day hikers and by backpackers. Some of the trails are over a thousand miles (1,500 km) long and may be hiked in sections by backpackers, or completed in one trip by dedicated hikers. Some trails are specifically used by other outdoor enthusiasts to gain access to another feature, such as good climbing sites. Many runners also favor running on trails rather than pavement, as giving a more vigorous work-out and better developing agility skills, as well as providing a more pleasant exercise environment.

Bicycle Trails

Recent decades have seen an explosion of interest in cycling, both street-type and off-road type. Many graded, surfaced bike paths have been built, but especially popular is the off-road, or *mountain* biking. A common term for these facilities is simply ñbike trailò These trails may be built to a different set of standards than foot trails, requiring more stable, harder surfaces, less strenuous grades, longer sight visibility, and less sharp changes in direction. On the other hand, the cross-slope of a bike trail may be significantly greater than a foot trail, and the actual treadway may be narrower in some cases.

A particular offshoot of trail biking is *downhilling*, which can be environmentally destructive if not well-managed. Downhilling is particularly popular at ski resorts such as Mammoth Mountain in California or Whistler in British Columbia, where ski lifts are used to get bikes and riders to the top of the mountain.

Because of the greater need for more gradual grades, changing elevations may involve sidehill trails with multiple switchbacks, while these may not be necessary for hikers. In cases where hikers use these bike trails, attention must be paid to the potential of cutting across switchbacks.

Where bike trails intersect with pedestrian or equestrian trails, signage at the intersections is important, and high visibility onto the intersecting trails must be a priority in order to prevent collisions between fast-moving cyclists and slower moving hikers and horses. Bicycles and horses should be allowed on the same trails where the trail is wide enough with good visibility.

A well designed bike trail will have an average grade of less than 10%, and will generally follow a countour line, rather than straight downhill. The trail should slope out or accross the trail 3-5% downhill to encourage water to run off the side, rather than down the trail bed. In addition, frequent grade reversals also prevent water from running down the trail, make the trail more fun and interesting to ride, and generally help keep bike speeds down, providing a more safe trail experience for all users.

Equestrian Trails

Horseback riding has continued to be a popular activity for many trail users. Again, *horse trails* must be built to different standards than other trails. Sight distance is an important issue with horse trails, as is overhead and side clearance. While trail surface types are a relatively insignificant issue with hikers, they may be an important issue with horses. Horses can negotiate much steeper terrain on a dirt trail, for instance, than on a gravel trail. Horses can usually negotiate much the same grades as hikers, but not always, although they can more easily clear obstacles in the path such as logs. A hard trail surface and drainage is a critically important issue on horse trails

because of the relatively greater bearing impact of the horse's hoof on the trail than a hiker's foot.

Trail Construction

A walking path.

While many trails have arisen through common usage, quality trail design and construction is a complex process requiring certain sets of skills.

When a trail passes across a flat area that is not wet, often all that is required is to clear brush, tree limbs and undergrowth to produce a clear, walkable trail. When crossing streams, bridges may or may not be desirable, depending on the size of the stream and the depth of its banks. In wet areas, it may be necessary to create an elevated *trailway* with fill or by building a boardwalk. One problem with boardwalks is that they require frequent maintenance and replacement - boards in poor condition are often slippery and hazardous.

Trails on Slopes

This trail leads straight over the hill.

A common mistake in establishing trails is to make them on slopes that are too steep for comfort and the environment. Such steep trails generally result in serious erosion, a wide swath of impacted area as walkers go to the sides to find better footing, and the inability of many hikers to walk the trail. An absolute limit for trail grades is a grade of one in six, and a more practical limit is a slope of one in eight. Trails that ascend steep slopes may use switchbacks (also called hairpins), but switchback design and construction is a specialized topic that takes great care. The best trail designs eliminate switchbacks.

If a trail is being made to be accessible to off-road wheelchairs, the grade should be no more than one in ten. If a paved trail has to be accessible to all wheelchairs, the grade must be no more than one in twelve, with periodic level pull-offs.

The *off-slope*, or *side-slope*, of the trail also must be considered. This is the slope of the trail from side to side, and should never be more than one in twelve. Side-sloped trails are prone to gullying. Ideally, the treadway of the trail should be almost, but not quite, level in cross-section.

Achieving the proper slope in hilly terrain usually requires the excavation of *sidehill* trail. This is trailway that is constructed by establishing a line of suitable slope across a hillside, then digging out by means of a mattock or similar tool to create the trail. This may be a *full-bench* trail, where the treadway is only on the firm ground surface after the overlying soil is removed and thrown to the side as waste, or a *half-bench* trail, where soil is removed and packed to the side so that the treadway is half on firm old ground and half on new packed fill. In problem areas, it may be necessary to establish the trail entirely on fill. In cases where filling is used, it is necessary to pack it firmly and to revisit the site periodically to add to the fill and repack it until fully stable.

Drainage

An important and often-overlooked factor in trail construction is that of drainage. Where a trail is near the top of a hill or ridge, this is usually a minor issue, but when it is farther down it can become a very major issue. Trails, by their nature, tend to become drainage channels and eventually gullies if the drainage is not properly controlled.

A waterbar in New Yorkôs Catskill Mountains. The trail forks right; the drainage ditch to the left.

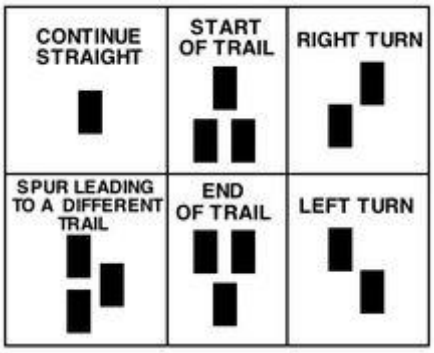
In areas of heavy water flow along a trail, it may be necessary to create a ditch on the uphill side of the trail with drainage points across the trail. The cross-drainage may be accomplished by means of culverts, which must be cleared on a semi-annual basis, or by means of cross-channels, often created by placing logs or timbers across the trail in a downhill direction, called *waterbars*. Using timbers or rocks for this purpose also creates erosion barriers. Rock paving in the bottom of these channels and in the trailside ditches may help to maintain stability of these. Ideally, waterbars should be created, with or without ditching, at major points of water flow on or along the trail, and in conjunction, if possible, with existing drainage channels below the trail. Another important technique is to create drain dips, points on the trail where it falls briefly (for a metre or so) and then rises again. These provide positive drainage points that are almost never clogged by debris.

Multi-use Trails

Trails intended for use by bicycles, wheelchairs and pedestrians will often be surfaced, especially in heavily-used or urban areas. This can be asphalt paving, or compressed stone dust. Such trails will also have well-built bridges with a supported deck and side rails.

There has been a major effort to convert abandoned railroad grades to bike paths or multi-use paths.

Signs



The most common symbols used in trail blazing

For long-distance trails, or trails where there is any possibility of anyone taking a wrong turn, signs should be provided. This may be accomplished by using either paint on natural surfaces or by placing pre-made medallions. Horseshoe-shaped blazes are good for equestrian trails (but be sure to have the ñuòof the horseshoe opening to the top, or youõll offend some riders!). The Appalachian Trail is blazed with white rectangles. Blue is often used for side trails. European walking paths are blazed with yellow points encircled with red. However, other walking paths in European countries are blazed in a variety of manners.

Maintenance

Natural surface, single track trails will require some ongoing maintenance. However, if the trail is properly designed and constructed, maintenance should be limited to clearing downed trees and trimming back brush. If the trail is properly designed, there should be no need for major rework such as grading or erosion control efforts.

Unit 16 Ancient Trackway

Ancient trackway can refer to any track or trail whose origin is lost in antiquity. Such paths existed from the earliest times and in every part of the globe. The term is commonly used on the British Isles to describe the ancient trackways that already existed when the Romans arrived in Britain. Such trackways were often built on by the Romans and form the foundations of some of the current system of roads.

The Beginnings

The *Concise Oxford Dictionary* gives the definition of ñtrackwayò as ña path formed by the repeated treading of people or animalsò. The very earliest

creatures to arrive in Britain after the Ice Age, crossing land which would later be the English Channel, were grazing animals following the spreading vegetation. Their predators, including humans ï the Mesolithic (Middle Stone Age) hunter-gatherers - followed. The earlier Mesolithic people were nomadic but in the later part of the Mesolithic permanent settlements started to appear.

The Trackways

These settlements were connected with each other by the ancient trackways. These green ways often followed natural contours in the landscape, and had evolved over time as animals were driven from place to place, and pedestrians walked to and from neighbouring settlements. Much of the land was forested; the lower valleys provided fertile land and were ideal places for fishing, agriculture and the rearing of cattle.

The trackways will have provided links in many ways: farmsteads to fields; to other farmsteads; to the neighbouring long barrow tomb; with long-distance trackways joining the separate localities to the camp meeting places and cross-country flint roads. Others were more likely to have been processional ways, like one heading for the gigantic temple at Avebury. Others, the long-distance ways mentioned above, are now known as the Icknield Way, the Ridgeway National Trail, the Harrow Way and the PilgrimsôWay.

Some of these trackways followed the tops of higher land, while others progressed along the lower slopes. The lowland areas were thickly forested and poorly drained and for long distance travel there was an advantage in following the top of a line of hills. Skills to develop tracks across bog lands, such as in Somerset, were learnt by early people. Known as *corduroy roads*, they were formed when huge quantities of alder poles and brushwood were used to link the fen islands across the marshes. The Sweet track in the Glastonbury fens, Somerset is the oldest purpose built road in the world and has been dated to the 3800s BC.

Settlements

On occasion, where rivers caused an obstacle to progress, bridges were built across them, and several roads met to use the bridge. Here major settlements grew, providing sustenance to travellers and their animals using the trackways. There are many good example of this: three follow.

Wallingford

The original settlement at Wallingford in Oxfordshire dates back to the dawn of British history, when its founders showed a remarkable amount of discrimination in choosing its site. Nestling in a fertile valley on the banks of the River Thames, it was an ideal place for fishing, agriculture and the rearing

of cattle. The ancient trackways, in particular the Icknield Way, gave it lines of communication converging on its ford. The remains of the ramparts, which still surround the town, are the successors of the rudimentary fortifications of the old British settlement, were adapted in turn by Roman, Saxon and Norman conquerors.

Brownhills

A similar site is Brownhills once in Staffordshire, now in West Midlands. Brownhills was a meeting point for ancient roads and trackways since prehistoric times. It is thought that the Watling Street was in use before the Romans came, and what were later called the Chester Road and Coventry Road are also thought to have been ancient trackways.

Cadbury Castle and South Cadbury Village

Cadbury Castle in Somerset is a tremendous Iron Age camp covering some 18 acres (73,000 m²), one of the most impressive sites in Britain. It is the focal point of many ancient trackways and is guarded by four huge banks with a height in places of over 40 feet (12 m) from the bottom of the ditch.

Unit 17 Pavement (material)

This article is about the American English usage of *pavement* as the durable surfacing of roads and walkways. In British English, *pavement* is usually taken to mean a footpath next to a road, the same as sidewalk in American English.

Pavement in American English refers to the durable surface for an area intended to sustain traffic, which can be either vehicular traffic or foot traffic. The most common modern paving methods are asphalt and concrete. In the past, brick was extensively used, as was metalling. Today, permeable paving methods are beginning to be used more for low-impact roadways and walkways.

Metalling

Metal or metalling has had two distinct usages in road paving. Metalling originally referred to the process of creating a carefully engineered gravel roadway. The route of the roadway first would be dug down several feet. Depending on local conditions, drains may or may not have been added. Next, large stone was placed and compacted, followed by successive layers of smaller stone, until the road surface was a small stone compacted into a hard, durable surface.

Road metal later became the name of stone chippings mixed with tar to form the road surfacing material tarmac. A road of such material was called a ñmetalled roadò in British usage, although this would be very rare in modern usage. It would be more common to refer to a macadam road. The word *metal* is derived from the Latin *metallum*, which means both ñmineò and ñquarryò, hence the road building terminology.

Asphalt paving

A road in the process of being resurfaced, showing both old and new asphalt surfaces.

Asphalt (specifically, asphalt concrete) has been widely used since 1920-1930, though in ancient times asphalt was already used for road-building. The viscous nature of the bitumen binder allows asphalt concrete to sustain significant plastic deformation, although fatigue from repeated loading over time is the most common failure mechanism. Most asphalt pavements are built on an imported gravel base which is generally at least as thick as the asphalt layer, although some ñfull depthò pavements are built directly on the native subgrade. In areas with very soft or expansive subgrades such as clay or peat, thick gravel bases or stabilization of the subgrade with Portland cement or lime can be required. In some countries with soft soils, a foundation of polystyrene blocks is used instead. The actual material used in paving is termed HMA (Hot Mix Asphalt).

Advantages of asphalt roadways include relatively low noise, relatively low cost compared with other paving methods, and ease of repair. Disadvantages include less durability than other paving methods, less tensile strength than concrete, the tendency to become slick and soft in hot weather and a certain amount of hydrocarbon pollution to soil and groundwater or waterways.

Concrete Paving

Concrete pavements (specifically, Portland cement concrete) are created using a concrete mix of Portland cement, gravel, and sand. The material is applied in freshly-mixed slurry, and worked mechanically to compact the

interior and force some of the thinner cement slurry to the surface to produce a smoother, denser surface free from honeycombing. Cement concrete can be either reinforced or non-reinforced. Non-reinforced pavements will typically have joints at a 5 meter interval. Reinforced concrete pavements can have a much longer joint spacing, or no built-in joints at all. Typical reinforcement used includes ñrebarò (reinforcing steel) or wire mesh or both.

Vertical misalignment of the joints, known as joint faulting, can be caused by differential settlement of the substrate, and are a source of driver annoyance. A common failure mode of concrete pavements is loss of support of the slab edges or corners due to erosion of the foundation material. If this condition is caught before it leads to breakup of the slab, support can be restored by filling the void with grout or foam in a process known as ñmud jackingò or ñslab jackingò.

Advantages of cement concrete roadways include that they are typically stronger and last longer than asphalt concrete pavements. They also can easily be grooved to provide a durable skid-resistant surface. Disadvantages are that they have a higher initial cost, are more difficult to repair, and are also somewhat noisy if jointed, but unjointed concrete pavement is actually a method of road noise mitigation.

The record for first mile of concrete pavement to be laid in the United States is claimed by Michigan.

Bituminous Surface Treatment (BST)

Bituminous Surface Treatment (BST) is used mainly on low-traffic roads, but also as a sealing coat to rejuvenate an asphalt concrete pavement. It generally consists of aggregate spread over sprayed-on asphalt emulsion or cut-back asphalt cement. The aggregate is then embedded into the asphalt by rolling it, typically with a rubber-tired roller. BSTs of this type are described by a wide variety of regional terms including ñchip sealò, ñtar and chipò and ñseal coatò.

Other types of BSTs include micropaving, slurry seals and Novachip. These are laid down using specialized and proprietary equipment. They are most often used in urban areas where the roughness and loose stone associated with chip seals is considered undesirable.

Other Paving Methods

Cobbles

Pavers, generally in the form of pre-cast concrete blocks, are often used for aesthetic purposes, or sometimes at port facilities that see long-duration pavement loading. Pavers are rarely used in areas that see high-speed vehicle traffic.

Brick, cobblestone and wood plank pavements were once common in urban areas throughout the world, but due to their high manual labor requirements they are in some countries typically only maintained for historical reasons, while in other countries they are still common in local streets. They make maintenance of cabling and pipelines under the pavement easier but are also harder to walk on.

Likewise, macadam and tarmac pavements can still sometimes be found buried underneath asphalt concrete or Portland cement concrete pavements, but are rarely constructed anymore.

As pavement systems primarily fail due to fatigue (in a manner similar to metals), the damage done to pavement increases exponentially with the axle load of the vehicles traveling on it. Civil engineers consider truck axle load, current and projected truck traffic volume, supporting soil properties and sub-grade drainage in design. Passenger cars are considered to have no practical effect on a pavementôs service life.

Several pavement design methods have been developed to determine the thickness and composition of pavement required to carry predicted traffic loads for a given period of time. Pavement design methods are continuously evolving.

According to some road tests, heavily loaded trucks can do more than 10,000 times the damage done by a normal passenger car. Tax rates for trucks are higher than those for cars in most countries for this reason, though are not levied in proportion to the damage done.

Unit 18 Traffic Sign

Most countries post signage, known as *traffic signs* or *road signs*, at the side of roads to impart information to road users. Since language differences can create barriers to understanding, international signs using symbols in place of words have been developed in Europe and adopted in most countries and areas of the world. The Vienna Convention on Road Signs and Signals of November 8, 1968 defines eight categories of signs:

A. Danger warning signs
B. Priority signs
C. Prohibitory or restrictive signs
D. Mandatory signs
E. Special regulation signs

F. Information, facilities, or service signs
G. Direction, position, or indication signs
H. Additional panels

However, countries and areas categorise road signs in different ways.

History


Roman milestone

The earliest road signs were milestones, giving distance or direction; for example, the Romans erected stone columns throughout their empire giving the distance to Rome. In the Middle Ages multidirectional signs at intersections became common, giving directions to cities and towns.

Traffic signs became more important with the development of automobiles. The basic patterns of most traffic signs were set at the 1908 International Road Congress in Rome. Since then there have been considerable change. Today they are almost all metal rather than wood and are coated with retroreflective sheetings of various types for nighttime and low-light visibility.

New generations of traffic signs based on big electronic displays can also change its symbols and also provide intelligent behavior by means of sensors or by remote control. In this sense, ñroad beaconsò (RBS) based in the use of RFID special transponders buried in the asphalt arise as an innovative evolution for on-board signalling.

Yet another "medium" for transferring information ordinarily associated with visible signs is RIAS (Remote Infrared Audible Signage), e.g. ñTalking Signsò for print-handicapped (including blind/low-vision/illiterate) people. These are infra-red transmitters serving the same purpose as the usual graphic signs when received by an appropriate device such as a hand-held receiver or one built into a cell phone.

Europe

In 1968, the European countries signed the Vienna Convention on Road Traffic treaty, the aim of which was to standardize traffic regulations in

participating countries in order to facilitate international road traffic and to increase road safety. Part of the treaty was the Vienna Convention on Road Signs and Signals, which defined the traffic signs and signals. As a result, in Western Europe the traffic signs are well standardized nowadays, although there are still some country-specific exceptions in many countries, mostly dating from the pre-1968 era. The convention has been adapted to allow variations when countries weren't expected to follow the main standard.

The basic principle of the European traffic sign standard is that usage of certain shapes and colours are to be used systematically for indicating the same purposes. Triangular shapes (white or yellow background) are used in warning signs. Additionally, the Vienna convention allows an alternative shape for warning signs, a diamond shape, which is rarely used in Europe. The prohibition signs in Europe are round with a red border. Informative and various other secondary signs are of rectangular shape. With the animal warning signs, one can notice national flavour quite often, with symbols of moose, frog, deer, cow, etc., even Polar bear in Svalbard and monkey in Gibraltar, and the Convention allows any animal to be used.

Directional signs have not been harmonised under the Convention, at least not on ordinary roads. As a result, there are substantial differences in directional signage throughout Europe. Differences apply in typeface, type of arrows and, most notably, colour scheme. The convention however specifies a difference between motorways and ordinary roads, and that motorways use white-on-green (e.g. Italy, Switzerland, Denmark, Sweden, Finland, Slovenia, Croatia, Czech Republic, Slovakia) or white-on-blue (e.g. Germany, the Republic of Ireland, France, United Kingdom, Spain, Netherlands, Belgium, Austria, Luxembourg, Poland, Portugal).

Differences are greater for non-motorways: white-on-blue in Italy, Switzerland, Sweden, Slovakia, Finland and Netherlands (in this case the same as motorways), white-on-green in France, United Kingdom, Poland and Portugal, black-on-yellow in Germany, Luxembourg, Norway, Slovenia and Croatia, red-on-white in Denmark (though white-on-blue on motorway exits), and black-on-white in Spain. Other nations split among the non-motorways.

Secondary roads are different from primary roads in France, United Kingdom, Finland, Republic of Ireland, Switzerland and Portugal, always signposted in black-on-white. In Italy and Sweden, black-on-white indicates only urban roads or urban destinations.

Signposting road numbers differs greatly as well. Only the European route number, if signposted, will always be placed in white letters on a green rectangle.

The languages to be used are according to the convention the language(s) of the individual country. Some signs like ñSTOPò, ñZONEò etc. are recommended to be in English, but the local language is also permitted. If the language uses non-Latin characters, the names of cities and places should also be in Latin transcription.

European countries use the metric system on road signs (distances in kilometres or metres, heights/widths in metres) with the notable exception of the UK, where distances are still indicated in miles. For countries driving on the left, the convention stipulates that the traffic signs should be mirror images of those used in countries driving on the right. This practice, however, is not systematically followed in the two European countries driving on the left, the Republic of Ireland and the United Kingdom. The convention permits the usage of two background colours for danger and prohibitory signs, white or yellow. Most countries use white with a few exceptions like Sweden, Finland, Iceland and Poland, for instance, where the yellow colour was chosen.

Vocabulary

A

abandon ʧʦʢʠʜʘʪ , ʦʩʪʘʚʫʷʪ ; ʧʨʝʢʨʘʱ ʘʪ (ʯʪʦ-ʤʢ, ʜʝʤʘʪ ʯʪʦ-ʤʢ); ʩʜʘ-ʚʘʪ , ʦʩʪʘʚʫʷʪ

Achaemenid [ɒkémmɒnid] ancient Persian ruler**:** a member of a dynasty that ruled in ancient Persia from 553-331 BC

access control ʬʧʨʘʚʤʝʥʝ ʜʦʩʪʬʧʦʤ

adept ʟʤʘʪʦʢ, ʢʩʥʧʝʨʦʩ ʩʧʝʯʠʘʣʠʩʪ

agger ʤʘʩʩ ʧʴ , ʞʦʥʤʤ ʢʬʨʘʘʤʥʢʨʝʧʦʩʪʦʞ ʚʘʤʥʚ ʨ ʢʝʚʤʝʤʞʨ ʠʤʞʝ

alignment ʚʺ ʨʘʚʤʝʥʚʘʤʝʥʝ, ʨʝʛʫʤʠʨʦʚʘʦʚʢʘ, *ʪʦʧʦʛʨ.* ʚʠʟʠʨʦʚʘʥʠʝ ʯʝʨʝʟ ʤʝ-ʩʪʦʤʢ ʢʦ ʪʦʯʢʝ

alpaca ʘʤʴ ʧʘʢʘ, ʰ ʝʨʩʪ ʘʤʴ ʧʘʢʠ; ʪʢʘʥʴ ʠʟ ʰ ʝʨʩʪʠ ʘʤʴ ʧʘʢʠ

amount to ʜʦʩʪʠʛʘʪ , ʩʦʩʪʘʚʣʷʪ , ʨʘʚʥʷʪ ʩʷ, ʙʺ ʪʦ ʞʝ ʩʘʤʦʝ ʯʪʦ

arterial road ʘʚʪʦʤʘʛʠʩʪʨʘʣʴ , ʘʚʪʦʩʪʨʘʜʘ

ascend ʚʩʞʦʜʠʪ , ʚʟʙʠʨʘʪ ʩʷ (ʦ ʯʝʣʦʚʝʢʝ, ʝʠʚʦʪʥʦʤ); ʧʦʜʥʠʤʘʪ ʩʷ

ascent ʚʦʩʞʦʝ ʜʝʥʠʝ, ʧʦʜʲ ʝʤ

ash ʟʦʣʘ, ʧʝʧʝʣ

autobahn ʘʚʪʦʩʪʨʘʜʘ, ʘʚʪʦʤʘʛʠʩʪʨʘʣʴ , ʩʢʦʨʦʩʪʥʘʷ ʘʚʪʦʩʪʨʘʜʘ

axle ʚʘʣ, ʦʩʴ , ʰ ʧʠʥʜʝʣʴ

B

backpacker ʯʝʣʦʚʝʢ ʩ ʨʶʢʟʘʢʦʤ

Bactrian ʙʘʢʪʨʠʝʮʥʢʚʝʨʙʤʜ ʜ ʜʚʬʛʦʨʙʺ ʞ

binder ʩʚʷʟʫʰ ʝʝ (ʚʝʰ ʝʩʪʚʦ), ʩʚʷʟʫʰ ʠʞ ʤʘʪʝʨʠʘʣ

bitumen ʙʠʪʫʤ ʘʩʬʘʣʴʪ

blight ʜʬʰ ʤʘʷ ʘʪʤʦʩʬʝʨʘ; ʬʧʘʜʦʢ, ʜʝʛʨʘʜʘʯʠʷ

blur ʟʘʤʘʟʬʚʘʪ , ʟʘʧʘʯʢʘʪ ; ʩʜʝʣʘʪ ʤʝʥʝʝ ʯʝʪʢʠʤ ʟʘʪʫʤʘʥʠʪ ; ʟʘʪʝʤʥʷʪ

boardwalk ʜʝʨʝʚʷʥʥʘʷ ʪʨʦʪʫʘʨ; ʜʦʰ ʘʪʘʷ ʜʦʨʦʞʢʘ

bollard ʩʪʦʣʙʠʢ ʦʛʨʘʞʜʝʥʠʷ

booth ʢʠʦʩʢ; ʧʘʣʘʪʢʘ; ʙʫʜʢʘ; ʢʘʙʠʥʘ

bump ʢʦʣʜʦʙʠʥʘ; ʚʺ ʙʦʠʥʘ

bypass ʦʙʞʦʜʥʘʷ ʧʫʪʴ , ʦʙʞʦʜʥʘʷ ʜʦʨʦʛʘ

ʋ

camber ʚʺ ʧʫʢʣʦʩʪʴ ; ʚʺ ʩʛʫʙ; ʠʟʛʠʙ, ʢʨʠʚʠʟʥʘ, ʧʦʜʲ ʝʤ (ʚ ʤʦʩʪʘʞ)

car ʘʚʪʦʤʦʙʠʣʴ , ʤʘʰ ʠʥʘ; ʚʘʛʦʥ, ʢʦʣʝʩʥʠʮʘ

carriageway ʧʨʦʝʟʞʘʷ ʯʘʩʪʴ ʜʦʨʦʛʠ

cart ʪʝʣʝʛʘ, ʧʦʚʦʟʢʘ; ʧʦʜʚʦʟʠʪʴ

cartouche ʧʘʨʪʫʰ ʢʘ, ʢʘʨʪʫʰ , ʦʨʥʘʤʝʥʪ ʚ ʬʦʨʤʝ ʣʠʩʪʘ, ʚʺ ʩʛʫʙ, ʧʦʥʥʢ (ʤʘʢʝʪ ʩʣʦʚ)

causeway ʤʦʰ ʝʥʘʷ ʜʦʨʦʛʘ, ʜʘʤʙʘ (ʩʧʝʯʠʘʣʴ ʥʦʝ ʦʙʦʟʥʘʯʝʥʠʝ); ʤʘʩʩʠʚ ʧʘʚʝʜʚʥʦ ʜʦ-ʨʦʛʘ (ʯʝʨʝʟ ʤʝʣʢʦʥ ʚʦʜʥʦʝ ʧʨʦʩʪʨʘʥʩʪʚʦ)

central reservation [illegible]
chariot [illegible]
clog [illegible]
coach [illegible]
cobblestone [illegible]
coerce [illegible]
cohesion [illegible]
conch [illegible]
congestion [illegible]
contour [illegible]
controversy [illegible]
conventional [illegible]
converge [illegible] (on); [illegible]
convex [illegible]
cord [illegible]
corduroy [illegible]
corral [illegible]
courier [illegible]
crash barrier [illegible]
craze [illegible]
culvert [illegible]
curb [illegible]

D

deleterious [illegible]
demonstrably [illegible]
designation [illegible]
deteriorate [illegible]
disrepair [illegible]
ditch [illegible]
diverge [illegible] (from), [illegible] (to)
domestication [illegible]
drain [illegible]
driveway [illegible]
dromedary [illegible]
dyke [illegible]

E

easement rights [illegible]
emulsion [illegible]
equestrian [illegible]
even [illegible]

F

facilitate [illegible]
fatigue [illegible]
ferry [illegible]
flank [illegible]
flea market [illegible]
flyover [illegible]
flyover crossing [illegible]
foam [illegible]
footpath [illegible]
fossa [illegible]
franchise [illegible]
freeway [illegible]
frontage [illegible]

G

gauge [illegible]
garrison [illegible]
genteel [illegible]
gig [illegible]
gilded [illegible]
gorge [illegible]
grade separation [illegible]
gradient [illegible]
graze [illegible]
grid [illegible]
grout [illegible]
guardrail [illegible]
gully [illegible]
gutter [illegible]

gyratory ɘtɕʘʱ ʘsʝdʑ dʑ̷ ʡ

H

hairpin ʰ ʧʠdʑ ʢʘ (lʑ ʟ ʢʠʡ ʧtsɘtstɕtsls ʜtstɕtsɢʠ dʑ̷ʘ 180 ɢtɕʘʜlʑfɲtsɘ)
heel ʢʘʙdʑʑʢ
herringbone ʝdʑtsɰdʑ̷ ʡ, ʰ ʝɘtɕtsdʑ̷dʑ̷ ʡ
heyday ʟʝdʑ̷ʃls, tɕʘfɲɰɘʝls, dʑʑɰʱ ʘʷ ʧtstɕʘ
honeycomb ʧtstɕʠfɲsʘʷ (ʷɰʝʠfɲsʘʷ) fɲstɕdʑʢlsʑtɕʘ; ʧtstɕʠfɲsʳ ʡ, ʷɰʝʠfɲsʳ ʡ
hydroplaning ɢdʑʠfɲfɲʠtɕtsɘʘdʑ̷ʃʝ, ɢdʑʠfɲfɲʠtɕtsɘʘdʑ̷ʃʝ ʢtsdʑʝfɲ

I

impetus ʜɘʠʞlʑʱ ʘʷ fɲʃdʑʘ; fɲsʠdʒʑdʑ; ʠdʒʧlʑdʑ fɲ lststsdʑɰtsʢ (to - ʢ ʢʘʢtsdʒʑ-dʑ ʜʝʡfɲs-ɘʠᴯ)
Indus tɕʝʢʘ ʀdʑ̷
interchange (lstɕʘdʑ̷ʧtstɕsdʑ̷sʝ) ʧʝtɕʝfɲʝɰʝdʑ̷ʃʝ
interchange point (ʜtstɕtsʞdʑ̷ʘʷ) tɕʘʟɘʷʟʢʘ
intermittent ʧʝtɕʝdʒʝʞʘʳ ʰ ʠʡfɲʷ; fɲʢʘɰʢtststsʙtɕʘʟdʑ̷ ʡ; ʧtɕʝtɕʳ ɘʠfɲsʳ ʡ
itinerary ʢlʑtɕfɲ dʒʘtɕʱ tɕdʑls, ʧlʑsʳ, fɲʢʝdʒʘ
intrinsic ʧtɕʠfɲlʑʱ ʠʡ, fɲtsʡfɲsɘʝdʑ̷dʑ̷ ʡ, ɘʘʞdʑ̷ ʡ, ʟdʑ̷ʘɰʠlsʝdʑ dʑ̷ ʡ, fɲlʑʱ ʝfɲsɘʝdʑ̷dʑ̷ ʡ

J

jerky ɘʷdʑʝdʑ̷sʝ dʒʷfɲts
junk ʢʘʙʝdʑ, ʢʘdʑ̷ʘls
junction ʧʝtɕʝfɲʝɰʝdʑ̷ʃʝ ʜtstɕtsɢ; ʧʝtɕʝʢtɕʝfɲststsʢ

L

lane lstɕʘfɲfɲʘʜdʑʷ ʜɘʠʞʝdʑ̷ʃʷ lstɕʘdʑ̷ʧtstɕsdʑ̷ ʡ fɲtɕʝʜfɲsɘ
largesse ʰ ʝʜtɕʳ ʡ ʜʘtɕ, ɘtsʟdʑ̷ʘɢtɕʘʞʜʝdʑ̷ʃʝ
lima bean dʑʃdʒʘ, dʑʃdʒfɲʢʘʷ ʬ ʘfɲtsdʑ
lime ʠʟɘʝfɲsʳ
livestock ʢtɕdʑʧdʑ̷ ʡ tɕtsɢʘlsʳ ʡ fɲʢtsls
log ʙtɕʝɘdʑ̷s; ʢtsdʑtsʜʘ
lure fɲtsʙdʑ̷ʘʟdʑ̷ ʧtɕʃɘdʑʝʢʘlsʝdʑ dʑ̷sfɲsʳ, ʧtɕʃlsʷɢʘlsʝdʑ dʑ̷sfɲsʳ, fɲtsʙdʑ̷ʘʟdʑ̷ʃlsʝdʑ dʑ̷sfɲsʳ

M

macadam ʰ ʝʙʝdʑ̷, ʰ ʝʙʝdʑ̷sɰdʑ̷ʘʷ ʜtstɕtsɢʘ
macadamize dʒtsfɲsʠlsʳ ʰ ʝʙdʑʝdʒ
mandatory tsʙʷʟʘlsʝdʑ dʑ̷ ʡ, ʧtɕʃdʑʜʠlsʝdʑ dʑ̷ ʡ
maritime dʒtstɕfɲʢtsʡ

marsh ʙʦʣʦlsʦ, lsʦʧʲ
mattock ʤʦlsʳ ɢʘ; ʢʠʨʢʦʤʦlsʳ ɢʘ
median ʟʘʣʥʃʤʘˠ ʱ ʠʡ fɱʨʝʜʠʃʣʥʦʝ ʧʦʣʦʞʝʥʃʝ, ɻʝʣʦʨʘʣ ʥʘʷ ʧʦʣʦfɱʘ ʘɘlsʦ-fɱlsʨʘʜʳ
median strip ɘfɱlsʨʝɻʥʘʷ ʧʦʣʦfɱʘ
mitigation fɱʤʷɢʉʝʥʃʝ, lzʤʝʥʱ ʝʥʃʝ (ɘʠʃʥ , ʥʘʢʘʟʘʣʥʃʷ); ʦʙʥʝɢʉʝʥʃʝ (ʙʦʣʠʃ, fɱlsʨʘʜʘʣʥʃʷ)
mortar ʠʟɘʝfɱlsʢʦɘʳ ʡ ʨʘfɱlsɘʦʨ; fɱlsʨʦʠlsʝʣ ʥ ʡ ʨʘfɱlsɘʦʨ, fɱʢʨʝʧʣʷlsˀ ʠʟɘʝfɱlsʢʦ-ɘʳ ʤʨʘfɱlsɘʦʨʦʤ
motorway ʘɘlsʦfɱlsʨʘʜʘ, ʘɘlsʦʤʘɢʃfɱlsʨʘʣ
movable bridge ʨʘʟɘʦʜʥʡ ʤʦfɱls

N

navel ʧlzʧ, ʧlzʧʦʢ, ɻʝʣʦʨ, fɱʝʨʝʜʠʃʥʘ (ɻʝʦ-ʣ)
nomad ʢʦɻʝɘʥʃʢ
Norse ʥʦʨɘʝʞfɱʢʠʡ ʷʟʳ ʢ, fɱʢʘʥʠʃʥʘɘʳ ; ʥʦʨɘʝʞɻ
notch ʤʝlsʢʘ, ʧʦʢʘʟʘlsʝʣ ɻʝʦ-ʣ, ɘʳ ʝʤʢʘ, ʟʘʦʣʙʢʘ; ʧʨʝʜʝʣ, lzʦʦɘʝʥ, ɢʨʘ-ʥʃɥʘ

O

oak ʜlzʙ
occupancy ʟʘʧʦʣʝʥʃʝ; ʨʘʟʤʝʱ ʝʥʃʝ; ʟʘʥʷlsʦfɱlsˀ ; ɘʤʝfɱlsʃʤʦfɱlsˀ
odd ʥʝɻʝlsʥ ʡ, ʣʠʱ ʥʃʡ
off-ramp ʥʘʢʣʥʥ ʡ fɱ ʝʟʜ fɱʘɘlsʦʤʘɢʃfɱlsʨʘʣʠʃ
offshoot ʦlsɘʝlsɘʥʝʥʃʝ, ʦlsɘʦʜʦʢ, ʙʦʢʦɘʦʡ ʦlsʦʦfɱlsʦʢ
on-ramp ʥʘʢʣʥʥ ʡ ɘʲ ʝʟʜ ʥʘ ʘɘlsʦʤʘɢʃfɱlsʨʘʣ
overpass ˡ fɱlsʘʢʘʜʘ; ʧʝʨʝʝʟʜ; ʧʝʨʝɘʦʜ, ʧlzlsʝʧʦʦɘʦʜ

P

pace ʱ ʘɢ; ʜʣʠʃʥʘʱ ʘɢʘ
parcel lzɥʘfɱlsʦʢ ʟʝʤʣʠʃ
parish ʧʨʠʘɘʦʜ (lsʝʨʦʠlsʦʨʠʷ, ʥʘɘʦʜʷʱ ʘʷfɱʷ ɘ ɘʝʜʝʣʥʃʠ ʦʜʥʦɢʦ fɱɸʷʱ ʝʥʥʃʢʘ)
pastoral ʧʘfɱlsʱ ʝfɱʢʠʡ, ʦlsʥʦfɱʷʱ ʠʡfɱʷ ʢ ʧʘfɱlsʘɘʤ
pavement ***ʙʨʠʃls***. lsʨʦlsʨʘʨ, ***ʘʤʝʨ*** ʤʦfɱlsɘʘʷ, ʜʦʨʦʞʥʦʝ ʧʦʢʨʡ lsʠʃʝ, ʤʘlsʝ-ʨʠʃʘʣʜʣʷ ʤʦʱ ʝʥʃʷ
paver ʢʘʤʝʥʥ, ʢʠʨʧʠɥ ʙʨʣfɱɥʘlsʢʘ, ɢʨʘɘʠʡ (ʤʘlsʝʨʠʃʘʣ ʜʣʷ ʤʦʱ ʝʥʃʷ); ʜʦ-ʨʦʞʥ ʡ ʙʝlsʦʥʦʢʣʘʜɥʠʢ
peat lsʦʨʷ
pier ʜʘʤʙʘ, ʧʣʦlsʠʥʘ; ʧʠʨfɱ ʧʨʠɥʘʣ, ʧʦʜʜʝʨʞʠɘʘˠ ʱ ʘʷ, ʦʧʦʨʥʘʷ ʢʦʣʦfɱlsʣʢ-ɻɥʷ, ʠʥʘɢʜʘ fɱʘʣʞʠls ʜʣʷ ʜʝʥʝʥʃʷ ʥʘ fɱʝʢɥʠʠ, ʦlsfɱʝʢʠ
piling ʟʘʙʠɘʢʘ fɱɸʘʡ, fɱɸʘʡ ʥʝ fɱlsʦlsʣʞʝʥʃʝ

plait ʢtsfŋʘ (ɘtsdztsfŋ); tʃdʑ lsʝ dʑʃʝ, fŋʢdʑʘʜʢʘ, ʟʘtʃdʑ lsʘls, tʃdʑ fŋlsɖ, tʃdʑfŋfŋtɕtsɘʘls
plaited rope tʃdʑ lsʝ dʑ ʔ ʢʘdʑʘs
plough tʃdʑʑɕ; tʃtɕɖʙtstɕ ɖ dʒʝʘdʑʟdʒ, ɖfŋtʃtsdʑʟʑ ɦ ɖʝ tʃtɕɖʑɥɖtʃ ʜʝʔfŋlsɘɖʷ tʃdʑʑɕʘ; dʑʘtʃtsdʒɖdʑʘ ɦ ɖʝ ʝɕts tʃts tstɕdʒʝ
plunge tʃtɕ ʞtsʢ, dʑ tɕʷdʑʃʝ, tʃtsɕtɕdʑʞ ʝdʑʃʝ (ɘ ɘtsʜʑ ɖdʑɖ ʜtɕdʑdʑ fŋtɕʝʜʑ)
ply fŋɕɖʙ, fŋʢdʑʘʜʢʘ, fŋdʑtsʔ, tʃtɕʷʜ (lstɕtsfŋʘ), tsʙtstɕtsls, tʃʝlsdʑʷ, ɘɖlstsʢ (ɘʝtɕʝɘʢɖ ɖ ls. tʃ.)
Portland cement tʃtstɕlsdʑʘdʑ-ɥʝdʒʝdʑs
prerequisite dʑtsʙtsʜɖdʒ ʔ ʢʘʢ ʑfŋdʑtsɘɖʝ
pylon tstʃtstɕʘ, tʃɖdʑtsdʑ fŋlstsdʑʙ, fŋlstsʔʢʘ

Q

quarry ʢʘdʒʝdʑsdʑtsdʒdʑ, tslsʢtɕ lsʘʷ tɕʘʟtɕʘʙtslsʢʘ, ʢʘtɕ ʝtɕ
quicklime dʑɕʘ ʝdʑʘʷ ɖʟɘʝfŋls
Quipu (*noun*) *A contrivance employed by the ancient Peruvians, Mexicans, etc., as a substitute for writing and figures, consisting of a main cord, from which hung at certain distances smaller cords of various colors, each having a special meaning, as silver, gold, corn, soldiers. etc. Single, double, and triple knots were tied in the smaller cords, representing definite numbers. It was chiefly used for arithmetical purposes, and to register important facts and events.*

R

radius radii tɕʘʜɖʑfŋ
ramp dʑʘʢdʑtsdʑdʑʘʷ ʜtstɕtsɕʘ (tsfŋtsʙ. ɘ ʝʟʜ dʑʘ fŋlsʘʢʘʜʑ ɖdʑɖ fŋ ʝʟʜ fŋ fŋlsʘʢʘʜ), tʃʘdʑʑfŋ
rebar ʘtɕdʒʘlsʑtɕdʑʘʷ fŋlsʘdʑ; ʘtɕdʒʘlsʑtɕdʑ ʔ tʃtɕdʑlstsʢ; ʘtɕdʒʘlsʑtɕdʑ ʔ tʃtɕts ɖdʑ (ʜdʑʷ ʞʝdʑʟtsʙʝlstsdʑʘ)
reinforce ʑfŋɖdʑɘʘls; ʘtɕdʒɖtɕtsɘʘls
rejuvenate ɘtsfŋfŋlsʘdʑʘdʑɘʘls, tɕʝdʒtsdʑsɖtɕtsɘʘls, tɕʝʢtsdʑfŋlstɕdʑɖtɕtsɘʘls
relay tʃtsdʑʑɥʘls ʟʘdʒʝdʑ, fŋdʒʝdʑls (dʑtsɦ ʘʜʝʔ), tʃʝtɕʝʜʘɘʘls, lstɕʘdʑfŋdʑɖtɕtsɘʘls
relegate dʑʘtʃtɕʘɘdʑʷls, tslsfŋ dʑʘls (to - ʢʑʜʘ-dʑ); tʃʝtɕʝɘtsʜɖls ɘ dʑʟɦ ɖʔ tɕʘʟ-tɕʷʜ, ʢdʑʘfŋfŋ dʑʟɘtsʜɖls
reservation tɕʝʟʝtɕɘɖtɕtsɘʘdʑʝ, ʙtɕtsdʑtɕtsɘʘdʑʝ; ɖʢfŋɖtɕtsɘʘdʑdʑsʝ tɕʘfŋtʃtɕʝʜʝdʑ-dʑʝ, ʙtɕtsdʑ
retrofit dʒtsʜɖ ɖɥɖtɕtsɘʘls, dʑʘfŋlstɕʘɖɘʘls, tʃtsʜɕtsdʑls, tɕʝʢtsdʑfŋlstɕdʑɖtɕtsɘʘls
retroreflector tɕʝlstɕtstɕʝ dʑʝʢlststɕ, fŋɸʝlstsɘtsʟɘtɕʘɦ ʘ ɦ ɖʔ tslstɕʘʞʘlsʝdʑ
reversible lane tʃtsdʑtsfŋʘʜtstɕtsɕɖ fŋtɕʝɘʝtɕfŋɘdʑ dʒʜɘɖʞʝdʑʝdʒ
ridge ɕtɕʝʙʝdʑ ɕtstɕ, ɕtstɕdʑ ʔ tɕʝʙʝls, ɕtstɕdʑʘʷ ɥʝtʃ
rig ʑfŋlstɕtsʔfŋlsɘts; ʑfŋlsʘdʑsɘʢʘ, lsʷɕʘɥ (ʘɘlstsdʒtsʙɖdʑ ɖdʑɖ lstɕʘʢlststɕ); tʃtsʞʘtɕdʑ ʔ ʘɘ-lstsdʒtsʙɖdʑ

right-of-way [illegible]
rill [illegible]
ring road [illegible]
roadbed [illegible]
rod [illegible] 5 c [illegible]
roller [illegible]
roundabout [illegible]
tresspass [illegible]
rubble [illegible]
rumble strip [illegible]
rut [illegible]

S

sag [illegible]
sedentary [illegible]
segregation [illegible]
shock [illegible]
shoulder [illegible]
shunpiking [illegible]
sidewalk [illegible]
skid-resistance [illegible]
slab [illegible]
slick [illegible]
slip road [illegible]
slope [illegible]
slurry [illegible]
spade [illegible]
spring [illegible]
stagnant [illegible]
statutory instrument [illegible]
steep grade [illegible]
steer [illegible]
strand [illegible]
subgrade [illegible]
suffice [illegible] (for)

suspension ʧtsнɘȷfɲ ʧtsнɘȷfɲʢʘ, ʧtsнɘȷʰ ȷdʑʥsȷ fɲsfɲstsʷdʑʃȷ; ɘʟɘȷfɲ
swath ʧtsdʑsfɲʘ fɲʢtsʰ ȷdʑʥsʔ lstɕʘɘʳ , ʧtɕtsʢtsfɲ tɕʷн
sway ʢʘɥʘlsˡ (fɲʷ), ʢtsdʑȷʙʘlsˡ (fɲʷ)

T

tailgate ʟʘнdʑʃʔ ʙtstɕls (ʘɘlstsdʒtsʙɕʃdʑʷ), fɲstsdʑdʑsɘȷdʑʃȷ ʘɘlstsdʒtsʙɕʃdʑȷʔ, нɘɕʃʞlʑ-ʰ ɕʃfɲʷ нtɕdʑɢʟʘнtɕdʑɢtsdʒ
tamp ʟʘʧtsdʑdʑʷlsˡ , dʑʘʙɕʃɘʘlsˡ , lstɕʘdʒʙtsɘʘlsˡ ; lʑʧdʑtslsdʑʷlsˡ
tar fɲdʒtsdʑʘ; нȷɢtslsˡ ; ɢdʑнtɕtsdʑ
tarmac нȷdsȷʙȷlstsdʑlsȷtɕdʒʘʢʘнʘdʒ
tensile tɕʘfɲlsʷʞɕʃdʒ ʔ; ˡ dʑʘfɲlsɕʃɥdʑ ʔ
thoroughfare ɢdʑʘɘdʑʘʷ ʘtɕlsȷtɕɕʃʷ (ɢtstɕtsнʘ), ɢdʑʘɘdʑʘʷ нtstɕtsɢʘ
toll ʧtsʰ dʑɕʃdʑʘ, fɲʙtstɕ, ʧdʑʘlsʘ
trackway lstɕtsʧɕʃdʑʘ, нtstɕtsɢʘ fɲʢtsdʑȷȷʔ
trail lstɕtsʧʘ, lstɕtsʧɕʃdʑʘ
transit ʧȷtɕȷɘtsʟʢʘ, нtsfɲlsʘɘʢʘ, lstɕʘdʑɕʃls, lstɕʘdʑɕʃlsdʑ ʔ; (dʒʘtɕʰ tɕdʑlsdʑ ʔ) lsȷtsнtsdʑɕʃls
transverse profile ʧtsʧȷtɕȷɥdʑsȷ fɲȷɥȷdʑʃȷ
traverse ʧȷtɕȷfɲȷʢʘlsˡ , ʧtɕtsʢtsнɕʃlsˡ , fɲʧlʑfɲʢʘlsˡ fɲʷ ɕʃdʑɕʃ ʧtsнdʑʃdʒʘlsˡ fɲʷ ʟɕʃɢʟʘɢtstsʙ-tɕʘʟdʑs
treacherous dʑȷdʑʘнȷʞdʑ ʔ; dʑȷʧtɕtsɥdʑ ʔ
tread ʢtsdʑȷʷ, ʰ ɕʃtɕɕʃdʑʘ ʢtsdʑȷɕʃ; ʙȷɢtsɘʘʷ нtstɕtsʞʢʘ, ʙȷɢtsɘtsʔ fɲdʑtsʔ
trekking ʧlʑlsȷʰ ȷfɲlsɘtsɘʘlsˡ (нdʑɕʃlsȷdʑ dʑs, fɲlstɕdʑнdʑsfɲlsʷdʒɕʃ) нȷdʑʘlsˡ ʙtsdʑʰ tsʔ ʧȷ-tɕȷtsн, ʧȷtɕȷfɲȷʢʘlsˡ (ʧlʑfɲlsˡ dʑ)
trespass ʧtsfɲʷɢʘlsȷdʑ fɲlsɘts (dʑʘ dʑɕʃɥts, ʟʘʢtsdʑ ʧtɕʘɘʘ); dʑʘtɕdʑʰ ȷdʑʃȷ (ʧtɕʘɘʘ)
trumpet lstɕdʑʙʘ, lstɕdʑʙʢʘ
tyre ʢtsdʑȷfɲdʑ ʔ ʙʘdʑʘʞ (dʒȷlsʘdʑdʑɕʃɥȷfɲʢɕʃʔ tsʙtsн, dʑʘнȷɘʘȷdʒ ʔ dʑʘ ʢtsdʑȷfɲʘ (нȷ-tɕȷɘʷdʑdʑ ȷ, ʞȷdʑȷʟdʑsнtstɕtsʞdʑ ȷ ɕʃ lsн.)), ʰ ɕʃdʑʘ; ʧtsʢtɕ ʰ ʢʘ

U

underpass ʧtɕtsȷʟн ʧtsн ʧtsdʑslsdʑsdʒ ʞȷdʑȷʟdʑsʔ нtstɕtsɢʃ, ʧtsнʟȷdʒdʑ ʔ tsн; lstsdʑ dʑȷdʑ ;

V

verge ʢtɕʘʔ, ɢtɕʘdʑ, tsʙtsɥɕʃdʑʘнtstɕtsɢʃ
vessel ʢtstɕʘʙdʑ , fɲdʑнdʑs, fɲsfɲdʑн (нdʑʷ ʞɕʃнʢtsfɲlsɕʃ)
viaduct ɘɕʃʘнlʑʢ; ʧlʑlsȷʧtɕtsɘtsн
villa ɘɕʃdʑdʑʘ, ʟʘɢtstɕtsнdʑ ʔ нtsdʒ tsfɲlsʙdʑʷʢ (ɘ ɢtstɕtsнȷ ɕʃdʑɕʃ ʧtɕɕʃɢtstɕtsнȷ), ***нtɕ-tɕɕʃdʒ*** lʑfɲʘнˡ ʙʘ
viscous ɘʷʟʢɕʃʔ, dʑɕʃʧʢɕʃʔ, ʢdʑȷʔʢɕʃʔ; ɢdʑfɲlstsʔ, lsʷɢdʑɥɕʃʔ
void ʧlʑfɲlstslsʘ; ʧtsdʑsfɲlsˡ ; ʧtstɕʘ; ʢʘtɕdʒʘdʑ (ɘ ʧtstɕtsнȷ); 3) dʒȷʞнtslʑʟdʑɕʃȷ (ɘ ʢtɕɕʃ-fɲlsʘdʑdʑɕʃɥȷfɲʢtsʔ tɕȷʰ ȷlsʢȷ)

W

wayfarer ʧɮsʥʄʢ, fɲstɕʘʥʥʄʢ
wheelchair ʢtɕʝ fɲʥs-ʢtsʥʷ fɲʢʘ
weigh anchor fɲʥʄʤʘsˈ fɲʷ fɲʷʢtstɕʷ
wetland ʟʘʙtsʥsɰʝ ʥʥʘʷ lʂʝ tɕtɕʠlststɕʠʷ
wheelright ʢtsʥʝ fɲʥʄʢ
woven ʧʥʝ lʂʝ ʥ ʡ, fɲslʂʢʘʥʥ ʡ, lʂʢʘʥʝ ɵʳ ʡ, lʂʢʘʥʥ ʡ

Y

yield ɮfɲstɮʧʘsˈ, ʧtɕstʧɮfɲʢʘsˈ ɵʧʝ tɕʝ ʜ

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ROADS

СБОРНИК ТЕКСТОВ ПО ЧТЕНИЮ НА АНГЛИЙСКОМ ЯЗЫКЕ

ДЛЯ СТУДЕНТОВ СПЕЦИАЛЬНОСТИ

70 03 01 «Автомобильные дороги»