# THE ROMANS AND THEIR ROADS THE ORIGINAL SMALL ELEMENT PAVEMENT TECHNOLOGISTS

J. Knapton University of New Castle Newcastle upon Tyne, UK

## 1 Introduction

French lawyer Bergier published the first work on Roman roads in 1622<sup>10</sup> having discovered the remains of Roman roads near Rheims. He was so taken with his finds that he began to investigate classical literature and monuments. Bergier's work influenced 17th and 18th century French roadbuilding which in turn influenced British roadbuilders Metcalf, MacAdam and Telford who adopted a scientific approach in developing road construction techniques in the 19th century which are essentially unchanged today. For this reason, an understanding of Roman road engineering is crucial in understanding how present day UK road construction technology evolved. The introduction of flexibly bedded pavers as a road surfacing material during the second half of the 20th century coupled with the rediscovery of Roman roadbuilding during the 17th, 18th and 19th centuries has brought us to a point where it is more important than ever to look back at how, where, why and by whom Romans roads were built.

## 2 The Peoples of Italy

Roman roads comprised a crucial part of the development of Roman civilisation and it may be no exaggeration to state that the Roman Empire comprised a network of roads unifying many disparate cultures from Newcastle to North Africa, from Portugal to Arabia. Indeed, one theory has it that the location of Rome is at the cross-roads of two pre Roman roads - the Via Salaria ('The Salt Way') and the Via Latina<sup>3</sup>. The Via Salaria followed the course of the Tiber into the central Italian mountains and was originally built in pre-Roman times to transport rock salt quarried in the mountains to the centres of population near the coast. Salt was a valuable commodity in Roman times and soldiers would often be paid in salt at the end of each month when the spoils of war were insufficient to provide cash - hence the word salary.

Before dealing with the development of Roman road building, it is important to understand how the Romans developed the most successful empire in the history of civilisation. Prior to the growth of Rome as a world power, Italy comprised a diverse collection of peoples - the most distinctive group of which was a collection of Greek colonies in the south between Cumae and Tarentum<sup>5</sup>. These colonies comprised independent cities established from the 8th century BC onwards. From the 5th century onwards, they were frequently attacked by peoples from the Italian mountainous interior who spoke Italic rather than Greek language. To the north, Latins on the coast and Sabines in the interior also spoke Italic language and played a crucial part in the formation of the Roman State, together with Etruscans to the north of Rome. The Etruscans dominated much of Italy during the period 800-350 BC and their roads became the model for the development of Roman roads<sup>9</sup>. In fact, when we refer to Roman roads, we should credit the Etruscans with their invention; they seem to be the first to join distant locations with a long floor, before that, roads were merely well trodden paths. The Etruscan roads were cut deeply into the rocky soil to a depth of 2.5m and a width of 3m. They were paved and may have included artificial ruts to guide carts with shunts for overtaking and parking. Etruscan town streets were 15m wide and included stepping stones to prevent pedestrians from walking on the wet street surface<sup>9</sup>.

During the 6th century BC, villages on the hills surrounding the Forum became merged to form the city of Rome, as a result of the migration of Etruscan and Sabine peoples to that productive area. Trade and prosperity developed and the city became wealthy and was rivalled only by the Etruscan city of Veii; all the other communities comprising small agricultural villages.

## <u>3 The Formation of Rome</u>

According to tradition, Rome was founded in 753 BC, but its origins are disputed by Roman historians<sup>2</sup>. There are no contemporaneous documents describing Rome's founding and it can sometimes be difficult to distinguish between legend, myth and fact. In the 5th century BC, Greek historians wrote that Rome was founded by the Trojan hero Aeneas. He was a mythological figure, the son of Venus by Anchises, who fled to Italy after the sack of Troy in the 12th century BC.

Another mythological explanation for the formation of Rome was that the twins Romulus and Remus were abandoned as children on the banks of the River Tiber. They were looked after by a wolf and then rescued by a shepherd who brought them up on the left bank of the river. It was there, on the Palatine Hill, that Romulus later founded the city of Rome, having killed his brother Remus in a quarrel. As there were insufficient women in Rome, Romulus arranged for women to be abducted from the nearby Sabine tribe (an incident often referred to as `the rape of the Sabine women')<sup>2</sup>. He also chose one hundred `fathers' (*patres*) to advise him, a group which developed into the first Senate or ruling council. The descendants of these men were known as patricians and represented the leading families of Rome. Gradually, the legends gained credibility and Romulus came to be regarded as a direct descendant of Aeneas.

Historically, the formation of Rome could be considered to have occurred when the Forum was no longer used for burials but instead became the city square for the collection of hill villages which had expanded and become one city.

During the pre-republic era, the monarchy was supported by the powerful Patricians whose great wealth permitted them to dominate the remainder of the community. Other families who were not favoured by royalty were the plebeians and a well organised plebeian movement developed in parallel to the patrician movement. This plebeian movement became important in that it broke down barriers to any Roman citizen achieving high office. A particular and unusual aspect of the plebeian system was that a Roman citizen could declare slaves free; the slaves then became Roman citizens themselves<sup>2</sup>. The development of Roman power was greatly accelerated by the egalitarian system developed by the plebeians.

At the end of the 6th century BC, Rome ceased to be ruled by kings and instead was ruled by two consuls, each holding office for one year. The new Republic was dominated by plebeian organisations who appointed officials of whom the most important were the tribunes of the plebs. At this time, the Romans were very active in developing new officers with specific functions. For example, the Censors had the task of listing members of the citizen body every five years, principally as a means of developing taxation systems and of ensuring that sufficient prayers were said to the Roman Gods. Also, the census was the process by which men were assigned their roles as soldiers, tax payers and voters. The importance of the census can be gauged by the fact that Mary and Joseph had to return to Bethlehem at the most inconvenient of times.

The complex Roman administrative structure of the early republic was paralleled by a complex priesthood system<sup>5</sup>. There were two major colleges, the Pontifices with the Pontifex Maximus at their head with the Vestal Virgins under his general control and also the Augurs whose job it was to ascertain the will of the Gods by, for example, observing the flight of birds. Priests were usually part-timers who held full-time secular jobs, often on short term contracts - the priesthood was for life. At this time, it was difficult to separate completely the world of the Gods from the world of politics. New Gods were regularly imported from Etruria and from overseas. The more Gods who were worshipped, the more the Romans felt able to conquer others and it was an obligation of Roman citizens to pray to many Gods<sup>5</sup>.

The 5th century BC, as well as being the time in which the administration and the priesthood developed, was also an important time in the development of the law. Previously,

legal matters had been resolved according to the whim of the patricians but the Twelve Tables were formulated in 450 BC as original Roman Law.

The erosion of the privileges of the patricians was accompanied by the development of wealth by the low orders of society. Much of this wealth was gained as the spoils of victory during the wars which Rome waged against other Italian communities and against foreign powers. An important event occurred in 338 BC when several communities near Rome, seeing the growing prosperity of Rome, attempted to attack the city. They were all defeated but rather than inflict punishment on the attackers, the Roman bureaucracy instead sought to found new communities which would pay taxes and provide soldiers to Rome. This apparently magnanimous gesture was the model by which Rome was later able to conquer the known world. The Romans established coloniae; the first of which was Cales, founded in 338 BC. Coloniae not only provided wealth to Rome but defended themselves on Rome's behalf against other aggressors. The Roman Empire began to develop. A consequence of coloniae was the granting of Roman citizenship to millions of people. Effectively, entire Italian communities became Roman citizens without the vote. These new citizens were expected to pay taxes and to fight and it may be that their lack of voting power was as much a consequence of geography and language as politics.

#### <u>4 Expansion throughout Italy</u>

By supporting the privileged classes in other parts of Italy, Rome was able to export its own pattern of bureaucracy to other parts of Italy. Friendship and inter marriage became commonplace throughout Italy as more and more coloniae were formed. In particular, Rome developed power over the Volscians and the Etruscans whose men were made to serve in Rome's army and who were well rewarded using the booty acquired from areas conquered.

A feature of the colonising of Italy by Rome was the way in which land was partitioned to be worked by the people newly conquered. This system of land division became known as centuriatio and was begun in 334 BC. Land was divided into strips 10 actus wide (1 actus = 35.5 m). The lines of division were called Decumani and the rectangular plots were packaged into squares of size  $20 \times 20$  actus. Road systems were developed using the boundaries of these squares as their line and this system is still evident in the Po Valley today.

The final Italian conflict was completed in 295 BC when the Romans defeated the Sammites at Sentinum in Northern Italy. No sooner had peace been declared in Italy than the Greek mercenary commander, Pyrrhus King of Epirus in Greece, attacked the Romans to protect the Greek run city of Tarentum. Pyrrhus initially won a number of costly victories against the Romans (hence the phrase 'Pyrrhic Victory') but was eventually defeated at Beneventum and returned to Greece. During the war against Pyrrhus, the Romans struck silver coins as a way of indicating the position of Rome on the side of civilisation with the barbarians on the obverse<sup>5</sup>.

## 5 Expansion in the Mediterranean Basin

The first Punic war for the control of Sicily was won between 264 and 241 BC against Hirero of Syracuse. This led to both Sicily and Sardinia coming under the control of Rome. By this time Rome could rely upon 7 million soldiers contributing from the coloniae<sup>5</sup> and this massive potential army enabled Rome to resist Hannibal's invasion of Italy in 218 BC, although Hannibal inflicted several crushing defeats on Roman armies between 218 and 216 BC. Rome finally defeated Hannibal in 215 BC and thus recovered Sicily and annexed Spain. Eventually Carthage sued for peace and this led to Roman influence developing in North Africa. Also some Italian communities had allied themselves with Hannibal and Rome imposed economic sanctions such that the power of Rome in Italy became total as a result of Hannibal's defeat.

Rome turned its attention to overseas wars principally as a means of accommodating soldiers in the Italian coloniae who needed wars to generate wealth in their areas. These foreign wars led to a gradual professionalism of Roman soldiers. Prior to 200 BC Roman soldiers were essentially farmers fighting in their spare time, but after that full-time soldiers were often serving abroad.

From 200 BC onwards Rome became very wealthy as a result of payments made by conquered regions. Much of this wealth was used to construct major public works such as aqueducts and roads. Indeed, it is the possession of this wealth which led to the development of the engineering capability of the Roman road builders. Necessity for these roads initially developed for military reasons but soon they became essential components of the growing Roman economy, not just in Italy but in many Mediterranean regions. Indeed, the second century BC has been called `the golden age of Roman roadbuilding' and it is the period when the whole of Italy became interlinked with a network of `all weather' roads. In turn, the roads led to greater mobility and it became common for Romans and Italians to live overseas and become wealthy.

The full extent of the Roman Empire was achieved by 117 AD. During the first centuries BC and AD, Roman roadbuilding technology and wealth allowed the Roman Empire to expand away from the Mediterranean into what is now the whole of France, much of central Europe and England and Wales. The Roman Empire was at its zenith during the first and second centuries AD when much of the road building technology which is described in this paper developed.

#### 6 The End of the Roman Republic

In 133 BC Tiberius Gracchus, a tribune, introduced land reform law which permitted the resettling of dispossessed peasants on parcels of land. This led to riots in which he and many of his supporters were killed. His brother Gaius Gracchus was elected tribune in 123 BC and he introduced economic and legal reform and also lost the confidence of the population such that he and 3000 of his supporters were killed in 121 BC. This civil unrest led to the growth of power of the military generals and a collapse in the stability of Roman politics. Rome began to suffer military defeats, including in 105 BC a defeat by Germanic tribes advancing on Italy. The situation was so serious that the whole future of the Roman state was in jeopardy. The Germanic forces were finally defeated by consul Gaius Marius in 102 BC but resent continued throughout Italy at the high level of central control by Rome. Armed revolt broke out in 91 BC which grew into the two years Social War which led to Roman citizens having more say in political matters. Power was eventually transferred to Lucius Cornelius Sulla who was elected consul in 88 BC and who became the first Roman dictator in 81 BC, following his march on Rome to oppose the supporters of Marius.

From 60 BC the First Triumverate was formed when Pompey Crassus and Caesar formed a private alliance in order to fulfil their political ambitions. Pompey had been a powerful general, having achieved military success in Spain in the 70s. Crassus was an unscrupulous politician and Caesar was from a patrician family who claimed its roots back to Anaes. Following the death of Caesar's daughter in 56 BC and the death of Crassus in 53 BC, the First Triumverate became weak and ceased to exist with the murder of Pompey in 48 BC. Caesar continued for a further 4 years as dictator but was assassinated on the Ides of March (15 March) and this led to renewed civil war.

A Second Triumverate comprising Marcus Antonius, Marcus Lepidus and Caesar's great nephew Octavian took power in 43 BC initially for a period of five years. Lepidus served as consul whilst Antonius and Octavian engaged in foreign wars in the east. In 40 BC Lapidus took over Africa, Octavian took over the West and Antonius took over the East. The second Triumverate ceased in 31 BC after which Octavian went to war against Cleopatra in Egypt who had become involved with Antonius. Antonius and Cleopatra committed suicide in 30 BC whilst being pursued by Octavian. Octavian then claimed to have restored the Roman republic but in effect he was the new dictator. He undertook reforms which created stability which lasted for 300 years principally by giving land to many soldiers and detaching politics from the army.

#### 7 The Emperors

Octavian took the name Augustus in 19 BC and ruled to 14 AD as Emperor during which time he initiated vast programmes of building work including the network of roads stretching across the Roman empire. He claimed to have come to power in Rome, a city of bricks, but to have left it a city of marble.

Senate elected Tiberius, stepson of Augustus, and successor to Augustus, in 14 AD and thus instituted the succession by inheritance. The reign of Tiberius was stable in its early years but was noted for terrorism later, so much so that his death in 37 AD was greeted with pleasure. He was succeeded by his great nephew Caligula (Little Boots), who was unbalanced, believing himself to be a God. He was assassinated after 4 years as Emperor and was succeeded by Claudius in 41 AD. Claudius is best known for his invasion of Britain in 43 AD and is generally thought to have been weak willed until his death in 54 AD, having allegedly eaten poisoned mushrooms served to him by his wife Agrippina as a means of assisting her son, Nero, to become emperor. Nero's reign was characterised by tyranny and cruelty, punctuated by a British rebellion by Queen Boudicca who was eventually defeated and by a rebellion in Judaea, eventually put down by Titus. Nero was blamed for a great fire in Rome in 64 AD and tried to blame the Christians and increased his persecution of them. In 68 AD Nero committed suicide following an uprising against him engineered by Julius Vindex, Governor of Gaul.

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In 69 AD, a series of short-lived emperors took power followed by a ten year rule by Vespasian whose son Titus succeeded him in 79 AD, the same year in which the volcano Vesuvius destroyed Pompei. Titus reigned for two years and died of ill health following which is brother, Domitian, became emperor. He was murdered in 96 AD, probably by his wife and Nerva was chosen as emperor by Senate. Nerva appointed Trajan as his successor who took over as emperor in 98 AD for 19 years. Under Trajan, the Roman empire expanded to Hadrian's Wall in the North, to Africa in the South, to Portugal in the West and to Syria in the East.

Hadrian, from a town called Italica, north of Seville, had been chosen as Trajan's successor and assumed power in 117 AD. Hadrian travelled extensively around the empire and authorised the construction of Hadrian's Wall in 122 AD as a means of defending the northern outpost of the empire. Pius succeeded Hadrian in 138 AD and was himself succeeded by Aurelius, his adopted son, who reigned until 180 AD. Until then the Roman world had been prosperous and peaceful but the unpopularity of the new emperor Commodus. led to instability and he was assassinated in 193 AD. After a 3 month reign Pertinax was murdered by the Praetorian Guard and Senator Didius Julianus took over as emperor. He was soon replaced by Ceverus who marched on Rome with his army and captured the city. From 209 AD, Ceverus waged war against the Picts in Britain and was killed in York in 211 AD. He was succeeded by his son Caracalla who created all free men Roman citizens in 212 AD as a means of increasing taxation. In 217 AD Caracalla was murdered by his Praetorian prefect, Macrins, who took over as emperor but who only lasted for one year. Several other emperors followed in quick succession but by 213 AD anarchy had developed which lasted for 50 years. The Praetorian guard appointed Diocletian as emperor in 284 AD so re-establishing administration and government. He established a tetrarch (a four man ruling council) which lasted until 305 AD during which time inflation led to the worsening economic situation.

In 313 AD Licinius issued a declaration of freedom of worship (the Edict of Milan) which effectively marked the conversion of the Roman empire to Christianity and Constantine becoming the first Christian Roman emperor. The city of Byzanteum submitted to Constantine who then renamed it Constantinople and created it as his new capital (now Istanbul). He changed his name to Augustus and reigned until his death in 337 AD. Effectively the Roman empire had come to an end and it became replaced by a Greek speaking Christian empire and Rome was eclipsed, leaving a network of roads which became the routes for many of Europe's present network of highways. Only in Britain did many of the roads fall into disrepair and it is for this reason that the British Roman roads are now some of the most valuable archaeological sites in the Roman world.

Much of the information in the next section has been gathered from the roads which had been initially built for military reasons but which then found commercial value in the British northern outpost of the Roman empire.

## 8 Roman Road Users

The Romans built over 53,000 miles of main roads<sup>6</sup> from Newcastle in the north west to Damascus in the south east. The way in which roads were built varied according to the level of anticipated traffic, the nature of locally available materials, climate, topography and, particularly in the case of Britain, the disposition of the local people towards the Romans. British Roman roads were unique in being constructed on an embankment or agger, principally as a means of allowing the Roman users greater visibility and in the case of attack, to give them the advantage of height. Lowland British Roman roads were usually built through wooded countryside and a significant clearing was formed each side of the road, again for reasons of security.

Materials from which the roads were surfaced also varied with location and time. For example, stone surfaced roads came later in the development of the Roman empire and most of the long distance roads were surfaced with gravel; only in towns where the level of usage was greater was it common for roads to have stone surfaces. We know that the streets in Jerusalem were paved from the following extract from John's Gospel, Chapter 19<sup>vv13-16</sup>:

"Pilate brought Jesus out and sat down on the judge's seat at a place known as the Stone Pavement. It was the day of Preparation of Passover week, about the sixth hour. 'Here is your king,' Pilate said to the Jews. But they shouted, 'Take him away! Take him away! Crucify him!' 'Shall I crucify your king?' Pilate asked. 'We have no king but Caesar,' the chief priests answered. Finally Pilate handed him over to them to be crucified"

(The influence of the Roman roads in spreading Christianity cannot be overstated: the dominance of Christianity throughout Western Europe, and from there to much of the rest of the world, sprang from Rome following Paul's imprisonment there and the subsequent conversion of the Emperor Constantine)

The Appian Way, now frequently portrayed as a principal example of a Roman road, was in fact unpaved until the second century AD and it is unlikely that any long distance roads were paved before that time. It is interesting to note that those roads which were paved sometimes used rectangular stone and sometimes used close fitting polygonal stone<sup>3</sup>, often eight sided and it is possible that the present debate regarding relative structural advantage of rectangular and non rectangular pavers may well be a continuation of the Roman debate. Africa seems to have a predominance of polygonal surfacing stones and Italy frequently had rectangular ones.

It is clear from the level of wear on well preserved examples that Roman roads were trafficked by a large number of wheeled vehicles in addition to pedestrians. Most of the roads were built for military purposes but the Roman policy of ensuring that their colonies developed their own prosperity led to the roads being used for civil purposes for most of their history. The roads were trafficked by a mixture of business travellers, people travelling to fairs, migrant workers, teachers, pilgrims and the sick travelling to drink Holy waters<sup>11</sup>. The roads varied in width according to their importance and this would suggest a steady flow of traffic requiring more than single line travelling and from this it can be concluded that at busy times at least, there would be a steady stream of travellers in each direction, although except when passing, both pedestrians and vehicles would occupy the centre of the road. Surviving

pictures of carts indicate that the driver occupied the centre of the vehicle which suggests that he drove in the centre of the road. Also, where ruts are evident, they are usually down the centre of the road. Occasionally, ruts were carved deliberately in the road at the time of construction in order to guide the vehicles. For example where the road ran alongside the edge of steep cliffs. It is interesting to conjecture that in the absence of drink driving legislation, it had originally been common for accidents to occur in mountainous areas.

As is the case today, Roman roads developed an economy of their own. A network of both public sector and private sector wayside resting houses developed. The public sector resting houses generally served military and official travellers whilst the private sector ministered to the needs of the general public. Blacksmiths, Horse Renters and Traders also derived a living from the travellers on the road<sup>11</sup>.

Pliney the elder, voiced the feelings of many when he said:

"Which way was vice introduced if it was not by the public road? Which other way indeed could ivory, gold and precious stones have passed into private use?"

Clearly the road was very much a reflection of the society which it served and it may be no exaggeration to state that the Roman empire was a network of roads linking together many disparate peoples and cultures. It is also considered that the expansion of Christianity was dependent upon the network of Roman roads which had reached Jerusalem by the time of the birth of Christ.

The level of industry associated with the Roman roads can be gauged by considering the rich variety of vehicles which were available. Horses, mules and donkeys were used as pack animals and to pull carts. Many of the carts used by the Romans were introduced when they conquered Gaul (France) and the following varieties were in common use<sup>11</sup>:

| benna     | -                      | a light cart constructed to carry several passengers;                           |
|-----------|------------------------|---|
| carpentum | -                      | a two-wheeled covered gig used by women;  |
| carrus    |                        | a luxury chariot often used by officials, the forerunner of today's saloon car; |
| rhedda    | -                      | a four-wheeled cart used by the Roman Imperial Post to transport the mail;      |
| plaustrum | -                      | a two-wheeled cart used by farmers to transport their crops;                    |
|           | and and an and a state |   |

a four-wheeled cart with solid wheels and a low bed used for transporting timber (the Roman low loader).

In general, these vehicles imposed axle loads of up to 750 kilograms on the roads and the harnesses used were such that a significant tractive force could be generated. Quarry stones were frequently moved by wagons drawn by up to 30 horses, often two or more abreast. Because the pivoted front undercarriage was not invented until the 16th century, the heavy four-wheeled carts could not negotiate sharp bends. This is one reason why many Roman roads were straight and why rut roads would have been introduced as a means of guiding the vehicle in hazardous situations such as mountain roads. The harnesses used in Roman times bore on the neck rather than the shoulders of the harnessed animal and this reduced significantly the pulling force and therefore the weight of carts. The development of the shoulder harness in the 12th century allowed heavier loads to be pulled which caused the remaining Roman roads to deteriorate rapidly. It is interesting to note that cart owners had to be advised that animals should not be yoked by their horns. Perhaps the most opulent of travellers were those who sat in a litter borne by men whose bodies were effectively acting as propulsion, steering, suspension and brakes.

An interesting purpose for the roads was in the propagation of news<sup>11</sup>.Messengers were employed to carry news between major population centres. For example, it is reported that three days fast march could take information from Caudium to Rome. The need for news messengers is illustrated by the fact that the people of Rome learned about the beginning of the Illyrian war after the war had ended. Augustus created the Cursus Publicus, a network of relay runners in order to accelerate the spreading of news. Letters were sealed and Augustus always included the time and date on his letters. Also of course the Romans soon learned that their roads could become a source of revenue and tolls were collected at bridges, fords and gates to large towns. It was common for example for 2.5% of the value of goods transported to be taken at the tolls. In Egypt the military road between the River Nile and the Red Sea could only be used for payment as follows:

| Red Sea Ship's Captain | 8 Drachmas |
|------------------------|------------|
| Sailor                 | .5 "       |
| Courtesan Women        | 108 "      |
| Soldiers' wives        | 20 "       |
| Carts                  | 4 "        |

Again, Pliny commented:

"Wherever you go, you have to pay, here for water, there for fodder, for halting overnight, for tolls of all kinds".

At Palmyra the tolls varied according to the type of cargo being transported and specific rates were stated for slaves, animals, foodstuffs, wool, myrrh, skins and bronze. Also, some traders had to pay and butchers, builders, clothiers and whores are specifically mentioned whereas those travelling who were considered to create wealth were not subjected to Roman taxes.

Mansio, (overnight stopping points, and in particular a resting place for the emperor), were located every 30 to 35 kilometres. Between them Mutationes (or Relay Stations) were situated every 8,333 paces. Thus, a day's journey of up to 35 kilometres would be undertaken in four stages, with new horses being taken for each stage. These staging posts developed into full scale service areas where supplies could be taken. In some areas the Mutationes and the Mansios required a military guard and were an important part of the protection of the area.

Accommodation was often provided at these places and information recovered in Pompeii records

#### "Accommodation to let -room with three beds and all conveniences".

Beside accommodation, a bathing establishment, a chapel and shops would often develop and over the centuries, these service areas have developed into present day downs. In some places inn signs have been recovered and names such as "*Red Houses*", "*The Water Wheel*" and "*Cross-roads*" were common. Other Inns were named after the owner or after the local town. Guests included freedmen, often from abroad, who were generally mistrusted by the local population. Crime was reputed to be rife in the Inns and Innkeeper's wives were credited as being witches. Romans of some standing would prefer to say with friends and Christian writers would condemn inns as being places of sin.

In summary, the roads served diverse purposes and were as much a part of the economy as servants of the economy. As with present day roads, they generated their own wealth and it is possible that the Romans had recognised that the investment in a road was soon repaid both directly by tolls and indirectly by the wealth which was generated along the line of the road. It is probably this recognition of the wealth creation associated with their roads which fuelled the Roman appetite for road building.

#### 9 Roman Roads in Literature

Roman literature deals only rarely with road construction since Roman writers were more concerned with politics and culture than they were with engineering. However, there are some notable exceptions which provide an insight into the Romans' views on their roads. There are several words used to describe different types of roads and different parts of roads, as follows<sup>11</sup>:

| via       | -          | a carriageway permitting two vehicles to pass;                     |  |  |
|-----------|------------|--|--|--|
| vicus     | · <b>-</b> | a city street;   |  |  |
| actus     | -          | a single lane road 1.2m wide, originally used for driving animals; |  |  |
| agger     |            | an embankment upon which a pavement is built;                      |  |  |
| ambulatio | -          | a pedestrian town street;  |  |  |
| clivus    | -          | a street on a hill;  |  |  |
| fundula   | -          | a cul-de-sac;  |  |  |
| pervium   | -          | a town street.   |  |  |

The word via became used most commonly to denote long distance Roman roads and ruga began to replace vicus to describe town streets.

Livy referred to roads in his recorded documents. He confirmed that the Censor Appius Claudius was responsible for the construction of the Appian Way and stated that the road from Capena Gate to the Temple of Mars in Rome was paved using finance resulting from the confiscation of the wealth of usurers. Also the Via Lavicana in Rome was paved using fines imposed on farmers who were caught grazing their stock on public pasture. Livy also reports that the Censor Flaccus built a road for the benefit of the plebs which led to the waters of Neptune and he states that the Censors would invite contractors to tender for the paving of city streets and the improvement of rural roads. In general, the roads were built by civilian labour but Livy refers to Flaminius occupying his otherwise idle soldiers by having them build a road from Bolognia to Arretium. Interestingly enough, the roads also served the opponents of Rome and Hannibal is reported to have used Roman roads during the Punic wars. Present day planning regulations were reflected in Roman times where the censors would order the demolition of properties which obstructed the highway.

Pliny the younger provides some details of Roman roads in his letters. He frequently travelled to visit his land in different parts of Italy and he records how he would ride in his carriage and sometimes how he would ride his horse. Effectively, Pliny is the first recorded tourist, travelling simply for the pleasure of visiting distance lands. An indication of the state of the roads can be gained by some of Pliny's writings. For example, he states that "horse carriages move along it slowly and with some difficulty" when referring to the Via Ostiensis. The danger inherent in travelling alone was illustrated when Pliny the younger referred to the disappearance of a centurion during a solitary journey. Suetonius commented upon the way in which emperors travelled through the empire. Caligula is described as travelling in one of two modes. Either he would travel so fast that his praetorian guard needed to put their heavy standards on pack animals to keep up with him or alternatively he would travel so slowly in his litter with eight bearers that local plebs would sweep and water the road ahead of him to keep down the dust. Claudius was so keen on gambling that he had a carriage especially constructed for the purpose. Suetonius explained why some of the prestigious Roman roads were constructed. Gracchus "had great roads built the length and breadth of Italy and set to work a hoard of workmen of every kind" according to Appius<sup>11</sup>.

In 44 BC, Caesar constructed a road from the Adriatic Sea to the Tiber over the Apennes and in 30 BC repaired the Via Flaminia at his personal expense. According to Suetonius other generals who had won battles used the spoils of war to improve roads prior to using them for their victorious entering into Rome. He also reports that in 37 BC, the Public Works Department was created in Rome to oversee roads and water supply. The perils of travel included the detention of travellers by small factory owners as slaves, having first welcomed them as guests. Tiberius is reported to have increased the number of military posts along the Roman roads following the ambushing of a military supply convoy in Pollentia.

In 25 BC Claudius restricted travellers in Italian towns to pedestrians only; clearly a pre-cursor of today's pedestrianised streets and an indication of the environmental nuisance caused by carts.

Apuleius referred regularly to travel, mentioning how people would travel to the Olympic Games and how priests would survive on begging as they journeyed from town to town. It seems that people were often superstitious and one trader blames his losses on having started to journey left foot first. Fortune tellers were often consulted prior to travel. Apulius confirms that travel was expensive in Roman times and in one case reports how Lucius spent his inheritance in travelling to Rome. People would travel on foot, on horseback, on a mule or in two or four wheeled vehicles. The vehicles may have been less use than might be thought; often the unpaved roads were reported as being heavily rutted and muddy, particularly in winter. It seems that extortion was common and one gardener is reported to have been relieved of his tools, helmet, shield and javelin by a Roman military officer whom he came across. Dogs were also a source of danger and packs would often set upon travellers who were advised to walk in groups and to keep close together. Journeys at night were avoided for fear of robbery and this seems to have been a reason for the development of hostelries where people would rest during the night.

It is probable that people used rudimentary maps to navigate on the Roman roads; the Puetinger Table, a copy of a Roman map is kept at the Library of Vienna in Austria. It shows Roman roads in diagrammatic form, providing all of the information which a traveller would need without being cartographically accurate. It is 6.8m long and shows roads radiating from Rome all in fact going in the same direction on the map. Public baths, towns and temples are represented on the Puetinger Table and cross-roads and forks in roads are given particular prominence. The lack of directional accuracy to the roads was of no concern to the traveller and it would seem reasonable that all journeys from Rome were considered to be in one direction. The Table does not deal with towns on route since most of the roads bye-passed them and dealt much more positively with any type of road junction in much the same way as the UK network of roads now does.

#### 10 British Roman Roads

British Roman roads are unique in several respects. Firstly, they formed a self contained network, largely radiating from London and secondly they were built during a compressed period between 43 AD and 81 AD. Interestingly enough, this is approximately the same duration over which the present UK motorway network was constructed. The network of roads is shown as Figure 1 from which it can be seen that the network extended as far north as present day Perth and several of the roads were constructed to the north of Hadrian's Wall.

A unique feature of British Roman roads was the use of the agger (an embankment of height between 300mm and 1.5m) upon which the roads were generally built. The agger was constructed using material excavated from ditches running parallel with and adjacent to the road. Several reporters have speculated upon the purpose of the agger: some have considered it to have an engineering function, allowing water to drain away from the road surfacing materials above, whilst others have considered the fact that during the first few years following the Roman invasion of Britain, the Britons were hostile so that the agger may have been provided for security<sup>4</sup>. Not only would a Roman traveller have a better view from the elevated road, but also he would be better able to defend himself against possible attack. It should be borne in mind that Britain was largely forested two thousand years ago and all of the roads were built through cleared land, usually with the clearing extending to a width of 30m, even though most of the roads were less than 10m wide. The purpose of the clearing was probably to improve security and possibly to make the roads easier to find.

The straightness of Roman roads is frequently commented upon but is less surprising than might at first appear. Apart from the straight line being obviously the shortest distance between two points and therefore the route requiring least construction effort, the surveyors used instruments which could extrapolate any two points to create a straight line of great length. Also, the Roman surveyors were familiar with sea-going navigation and it would have seemed natural to them to have created straight routes of communication. The Romans were not slaves to the straight line and would often create detours to avoid natural obstacles such as valleys and hills. A common geometric feature is for roads to make deviations at hilltops where the linear extrapolation procedure would have been more difficult. Roads deviated from straight lines more in Northern Britain than in the south where mountainous regions militated against constructing to a straight line. Road widths varied from 10m for the major routes to 8m for other main roads and 5m for most minor roads with town streets often being no more than 3m wide - many such narrow streets were found in Pompeii<sup>3</sup>.

Figures 2 shows a typical British Roman Road construction sequence. After clearing the route through the woodland, the edge ditches were dug to mark the road boundary. The deeper ditches at the road edge were then excavated and the material was used to construct the agger. Usually, the material from the agger ditches was placed directly on the existing grade and no attempt was made to remove the uppermost unconsolidated material. At a height above grade of approximately one metre, the large rough road foundation stones were laid in the condition at which they arrived from the quarry. Coarse crushed rock or gravel was placed and compacted over the foundation stones and longer edge stones were placed at the side to contain the crushed rock or gravel. Usually, two courses of crushed rock or gravel were placed over the foundation stones. The upper layer comprised smaller sized material and was sometimes cemented with materials described in Section 18. Finally, the road surface of smaller cobbles was placed. The cobbles were cut to accurate size at the construction site so as to fit together tightly. The installation of the surface stones followed many of the present day paver technology principals. The surface integrity relied upon interlock, i.e. the inability of an individual stone to move in isolation from its neighbour when trafficked. This interlock was developed as a consequence of the high levels of accuracy which were achieved in stone cutting. The lack of road surface archaeological remains is a result of the accuracy of cutting which rendered the stones excellent construction materials during subsequent periods.

There is little evidence regarding the way in which traffic was marshalled on these roads but bearing in mind that Roman carts were of width less than 2m, it would seem that the main roads could have accommodated three lanes. Whether or not there was a rule of the road in relation to which side to travel on is open to conjecture, but it would seem likely that travellers would use the centre of the road as far as possible unless passing someone travelling in the opposite direction.

In addition to the large ditches from which the material for the agger was won, smaller ditches were constructed at each side of the road running parallel with the road. These smaller ditches, usually approximately 1m wide and 300mm deep, were separated by either 27m or 20m. They appear to have represented the boundary of the road zone and are analogous to today's motorway fences. Effectively, the road comprised the agger running down the centre of the cleared zone with large ditches, sometimes 3m wide and one or more metres deep running along each side, then a space at each side of the agger roughly equal in width to the agger. In all, four parallel ditches were dug, the two smaller boundary ditches at the edges of the clearing and the two larger ditches beside the road whose material was used to construct the agger.

Because British Roman roads fell into disuse following the termination of Roman Government in 410 AD, they provide far more information on construction materials than do

continental Roman roads which usually remained in service and have therefore been reconstructed periodically.

From 410 AD, a gradual decline in the British Roman way of life developed as the Saxons and the Picts commenced their raids. By 450 AD, Roman life in Britain had been overtaken and the Roman road system fell into disrepair. Wooden bridges began to deteriorate and gales frequently caused uprooted trees to block roads such that the roads became independent short sections. The Saxon economy was based upon local market centres and long distance travel was no longer required. Aggers became useful to the Saxons as boundaries between farms. Those roads which did remain in service became subjected to increasingly heavy traffic in the middle ages and when the turnpike roads were built in the 16th and 17th centuries, material from the Roman aggers was employed in their construction. When the new roads followed the line of the Roman roads, the agger was sometimes spread to form the foundation for the new road.

Because of neglect and plundering, there are now only minor lengths of good quality Roman roads in existence in the UK and much of what we now know of Roman roads is a result of recent construction work exposing sections of Roman roads which were sometimes recorded. However, it is interesting to note that the Roman road network survived for 350 years and constitutes a very rare occurrence of a major work of civil engineering serving its purpose without significant alteration over several centuries. It is for this reason that it is important to understand the way in which the roads were built and the materials from which they were formed. By comparing Roman roadbuilding technology with today's roadbuilding specifications, conclusions can be drawn regarding the future of roadbuilding.

Our own recent developments of paving systems seems to parallel Roman developments. In the early days of the Republic, roads were generally gravel surfaced but by the time Britain was conquered, major roads were usually paved. Also, it is interesting to note the accuracy with which the paving stones were laid. One Roman specification states that the joints between the stones had to be so small as to prevent a Roman soldier's knife from being able to penetrate them<sup>1</sup>. This would suggest joint spacings of less than 3mm, which is particularly relevant to present European highway paver specification development.

#### 11 The Development of the British Roman Road System

The Romans first landed in Britain in 55BC and again a year later. On both occasions, Julius Caesar failed to establish Roman dominance, although he did reach St. Albans in 55BC before retreating back to continental Europe. At this time, Britain was populated by separate tribes, mostly speaking the same language. The four principal tribes were the Catuvellauni in the South east, the Silures in South Wales, the Brigantes centred in the Vale of York and the Caledonians in the Grampian Hills and Eastern Scotland. Three major pre Roman roads, Harroway, Icknield Way and Jurassic Way radiated from Stonehenge. Whereas in other conquered regions, the Romans used and sometimes improved existing roads, in Britain the created a new road system as now described.

Following Claudius' successful Roman invasion in 43 AD, roadbuilding initially commenced in the South East and in the South Midlands as the Romans progresses ever further from Rome. Following the crossing of the Thames at London, the first major town to be captured was the Catuvellaunian capital Colchester which then became the capital of Rome's newest colony, Britannia. The remainder of Britain was conquered by Legions operating from Colchester to the North and the West. For example, the Fourteenth Legion advanced along what was to become Watling Street and the Ninth Legion moved north, so capturing land to allow the construction of Ermine Street.

By 50 AD, a significant network in the South of England had developed, but the hilly North and the mountains of Wales proved difficult both in terms of engineering and in terms of the reluctance of the local Britons to accept the Romans. Fighting continued in Wales and in the north through the 50s and Oueen Boudica (often called Boadicea) led the Iceanians of East Anglia against the Romans in 61 AD. Initially, Boudica wiped out the Ninth Legion but was eventually defeated when reinforcements from the Fourteenth and Twentieth Legions arrived. This conflict led to the destruction of St. Albans, Colchester and London. The honour of the Ninth Legion was restored during the 70's when they regrouped at Lincoln and moved to defeat the Brigantes and so take York. Once the Romans had overcome Boudica and the Brigantes in Yorkshire roadbuilding continued in the North of England and Julius Agricola was the first to build roads in Scotland as far north as Strathmore<sup>4</sup>. Agricola advanced Roman dominance through Northern England, using the Ninth Legion in the east and the Twentieth in the west. These legions recruited local labour for build roads as they advanced, including three cross country routes, Stainmore Pass between Catterick and Carlisle, Stanegate, from Newcastle to Carlisle and a road following the River Tweed. This "ladder" strategy, using two main roads as the shafts and cross country roads as the rungs had previously been used with success in Italy and would later be used in North Africa. Stanegate was used as an access road to construct Hadrian's Wall to control troublesome tribes both to the north and the south of Stanegate. (Hadrian's Wall was not the Roman Empire border, rather a linear fort constructed through a distant and troublesome part of the Empire.) Because of the troublesome nature of the British tribes, Britain was dominated by a military presence to a much greater degree than any other Roman colony.

The first main road to be built was Watling Street from Canterbury to London following the Romans' first landing at the East Kent ports. Southampton and Poole became military harbours so that the south coast roads were built at an early date. These roads were lengthened to reach Cirencester and Bath in the west and then on to Dorchester and Exeter with branches northwards to the Bristol Channel. By 50 AD, roads had been constructed to Gloucester and a fort developed in that town.

Once Watling Street had reached London, roads were constructed from London to the west, to the north west - a continuation of Watling Street, to the north (Ermine Street) and to the north east. Two important tribal capitals were at St. Albans (Verulamium) and Colchester (Camulodunum) and roads were constructed through those capitals from London, probably to impress upon the locals the dominance of the Romans. East Anglia became a major roadbuilding region and a network of roads was constructed as far north as The Wash with Ermine Street as a major trunk road to the Humber and beyond. Ermine Street was the earliest main road constructed in eastern England and the roads crossing it were constructed later as the Roman influence penetrated the region. For example, a route ran from Ermine Street to a small port near Caister in Norfolk and Lincoln was connected to The Wash, which appears to have been a major sheltered anchorage for the Roman fleet.

Watling Street continued north west from St. Albans through Towcester and onto Leicester. It was constructed in discrete sections as the Romans gradually occupied more territory and its branches were added later. Fosse Way, one of the remarkably straight Roman roads, runs diagonally from Lincoln through Newark, Leicester, Cirencester and Bath to Exmouth. It was originally constructed in the Midlands as a link road along what was then the limit of penetration between the fertile agricultural lowlands of Britain and the northern highlands in 47 AD<sup>4</sup>. The principal evidence for this is that many roads led up to Fosse Way from the south east and join it at right angles, suggesting that it was indeed a boundary. As the Romans progressed into the highlands of England, Ryknild Street was constructed through Alcester, Birmingham, Derby, Chesterfield and finished at the Roman Fort of Templeborough in Rotherham. Again, this road is thought to represent a temporary limit of the Roman penetration up to approximately 70 AD with the Romans having occupied the land to the east of that road but not yet to the west. By 73 AD, the northern frontier had been extended northwards to a line from the Humber through Doncaster and Manchester to Chester. Julius Agricola conquered North Wales in 78 AD so that all of Britain south of a line from the Humber to the Mersey was under Roman occupation by 78 AD. The remainder of the Roman conquest of Britain and the roadbuilding north of this line took place within the next three or four years.

Dere Street was the principal road along the east coast whilst a second northern road ran close to the west coast through Lancashire. The cross country northern routes followed later, in particular the road along the line of Hadrian's Wall was not built until the wall itself was built between 122 and 126 AD. Dere Street was continued northwards to near Edinburgh linking with roads continuing to Strathmore where branch roads connected with east coast ports.

The Romans had learned how much easier it was to transport goods directly to the north by sea rather than undertake the risky road journey through Britain. What is remarkable about the development of the Roman road network is the speed during which it was constructed, bearing in mind the hostility of local tribes. It seems that the conquered people were used as road building labourers under the supervision of Roman soldiers, who in turn were working to designs and locations developed by the Roman surveyors. The system of coloniae originally developed in Italy was established in Britain such that the conquered regions were encouraged to prosper and a period of stability developed for the 350 years of the Roman occupation and with stability usually largely dependent upon the communication system of the Roman roads.

All of the usages previously discussed occurred in Britain such that the roads became an important contribution to the wealth of the country and settlements very soon began to develop along their line. In particular, the Roman forts along Hadrian's Wall soon developed surrounding townships as the local population began to supply the Roman military system with its requirements. It was probably the development of this trade which led to cessation of hostilities and the development of a relatively strong economy in Britain.

## 12 British Archaeological Roman Road Evidence

After unsuccessful raids in 54 and 55 BC (although in 55BC, they reached St. Albans and governed for a brief period), the Romans landed in Britain at Dover in 43 AD and met with some resistance. Initially they recaptured land to the south of the Thames and continued along the south of the River via Canterbury, Rochester and Dartford until they found a suitable crossing at London. The first British Roman road was Watling Street constructed through those towns and eventually on through the Midlands via St. Albans, Towcester, High Cross, Stratton and finishing at Wroxeter. Watling Street and Ermine Street, running from London north to the Humber, together with Fosse Way are the three Roman roads of greatest strategic importance and will now be dealt with.

#### 13 Watling Street

Because Watling Street runs in the main though areas of many recent developments, there have been opportunities to record its details during recent construction work. The straightness and length of Watling Street would suggest that it was conceived and constructed as one project. In fact archaeological evidence suggests that it comprised many short sections linked together in a similar manner to the present UK motorway network. It is typical of many Roman roads in that it follows straight lines except in locations where to do so would be illogical, in which case it follows natural features. Where sections of Watling Street have been excavated, it has generally been found to comprise several layers of locally won material, sometimes cemented with lime, clay or pozzolanic material to form a material which would be similar in strength to present day lean concrete. For example, excavations near Rochester Guildhall revealed the following road structure:

350mm gravel
150mm flints
300mm gravel
150mm compacted chalk
375mm sand, clay and flint mixture

Each of the courses above comprises one or more locally available indigenous materials installed to a level of compaction which would ensure appropriate engineering behaviour. For example the chalk was compacted to ensure that it would be effectively waterproof, whereas the gravel was laid to act as a drainage blanket. Effectively, the various layers at Rochester were sufficient to protect the underlying poor quality subgrade both from stresses created by moving carts and from the effects of the weather. It may be that this road originally was surfaced with large stones - certainly by this time the Romans had developed stone surfacing for their busy roads, and Watling Street would probably have been the UK's busiest road connecting the tribal capital of St. Albans with several Roman settlements and radiating from Rome.

At other sites, local materials have also been discovered during excavations. A particularly interesting find was recorded in 1887 when the remains of a Roman road running close to the River Medway were discovered. The road had a foundation comprising 1.2m

long oak piles supporting a timber deck. The timber deck supported a pavement comprising the following courses:

150mm Polygonal slabs laid flexibly
225mm gravel/fine silt mixture
175mm small flints
125mm compacted chalk
1050mm flints and broken tiles

Clearly, the road designer had considered the existing ground to be unsuitable for what was going to be a very busy road. Therefore he specified the piled structure beneath the pavement to act as a firm working platform and then specified just over 1m thickness of fill material, comprising flints and broken tiles. Above the fill, the courses are similar in materials, although not in sequence, to those at Rochester with the exception of the additional Polygonal slabs. It may be the case that the Rochester Road was originally surfaced with similar slabs which have been subsequently removed. The Romans had learned the importance of providing a significant pavement thickness over poor ground and they learned to use locally available materials to ensure a well drained structurally sound pavement. Other archaeological sites in the south east usually reveal a combination of flints, gravel and chalk frequently used in combination. Course thicknesses are generally between 150mm and 300mm; this range of thicknesses being suitable for compaction by ramming vertically in one layer.

North of London, Watling Street, takes on a different construction sequence. For example at Gailey Hill to the north of Wolverhampton, an excavated section comprised a foundation of logs laid 1.2m apart to a diagonal pattern with the logs having diameters up to 300mm. The pavement above the logs comprised:

150mm thick sandstone flags (presumed)300mm crushed sandstone150mm thick leaves, twigs, moss and clay

It is interesting to note that the thickness of Watling Street has lessened which reflects the lower levels of traffic which would have travelled so far northwards. Effectively, the structure of the road comprises only 300mm of crushed sandstone resting on the foundation of vegetation. Further on, excavations have revealed Watling Street to comprise large flat stones 200mm thick laid over coarse gravel at Green Bank. The surfacing stones were of dimensions 450mm x 300mm and were accurately fitted. Less accurately hewn stones, possibly the rejects, were set in a matrix of clay beneath the coarse gravel as the foundation to the road. Nearby at Heronbridge, the road surface comprises a double-deck layer of cobblestones laid over crushed sandstone. These variations in specification would suggest that the road was built at different times and that the constructors had become adept at employing locally available materials. At Eaton Mascot Hall, Watling Street comprises the classical Roman construction of large rough stones as the foundation layer with three courses of material and a stone surface. The three courses comprised:

> crushed rock fine gravel coarse gravel

A feature of this site is the use of kerbstones used to contain the granular materials. It is likely that kerbstones were used commonly, but in the main they will have now been used for other purposes. In most cases it is difficult to assess the width of Watling Street but it is likely that it was between 7m and 10m wide throughout its length, allowing carts and pedestrians to pass in both directions freely.

The fact that Watling Street is of lower strength north west of St. Albans is indicative of a reduction in traffic from there on. An analysis of the pavements before and after St. Albans indicates that approximately 10% of the traffic would continue beyond St. Albans. This provides an indication of the level of human activity once the Romans had passed south east of England. Indeed, the pattern of original activity is probably very similar to today's with the major population volume and wealth being centred in the south east. This was probably partly as a result of the proximity of the south east to Rome and possibly a result of the colder winters in northern Britain. Records indicate that the winters were colder than present winters and the attention paid to keeping officers warm in northern Britain barracks is also indicative of the Roman's aversion to cold British winters. The indigenous British population would have probably numbered no more that two million and it is likely that at least 50% of them lived in the south east and those numbers would have been supplemented by military and civilian Romans such that the population in the south east may have risen to two million with less than one million in the rest of Britain.

#### 14 Ermine Street

After Watling Street, Ermine Street would have been the primary thoroughfare in Britain providing a direct link between the major military facilities at London, Lincoln and York - York was later to become the centre of Government for northern Britain. Ermine Street was constructed shortly after the Roman occupation and probably followed existing tracks in some parts<sup>4</sup>. Many of London's major north/south streets such as Bishopsgate, Shoreditch High Street, Stoke Newington Road and Tottenham High Road, follow the line of Ermine Street.

An excavation in Hertfordshire has revealed the following section:

150mm thickness cemented chalk150mm flints bound with chalk450mm thickness flint rubble with sandstone.

The road was built over a 7.6m width on a 20m wide agger and had 600mm deep, 2.4m wide ditches at each side of the agger, probably for drainage reasons. Further north, excavations near Sleaford in Lincolnshire have revealed the following section:

375mm crushed rock surface375mm thickness crushed rock in a fine matrix250mm thickness cemented crushed rock450mm thickness gravel (possibly pre-Roman)

It seems that all of the main roads to the south of the Humber were characterised by layers of free draining gravel and either weakly cemented or fully compacted graded material which would inhibit the passage of water and would provide the pavement's strength. Effectively, the Roman road designers appear to have understood the need to have both structural capability and drainage. Gravels and flints where available were used as drainage material and material which could be solidly compacted was used as the pavement structure. Because the roads were built on their aggers, the layers of gravel would drain to the side so that the road building materials would not become saturated. Roads to the north of the Humber tended to have a layer of mortared stones (the Statumen) at the underside of the pavement as well as at the wearing surface (the Summum Dorsum).

#### 15 Fosse Way

Fosse Way was the principal Roman cross country road running from Axminster in the south west to Lincoln in the north east via Bath, Cirencester, Newark, Leicester and High Cross - where it crossed Watling Street. It had been constructed by 47 AD shortly after the Romans had reached St. Albans. The principal archaeological evidence of Fosse Way was found at Clandown on the Ilchester to Bath section. Here, Fosse Way was found to comprise the following:

112mm rough stone paving125mm cemented fine aggregate450mm cemented sandstone50mm marl150mm large aggregate

This specification conforms to the southern British Roman road specification whereby the foundation comprised free draining large aggregate rather than quarried stones. At Stratton-on-Fosse, a road surface was excavated comprising 225mm thick cobbles instead of 112mm stone paving at Clandown. It seems to be the case that the surfacing materials used on Roman roads varied along the line of the road according to local availability of durable stone. It also seems that the Romans had learned to vary the thickness of the surfacing material according to the strength of the stone and varied the size and shape of the stone according to the ease with which they could be cut to accurate dimensions. Those materials which could be cut accurately were used to form tightly jointed large flat stone surfaces whereas those which could be cut only roughly were used in the form of roughly cubic cobbles with more variable joints. In both cases, it seems that subsequently peoples took advantage of the availability of these stones in the construction of their buildings. It is for this reason that frequently even the main roads are found to not have a stone surface during excavation.

It is interesting to note that Watling Street changes direction after crossing Fosseway such that it then heads further westward rather than towards the north west. This would suggest that Watling Street was originally constructed towards Fosse Way and was then continued possibly for a different strategic reason to the north west of High Cross. Some authorities consider that Fosseway originally marked the boundary of the lands where the Romans felt comfortably in command of the Britons.

#### 16 Other British Roman Roads

Whilst there are many locations where fragments of Roman roads have been discovered, few of them provide significant information regarding the overall design and construction of the pavement. There are some exceptions and these are now dealt with<sup>4</sup>. In several places, the London to Brighton road has been exposed, particularly at Caterham, Lingfield, Fellbridge and at Ardingley. Over a relatively short length, the materials from which the road was constructed varied and were always from local sources. Flint, iron slag, sandstone boulders and sandstone aggregate were all used on this road which is a good example of how Roman roads far from being uniform in construction, changed according to the availability of local materials.

Akeman Street, from Alchester to Cirencester, has been excavated at Alchester, at Tackley Park and at Ouenington. A feature of this road is the use of large (approximately 150mm thick) limestone slabs within the structure of the pavement and at Tackle Park a It is probable that the foundation comprising crushed limestone, clay and brushwood. brushwood was originally laid over the subgrade to provide a membrane preventing the penetration of road construction materials into the subgrade -effectively a Roman geotextile. A feature of the excavation at Alchester is the use of two courses of limestone slabs as a road foundation. It was quite common for the Romans to install a layer of stone over a similar layer and the reasons for this are discussed in the next section. At Quenington a crushed limestone road 600m thick and 9.7m wide has been found to incorporate a longitudinal centre drain effectively dividing the road into two 5m carriageways. It is not clear how the water leaves the centre drain, it is possible that at some now lost location, the drain was taken to the edge of the road. Akeman Street is important in showing how one material could be used in two ways; the limestone was used both as a crushed rock, bound in a clay matrix at Tackle Park and also as large slabs. This indicates an element of design in the Roman roads whereby materials were fashioned to meet the specific needs of the road.

The Bath to Seamills Road has been revealed at Durdham Town and indicates a buildup comprising a paved surface of  $250 \times 200 \times 175$ mm thick rectangular stones bedded flexibly in a 150mm laying course of red earth. A further layer of sandy earth underlies the laying course and the whole is supported on a crushed limestone road base. The Bath to Seamills Road bears similarities to present day paved roads and illustrates the use of a flexible laying course material ultimately supported by rushed rock - many lightly trafficked present day paved roads follow this principal.

Ryknald Street, between Derby and Chesterfield, has been excavated at Breadsall and Morley Moor. A feature of this road is the use of rough-cut sandstone boulders and more accurately cut 450 x 450 x 150mm thick square sandstone blocks. The latter were used as the foundation with the 50mm thick by 150mm wide rough-cut sandstone blocks lying on them. Above the off-cuts, only 100mm of gravel was discovered at Morley Moor but it is possible that there had been a paved surface. The details of Ryknald Street are typical of many north British Roman roads whereby the lower layers comprise large blocks and the upper layers include both gravel and crushed rock in various configurations and sometimes include a paved surface. There are several existing comprehensive texts dealing with Roman roads. In the main, they deal with the social, political and economic aspects of the roads and pay little attention to their engineering. This is partly because they were written by historians and archaeologists who sometimes failed to appreciate the engineering implications of their finds and partly because there is scant evidence remaining in-situ. The Romans were victims of their own success in that throughout Southern Europe, successive peoples continued to use Roman roads and gradually replaced them as they wore out. In Britain, the Saxons abandoned Roman roads and often used the surfacing materials as building materials. For these reasons, archaeological evidence is scant in comparison for example with Roman buildings and other public works such as aqueducts.

This publication takes data produced by historians and archaeologists and places it in an engineering context. It uses present day comparisons and shows how the present day worldwide use of pavers is very much a parallel of the development of the Roman road system. It brings out similarities between Roman thinking and present day developments. For example, the Roman specification for paving stone joint widths is compared with today's specifications. It seems that the Romans achieved greater levels of accuracy in the laying of their surfacing materials than we do now. Perhaps our specifications should include the requirement that a soldier's knife blade cannot penetrate joints as did Rome's. It seems too that the Romans debated whether to surface their roads with rectangular stones or with polygonal ones. As is the case today, some regions favoured rectangular stones whereas others used square or rectangular ones. The polygonal stone roads have often survived longer - the material was a less useful building material for subsequent peoples.

The book starts with a look at the way in which the Roman empire grew from a few local communities who gravitated to a site at an ancient road cross-roads near the Tiber a few miles from the west coast of Italy. It shows how different leaders viewed their roads and how the roads became the arteries of trade throughout the Roman Empire.

An investigation into Roman roads reveals several surprises. They were not straight, at least not over great lengths. Contemporaneous surveying instruments permitted straight sections of road to be constructed only along a line of sight, which could often be extrapolated some distance, but it is common for Roman roads to turn at hilltops. Also, contrary to some opinion, the Romans often allowed natural features to influence the line of the road. Steep hills and marshy ground would often be avoided and roads would be diverted to a suitable river crossing. Roads which appear on a map to comprise one uniform structure usually consist of many short sections each built from locally available materials and designed to best use those materials. The term highway developed as a result of many of the British Roman roads being built on an embankment - called an agger from aggerere - "heaping together". Many have expressed the view that the agger was built for reasons of drainage. I think not; it is more likely that the Romans felt safer travelling at a height of over a metre from which vantage point they could more easily ward off attack. The Romans had learned to use free draining gravel and ditches for drainage and would have been unlikely to spend so much resource on building embankments everywhere for purposes of drainage only. Only in Britain was the agger an integral part of most roads<sup>1</sup>.

The Willington to Durham Road at Brancepath and the Lockerbie to Loch Maben Road at Lochbank are examples of paved roads which include stone blocks as the foundation. At Brancepath, 200mm thick sandstone blocks are used directly over the subgrade, overlain by 125mm of clay and 100mm of gravel. It is presumed that a paved surface was originally present which would have been cambered. Kerbstones have been found along this road separated by 6.6m indicating the width of the road. At Lockerbie two sizes of cobbles were used; 50mm cubes for the surface and 125mm cubes for the foundation. There is evidence at Lochbank that the lower level of cobbles were placed directly over the natural turf. It seems to have been common for the Romans to have left the topsoil on their roads, possibly relying upon the strength of the vegetation to prevent the lower layers from penetrating the ground.

One of the most important British Roman road archaeological sites is Wheeldale Moor Roman Road heading north over the North York Moors from a Roman fort near Malton to a commercial port near Whitby in North Yorkshire. Because of the remote nature of the area, the road foundation is largely intact and is visible over several miles. Locally quarried large stones of dolomitic limestone form both the foundation course and the edge restraint. Each stone is fitted closely to its neighbours and has a flat upper surface. Ditches which provided material for the agger are evident and the road follows a straight line with minor variations to accommodate the hilly topography. Where streams and gulleys crossed the road, a 100-200mm wide gap was left in the foundation stones. Smaller cubic stones lay scattered on the line of the road and these may have been the original surfacing material. They would have become a source of dressed stone suitable for later construction.

#### 17 Summary of British Roman Roads

Bearing in mind the vast length of roadbuilding undertaken by the Romans in the first century AD, it is surprising how few excavations have revealed firm data regarding the specification of Roman road pavements. The main conclusions which can be drawn are firstly that the Romans always used locally available materials and sometimes incorporated vegetation directly over the subgrade to separate the road from presumably soft ground. The road was always constructed in a clearing of width approximately three times the road width. The roads were constructed on an agger(embankment) constructed from material excavated from large ditches formed alongside the road.

Virtually all of the Roman road pavements comprised several courses and it is frequently possible to identify the three principal components of a road; the surface, the structure, and the foundation. It is not clear how many of the roads were paved since the paving stones have been used over the centuries as freely available building materials. However, it seems likely that all of the main roads were paved and that the paving stones were sometimes cubic and were sometimes similar in dimension to flags. In all cases, the surface was bedded flexibly - only those stones laid in the foundation of the road were cemented together. From examples of paved roads in Italy and North Africa, it is clear that the surface stones were laid to high tolerances and the Roman soldiers' knife blade was used as the means of checking whether or not the gaps between the stones were too large.

Road width seems to have been the principal factor in relating road design to the intensity of traffic. Main roads were often up to 10m wide but 6-7m seems to have been a common width. there seems to have been no rule of the road regarding the side of the road

which people used and it is likely that they kept to the middle of the road both as pedestrians and when using carts. It is clear that those roads in the south of Britain were heavily used and it may be that congestion was a feature of Watling Street and Ermine Street at the southern ends. It is very likely that Watling Street, between Dover and London, was regularly strengthened and the sections from Rochester and the Medway indicate particularly heavy traffic. It is probable that the section at Rochester was constructed at different times with the road gradually being strengthened as traffic built up from 43 AD. In the north, distances between settlements were greater and the population was less so that the roads would have been less busy in the vicinity of Hadrian's Wall. It is clear that the economy was based upon providing for the military presence and in that area the Roman soldiers would have been common users of the roads, whereas in other areas the roads were used principally for trade. The roads continued in regular use until the 5th century when Rome effectively pulled out of Britain leaving the Saxons to develop their locally based economies.

## 18 Construction of Roman Roads

Having observed the construction of the Via Domitiana, Statius wrote the following poem:

First comes the task of preparing the ditches, Marking the borders, and, as deep as needed, Cutting into the earth. Then, second, with other stuff, making a base for the crown of the highway. So that the soil does not sink on weakly made foundations. That give the flagstones a false base. Thirdly, they secure it with cobblestones, Closely packed. Now see how many hands are working together. Some fell the trees ahead, others tumble the rocks. While others cut and smooth the flagstones with iron tools. Then the masons, with heated sand that is mixed with volcanic tufa. Put this down as a base on which the flagstones are laid. And still others go ahead to drain the pools Bridging those thirsty streams that lie ahead.

This represents one of the best documented accounts of the way in which Romans built their roads. Statius also wrote the following:

"The first task is to begin the furrows and to open out the track, and then with deep digging to hollow out the soil between them. Next they fill in the hollow trench with other materials and prepare a foundation (gremium) on which the road surface may be laid, lest the ground should give way or **the spiteful earth** provide an unreliable bed for the rammed blocks. Then with close-set kerb-stones (umbones), on both sides, and with many cramps, they bind the road together. Others work around the road itself. Here trees are cut down and the slopes of the hills are bared; there the pick-axe levels the rock or creates a log from a tree; there clamps are driven into the rocks and walls are woven from slaked lime and grey tufa. Hand-driven pumps drain the pools formed by the underground water and brooks are turned from their course"

("the spiteful earth" - today, we would more usually define the properties of the subgrade in terms of a value determined by laboratory or field testing. We might for example define poor quality material as having a California Bearing Ratio of 3% but on the whole I feel that we would be safer road designers if we were to adopt Statius' more illuminating description)

Often, footways were constructed, known as *margines* for streets and *iter* for roads, being separated from the carriageway by low stone walls known as *umbo*. An example is shown in Figure 3. During the Imperial period, roads were constructed on a grand scale in Italy and typical widths of major routes were up to 13m for the carriageway with a footway 6m wide at each side. It is possible that all civil traffic used the unpaved footways and the central paved carriageway was reserved for military use, - an early priority system.

The construction operation began with the preparation of ditches which were to form the boundary of the road and is analogous to the erection of fences which is the first operation on the construction of many present day new roads. Statius states that the border ditches would be as deep as needed. The depth would have varied according to the difficulty of excavation and also according to whether or not the ditch was required as protection against hostile people or animals. It may also have been used for drainage, although this was not the primary function.

The second operation was to excavate into the existing ground on the line of the road. In Britain, this operation may have been omitted since some of the roads were built from existing grade upwards. However, in most of Europe the final surface of the road was at ground level so it was necessary to excavate sufficient material to permit the road to be constructed below grade. All of the pavement construction courses are dismissed by Statius as "other stuff". He clearly felt that the purpose of the other stuff was to provide the shape in the form of a crown for the surface of the road. He had appreciated the need to protect the underlying subgrade with structural courses, and regarded flagstones as the foundation, possibly with underlying material. It would seem that once the existing material had been removed, an initial supporting layer of granular material would be provided, followed by the main foundations - the flagstones, sometimes cemented together. The "other stuff" would then be compacted over the flagstones to form the main structure of the road and cobblestones would then be laid "closely packed" as a means of securing the whole structure. Statius specifically refers to the close packing of the cobblestones which probably indicates that some care was made to maintain joint spacings to a minimum, either by tapping the cobblestones together and/or by selecting cobblestones of appropriate shapes to fit. He refers to preliminary work being undertaken ahead of the pavement construction, telling how the route was cleared of trees and rocks.

It is interesting to note that the flagstones were cut to size on site and that a pozzolanic material was used as bedding for the foundation flagstones. This is both to strengthen the foundation layer and to ensure that it would be significantly waterproof. It is also interesting to note that the pozzolanic material was not used for bedding for the cobblestones on the road surface, which were flexibly bedded on granular material.

Statius paints a picture of a labour-intensive construction site with several operations taking place concurrently, from the initial clearing of the line to final surfacing. This indicates that Roman road construction sites were formally managed and it can be presumed that there would be a hierarchy on hand to ensure that each operation was completed in time to permit the next one to proceed.

The fact that a poem was written at all speaks of the impressive operation which a roadbuilding site must have represented. Assuming that Roman labour was of similar quality to present day labour, it would seem that each kilometre road of width, say 8m, i.e. 8000 sq.m. might occupy 70 men for one month. Bearing in mind that many of the main Roman roads were over 100 miles long and would have been built within a period of two years, this would suggest a workforce of several thousand men working independently at several sites which would eventually join together, possibly at the high points where Roman roads often change direction. Many of the Roman roads followed the course of previously existing tracks and access to the construction sites would often be possible. In many cases passers by would have been recruited as labour and may have been well rewarded for the task, especially for those roads which were being paved to permit a general to enter Rome for his victory parade. In other parts of the Empire, notably Britain, it is more likely that the labour was undertaken by slaves under the supervision of the Roman army.

During the construction of their roads, the Romans paid attention to aesthetics as well as engineering, documented by Plutarch who wrote of Caius Gracchus<sup>7</sup>:

"....roads which he was careful to make beautiful and pleasant as well as convenient. They were drawn by his directions through the fields, exactly in a straight line, partly paved with hewn stone, and partly laid with solid masses of gravel. When he met with any valleys or deep water-course crossing the line, he either caused them to be filled with rubbish, or bridges to be built over them, so well levelled that, all being of an equal height on both sides, the work presented one uniform and beautiful appearance."

The Romans had developed the technology of manufacturing lime based cements which allowed them to use lime mortar in their roads, particularly to strengthen the foundation stones. They used mortars between foundation stone slabs to permit rougher slabs to be used and to ensure that the foundation was waterproof. Lime mortars were also used to grout gravel layers within the pavement structure. Usually, the road surface was left flexibly bedded since the accuracy to which the surfacing stones were dressed precluded the need for mortar - a general maxim in construction is that whenever something is built from a collection of elements, the designer has a choice between using accurately manufactured components touching each other or using less well formed elements mortared together. The Romans recognised the differences in the quality of sands from different sources and Vitruvius<sup>9</sup> mentioned river sand (arena fluviata), dredged sand (arena marina) and quarry sand (arena fossica). He proposed the following mix designs according to sand quality, using river gravel (glarea) as the aggregate.

|                       | Lime mortar | Sand    | Gravel   |
|-----------------------|-------------|---------|----------|
| River sand concrete   | 1 part      | 2 parts | 9 parts  |
| Dredged sand concrete | 1 part      | 2 parts | 9 parts  |
| Quarry sand concrete  | 1 part      | 3 parts | 12 parts |

In 150 BC, a naturally occurring cement was discovered near Puzzeoli which was named puzzolana. This material was sometimes used as a partial replacement for lime mortar and a common mix comprised one part lime, three parts puzzolana and three parts sand. These mortars developed 28 day compressive strengths in the order of 15N/mm<sup>2</sup> and were used extensively in road construction. Such strengths are very similar to those achieved by present day lean concretes used in road construction.

The most relevant of all of the road construction materials developed by the Romans is the one which is given least attention by commentators. All of the Roman roads included crushed rock as the major structural component of the road. Usually, the crushed rock was placed directly above the large foundation stones and sometimes, a finer crushed rock course was placed above a coarser one. By crushing naturally occurring rock such that a range of particle sized resulted, the Romans were able to compact the material into a solid mass which had surprisingly high levels of strength and durability as well as being mouldable into the shape required for the road. The concept has survived and many present day roads rely upon crushed rock as a major component of the structure of the road. MacAdam demonstrated that by introducing fine crushed material into open textured coarser material, a resulting material could be produced which had enhanced engineering properties. MacAdam roads became common in Britain during the 19th century and were improved by including tar as a binding agent to form tarmacadam which could sustain loading from heavy 20th century pneumatic tyred vehicles. Today's dense bitumen macadam (DBM) represents a further development of the Roman invention, or possibly of the Roman adaptation of an Etruscan invention.

In cases where the crushed rock adopted a particle size distribution which did not produce sufficient strength or stability, the Romans introduced the practice of including a binder within the material. In the UK, this was often local clay. In the South East of England, local material won from the Thames Valley comprised gravel in a matrix of clay (called hoggin today) and the Romans used this for roads in the area. In other parts, slaked lime was used as a cement.

The strength of crushed rock is often described by reference to its California Bearing Ratio (CBR) which is a measure of the resistance offered by the material to a 50mm diameter steel

plunger being slowly pressed into the compacted material. The CBR of a sample is expressed as a percentage of the resistance of a standard limestone crushed rock used by the California State Transportation Board (Caltrans). It can be measured by a laboratory test or in the field. Typically, crushed rock road construction materials in the UK achieve CBR's of between 20% and 50%, whereas values of 80% or more are common in the US and elsewhere. The crushed rock materials revealed in archaeological excavations in the UK would have CBR values of approximately 30% and would have been capable of supporting Roman vehicles and pedestrian traffic directly. The purpose of the cobblestones used on the road surface was to prevent erosion of the crushed rock beneath and to provide a more comfortable surface for both carts and pedestrians. The cobblestones comprised a surface course and added little to the strength of the road.

The major difference between Roman roads and present day roads is in the use of large flat stones in the foundation of Roman roads. Today, the lower courses of a pavement usually comprise granular or sometimes stabilised material compacted to act as support for the courses above. The Romans placed loosely fitting stones of typical size 600x400x200mm thick directly over the natural ground, sometimes without even removing topsoil or turf. Sometimes, the foundation stones were mortared together and sometimes more than one layer was included. It is considered that this detail was installed for two reasons. Firstly, the Romans rarely removed soft existing material and they would have found that crushed rock and gravel would often penetrate the underlying soft material and so add little to the strength and durability of the road. Secondly, in many locations, large slabs required less effort to manufacture than crushed rock. More effort is needed to reduce rock to smaller stones and the Romans would have soon realised that there was no need to use crushed materials for this course, large stones would provide a foundation of suitable strength. Thirdly, the foundation stones would allow the granular materials placed above them to be fully compacted by ramming. No matter how much compactive effort is applied to crushed rock, it will densify significantly only when the underlying material can provide a counter reaction. The ramming technique adopted by the Romans required a particularly substantial reaction and the large flat stones provided that reaction.

## <u>19</u> Construction of the Via Appia and other Italian Roman Roads

The Etruscan roads had weak pavements and did not last. Appius Claudius Caecus insisted that the first main Roman road should be built to a higher specification and used the grey-black basalt stone from local quarries as the paving material for his Appian Way. This material is known as the silex-lava stone and became used commonly to pave Roman roads in Italy<sup>11</sup>. The silex was transported from local quarries on four-wheeled carts to the construction site where it was cut to an octagonal shape by construction workers so that it could be wedged tightly against its neighbours. In 535 AD, a Greek having walked over the Appian Way commented<sup>8</sup>:

"....Apius had the stones planed and polished and cut them so as to form eight angles. He joined them together without cement and so closely that they had not seemed to be jointed, but to form one whole; and notwithstanding the long time elapsed (847 years) and the fact of their daily being travelled over by so many vehicles and cattle, the compactness of the stones has not been lessened".

Clearly, the objectives of today's small element pavement constructors had been achieved on the Appian Way so confirming that the well designed and constructed paved road can survive many hundreds of years of use.

The Roman engineers who were in charge of the road projects were called *architecti*. Acording to Vitruvius an *architectus* should have skills in arithmetic, geometry, astronomy, history, law, painting, music and philosophy. He should be "*high minded and not arrogant, but easy going, fair, loyal and above all not greedy*". Also, he needed experience in setting out the original line of the road. Whilst the Emperor would dictate between which two cities the road should run, the *architectus* had full authority over the route which the road took. Typically Roman roads were constructed as a series of straight lines turning usually at high points. Soft ground would often be circumvented in order to eliminate material which would have been needed to form a large embankment over the soft material. It was common in early Rome for every householder to employ his own path maker who would be responsible for keeping his domestic paving in good repair.

The road engineers employed surveyors who used plum-line instruments to ensure the roads were constructed in straight lines. A feature of the Appian Way was the planting of trees along its edge to provide shade for travellers. As the Appian Way was extended further from Rome, it reached the Pontine Marshes where the highway engineers constructed a road 2m above ground level to avoid flooding. They first drove wooden piles along each verge which extended 2m above ground level. They then filled the void between these piles with crushed rock which was compacted to receive the polygonal silex-lava surfacing.

It is interesting to compare the polygonal surfacing stones used on the Appian Way with the rectangular stone used to pave African and British roads. For both rectangular and shaped stones each stone usually weighed over 100kg and would require several men to position it. Locating each stone accurately amongst its neighbours would require a good deal of skill and practice and was probably considered to be a prestigious occupation. At the edges, the surfacing slabs were cut to straight lines so as to abut the kerbstones. It is difficult to assess the visual effect of this arrangement, but it is certainly the case that the resulting roads were very attractive. Great care was taken to ensure that each edge stone was cut to a perfect straight line. It is probable that in most cases, the stones were laid as full sized stones so that a string line could be formed along their length so as to allow accurate edge cutting. The kerbstones would be laid later. The accuracy of the cutting and of the laying meant that no jointing material was used and the stones relied upon good fit to maintain their stability over hundreds of years. Figure 3 shows a typical cross section of a major Italian Roman road.

## 20 Roman Roads in Gallia (France)

Gallia or Gaul was, according to Caesar's Gallic War, divided into three parts. The first and smallest was Aquitainia in the south west between the Pyrenees and the River Garonne. The second part, from Garonne north to the River Seine, comprised Celtic Gaul and beyond the Seine was the third part, Belgic Gaul. All of these three parts were defeated by Caesar's army in 58 BC so that the Romans conquered what is now southern France. The remaining part of France, was Belgic Gaul, and this was gradually conquered although some parts of Reims capitulated without any fighting.

The importance of conquering Gaul was that the Romans then had a direct land bridge from the Mediterranean Sea to the North Sea and this encouraged them to construct a network of roads, some of which terminated at the Roman town of Gesoriacum near the Straits of Dover so that Britain could be conquered later in 43 BC. By 56 BC, Caesar had taken all of Gaul so that he was then able to undertake his initial unsuccessful expeditions to Britain and to cross the Rhine into Germany. Southern France was called Gallia Narbonesis by the Romans and had been under Roman occupation since 121 BC. The roads in Gallia Narbonesis followed natural geographical features. The main road was the Via Domitia from the Rhone to the Pyrenees and two main roads led off from it, one ran northwards beside the Rhone to Lyons and the other ran from Toulouse to Bordeaux on the Bay of Biscay.

A major problem for the Romans was crossing the Alps from Italy to Gaul. They used the Mont-Genevere Pass which became very difficult in winter. To travel from Rome to the Rhineland either the Little St. Bernard Pass or the Great St. Bernard Pass was used. The roads through these passes followed the Italian pattern of road-building in which large stones were used to surface crushed rock road bases. Usually, these roads were constructed only slightly above grade.

The roads of Gaul were not centralised on Paris as present day French roads are. Roman roads comprised a regular network covering the whole country. The eastern part of Gaul was more populated than the west and for this reason the roads were built to a higher standard usually being surfaced with cobblestones. Contemporaneous literature mentions the small town of Lutetia Parisiorum which was occupied by the Parisii tribe, a small independent tribe with more powerful neighbours. It is interesting to note that even in the 17th century, the Bishop of Paris was subordinate to the Arch Bishop of Sens. The major city built by the Romans was Lyons which was at the centre of Gaul and was constructed as a model of how the Romans wished their newly conquered people to construct their own cities. However, in the main, many of the pre-Roman towns such as Paris, Amiens, Reims, Bourges and Besancon continued their former role during the Roman occupancy. It is interesting to note that whereas most of the large French towns of the Roman period have evolved into the present large cities of France, in Britain most of the large cities today did not exist in Roman times.

Whilst there is good documentation regarding the pattern of the Roman roads in Gaul, there is less information concerning their details. This is because of the survival of the Roman towns and therefore of the roads connecting them. This means that subsequent construction has replaced that of the Romans so that the construction of the Roman roads has been obliterated in most areas. There are some exceptions. For example there are still roads in service in Nimes which are constructed according to the Roman pattern. It seems that the principal construction materials used by the Romans was the relatively hard limestone excavated from quarries along the coast of the South of France. This material is still used today in road construction and comprises very durable light coloured limestone which has a texture similar to marble. Even today, this material dominates construction in the area and gives many of the towns in the south of France their unique character.

## 21 The streets of Nimes

Many of the present day streets in Nimes, France, have paved surfaces which have survived from Roman times. Streets were surfaced with limestone pavers won from local quarries. In order that the surfacing could accommodate pavers of different sizes, the pavers were laid in rows across each street and pavers of similar width are each used for one row. Progressing along the street, the rows vary in width from large stones incrementally down to the smallest and then back to the largest. This system eliminates a good deal of labour and minimises waste of quarried material. Effectively, the stone mason was able to fashion a paver from each piece of quarried stone so as to use as much as possible of the stone. Interestingly the city of Nimes has recently repaved several city centre streets using the same system, having reopened the Roman quarry for the purpose. Because the new Nimes streets were trafficked by present day heavy commercial vehicles including buses with 12,000 kg axles, a good deal of thought had to be applied to designing the structure of the roads - the present day axle loads are over ten times greater than the ones in Roman times. The Author was retained by the architects who developed the new project to ensure that the streets would withstand present day loading.

#### <u>22 Germany</u>

In Roman times Germania was larger than the present Germany, stretching as far as the Danube in the east and including all of what is now Holland and Belgium and some of Denmark. The Romans considered Germania to be grim and gloomy. This was partly because of the climate and partly because of the preponderance of trees in Germany at that time. Even where there were no trees, there were often marshes and areas where large rivers, such as the Rhine, the Weser and the Elbe frequently overflowed. In Holland, the north sea would frequently inundate vast areas of the land. Because the rivers of Germania were navigable, the roads had played a much lesser role in the prosperity of the land then had been the case in southern Europe and Italy. The Cimbri and Teutons originally from the north of Denmark crossed Germania in 113 BC and defeated the Romans in the Alps and in 105 BC they again defeated the Romans themselves and take Rome, however, the General Gaius Marius defeated them. In 58 BC other German forces rose against the Romans but were defeated by Julius Caesar.

The most serious conflict between Rome and the Germans was the German War in which the Emperor Augustus sought to expand the frontiers of Rome to the Elbe and the Danube so that the Roman empire would no longer be concentrated around the Mediterranean. In 9 AD, Augustus suffered a defeat when he was ambushed in the Tuetonburger Forest and three legions were killed. From that time onwards, Rome never really dominated Germany again although some unsuccessful excursions were launched which led to significant Roman casualties and the loss of many ships in the north sea. The last Roman attempt to subjugate Germany took place in 180 AD when the Emperor Marcus Aurelius pursued the Germans and took control of the German province of Marcomannia. Because of the failure of the Romans to fully conquer Germania, the Roman roads in the country were not well developed. However, there were some roads which followed natural features. For example, Hellweg ran from the important Roman military base at Vetara on the Rhine through Tuetonburger Forest to Veser near Minden, it then ran past Hildesheim and met the Elbe near Magdeburg. Effectively, roads such as this and others comprised the east-west Germany communication system whilst north-south communication was by the rivers.

#### 23 Spain

The mountainous nature of Spain has always inhibited travel. Not only are the mountains difficult to negotiate, but the river valleys do not form particularly useful routes of communication. Roman roads in Spain were in the main historic tracks following natural features as best they could. The Romans travelled to Spain by sea and used the existing network of tracks to gain access to the interior. Although today the Spanish road network radiates from Madrid, this was not the case in Roman times and Madrid did not exist until the 9th century AD. Spain was considered by the Romans to be a backwater; the Romans centred their activities along the coast and the country gradually declined in importance throughout the Roman occupation. Its main function was as a source of minerals. Gold and silver were brought to Rome from Spain and copper was mined along the Rio Tinto in the south west. Tin, iron and mercury were also mined in the country.

#### 24 Macedonia and Greece

Macedonia, modern Greece, comprises mountainous land with many inlets and islands. For this reason, land travel has traditionally been circuitous and mythology frequently relates incidents of highway robbery. For example, Theseus ridded Greece of the bandit Sciron who operated on the road from Corinth to Athens. As well as Procrustes of whom it was said :

> Procrustes was a man to dread; He strapped his victims to a bed, And those who were too short, 'tis said,

He stretched until they fitted it; Nor did he fail to chop a bit Off those who were the opposite.

He never wore a bowler hat, Or used a ball-point pen. In that He differed from a bureaucrat.'

Oedipus is reputed to have killed his father in a quarrel regarding the right of way at a cross-roads on the road between Delphi and Daulis. The Macedonians conquered their southern neighbours in Greece and the Greeks regarded the Macedonians as being of poor

intellect, although they did speak Greek. Macedonia had been as large as Greece and comprised independent tribes such as the Illyrians who figured in Shakespeare's Twelfth Night.

Whilst the roads between the towns in Macedonia and Greece were of poor quality and often unpaved, the streets in Corinth, Delphi and Athenae were surfaced usually with rectangular stone of size approximately 600mm x 600mm. The Romans paid little attention to improving the existing network of roads preferring to travel by sea. One notable feat of Roman engineering comprised a 1km bridge of boats, i.e. a floating bridge constructed across the Danube. This bridge was eventually replaced by a permanent timber structure with stone piers and abutments with Roman Forts at each end. Other major engineering feats in Macedonia and Greece comprised canals and a road cut into the cliff wall of the Danube Gorge. This road was cut into the vertical cliff face and parts of it were constructed on a timber deck built out from the rock. This project probably represents the pinnacle of Roman engineering and illustrates the degree of ingenuity which the Romans were prepared to apply where necessary.

#### 25 Africa and Egypt

The major obstacle to communication in North Africa is the Sahara Desert which stretches as far north as the sea in many zones. The principal means of communication along the North African coast is the sea but the Romans built a significant network of roads centred on Carthage, just 150 miles by sea from Sicily. The streets of Carthage were usually relatively narrow and were paved with square stones of size 400mm by 400mm sometimes set square with the line of the road and sometimes set at 45° to achieve a diamond pattern. These roads were included approximately 1m long stone kerbs. The cutting of the diamond patterned stones to the kerbs was done particularly accurately.

The mobility of Roman legions is evident from the fact that the legion stationed in Nimes in France adopted the crocodile as its motif. This is because they had previously been stationed in Egypt where they were fascinated by the crocodiles which they had observed on the Nile. A present day major clothing manufacturer, originated in Nimes, has adopted the same crocodile motif for its garments. The Roman soldiers would have used the North African roads to reach the great port of Alexandria before sailing back to Rome. Because civilisation had existed in Egypt for thousands of years prior to the Roman conquest, the Romans made little effort to improve Egyptian roads and transport was usually undertaken by the Nile delta rivers and by the Nile itself. The Port of Suez already existed and was called Clysma. Goods were unloaded there and taken by road north to the Port of Pelusium on the Mediterranean or west to the Nile and then down the river to Alexandria. In fact, the Romans developed a canal close to the Nile to improve navigation but repeated silting made this canal unserviceable most of the time.

Many of the ships did not proceed as far north as Clysma at the very northern tip of the Red Sea but instead discharged their cargoes further south at one of the several harbours on the Egyptian East Coast. This was because the winds were generally from the north which made progress to the north of the Red Sea very slow. Hadrian built a new road, the Via Hadriana, which ran from one of these ports, Berenice, along the coast of the Red Sea heading north and then turned inland to Antinoopolis

## 26 Roman Road Maintenance

Julian law had been formulated by the first century BC and dealt at some length with the maintenance and repair of the city streets in Rome<sup>8</sup>. Much of the liability for keeping the roads in good order was taken by the frontagers, i.e. those whose properties lined the streets. Julian law stated that water was not to stand in the streets so that it would impede the passage of the population. Each frontager had the responsibility for maintaining his drains free flowing as far as the junction with a main drain. If someone defaulted, the city would appoint a contractor to make the necessary repairs and would charge the cost to the defaulting owner, possibly adding a fine. Ten days' notice was given and a public poster was displayed naming the street and the defaulting frontager. Most of the streets comprised stone blocks bedded flexibly and these were expected to be kept in very clean condition.

From 6 BC onwards, street commissioners were appointed and they had the authority over their part of the city to maintain the streets using slaves. Various rulers took maintenance more seriously than others and Vespasian is reported to have repaired, at his own expense, Roman streets which had decayed through former negligence. The maintenance of a road involved keeping it at its required width, removing all obstacles from its surface and keeping it clean. Magistrates had the power to require roads to be paved. One local text stated that nobody was allowed to dig holes in the streets or to build anything on them<sup>8</sup>. Fines were imposed upon anyone who was found to be breaking these rules. The law also stated that no-one was allowed to create a poorer quality road under the pretext of repairing it.

Julian law dealt at some length with street cleaning. Street sweepers were employed by the city council. Much of the attention to streets followed an incident in which returning soldiers had cut their feet on sharp and uneven paving stones<sup>8</sup>. It also seems that broken clay tiles having fallen from roofs could also be a danger to bare feet. It seems that it was common in Rome for citizens to dump their rubbish in the unlit narrow streets during the night. Interestingly enough, fighting in the streets was banned and the public were not allowed to fling dung or to throw out dead animals onto the street. It seems that fighting in the streets was regarded as an obstruction to passers-by and could frighten horses.

By the first century BC, traffic had become a major public nuisance through the day in Rome so wagons carrying heavy loads were forbidden to move through the day and all heavy deliveries or removals had to take place in the late afternoon and after nightfall. There were some exceptions, for example building materials for temples could be carried at any time of the day and dispensation could be obtained for those building major public works, such as aqueducts. Those driving carts through the day needed special licences which were issued for a specific contract. It seems that a Roman refuse disposal system was in operation with carts taking away the refuse early in the morning prior to the crowds filling the streets.

The basic picture is one of a chaotic mix of pedestrians and carts creating a significant level of litter each day such that the roads needed constant cleaning and maintenance. Restriction of carts through the day would not only be safer for pedestrians but would also reduce the noise level. However, there is some evidence that the night traffic kept people awake and was a major problem for many in Rome.

#### <u>References</u>

1 Von Hagen VW Roman Roads, 1966. Weidenfeld & Nicholson (Educational) Ltd., London.

2 Adkins L & R Introduction to The Romans. The Apple Press, London.

3 Sitwell NHH Roman Roads of Europe, 1981. Cassell Ltd., London

4 Margary ID Roman Roads in Britain. Vols. 1&2, 1955. Phoenix House Ltd., London.

5 Boardman J et al. The Roman World, 1986. Oxford University Press, London.

6 O'Flaherty CA Highways and Traffic. Vol. 1, 1967. Edward Arnold (Publishers) Ltd., London

7 Singer C et al. A History of Technology Vol. 2, 1956. Oxford University Press, London.

8 Robinson OF Ancient Rome City Planning and Administration, 1992. Routledge, London.

9 Forbes RJ Notes on the History of Ancient Roads and their Construction, 1934. N.V. Noord-Hollandsche Uitgevers-Mij, Amsterdam.

10 Bergier N Histoire des grandes chemins de l'empire Romain (1e edition, a Paris, 1626, 1 Tome). (2e edition, Bruxelles, 1728, j. Leorard, 2 Tomes; 3e edition 1736)

11 Chevallier R Roman Roads, 1976. BT Batsford Ltd., London.