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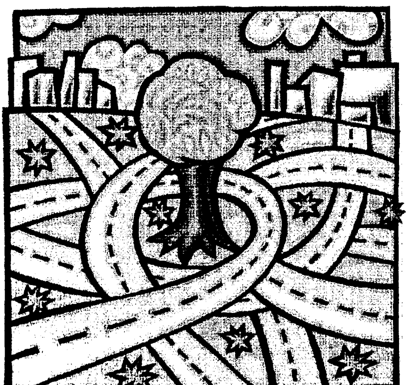
УЧРЕЖДЕНИЕ ОБРАЗОВАНИЯ
«БРЕСТСКИЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»

Кафедра иностранных языков по техническим специальностям

Road Engineering

Сборник текстов по чтению на английском языке

для студентов специальности
1-70 03 01 *«Автомобильные дороги»*
заочной формы обучения



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Сборник текстов по чтению предназначен для студентов факультета заочного обучения специальности 1-70 03 01 «Автомобильные дороги», продолжающих изучение английского языка.

Основной целью сборника является обеспечение активного владения выпускниками неязыкового вуза иностранным языком как средством формирования и формулирования мыслей в социально-обусловленных и профессионально-ориентированных сферах обучения.

Данный сборник включает четыре раздела, каждый из которых представлен пятью текстами по специальности. Перед каждым из текстов даны термины с переводом, а так же три задания на обсуждение проблематики текста.

Сборник текстов по чтению одобрен на заседании кафедры иностранных языков по техническим специальностям и рекомендован к изданию.

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Unit I

From the History of Road-making

Text 1. Early History of Road-making

I. Read the words and learn their meanings:

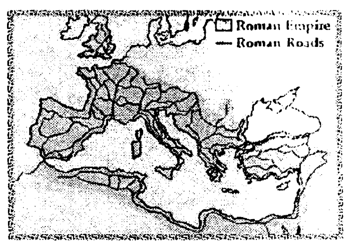
1. paved road – мощёная дорога
2. trade route – торговый путь
3. to build a road – прокладывать дорогу
4. cover *v* – охватывать, распространяться
5. roadway *n* – проезжая часть дороги
6. vehicle *n* – транспортное средство
7. steep *adj* – крутой
8. incline *n* – наклон
9. causeway *n* – насыпная дорога
10. surface *n* – поверхность

II. Read text "Early History of Road-making" and speak on the following points:

Which road is believed to be the earliest paved road?
Who were the best road-builders of ancient time?
What were the characteristics of the Incas' roads?

(1) From the earliest times, one of the strongest indicators of a society's level of development has been its road system. Increasing population and the growth of towns and cities brought about the need for communication and commerce between them. A road built in Egypt by Pharaoh Khufu around 2500 BC* is believed to be the earliest paved road[1] – 1,000 yards (914 m) long and 60 feet (18 m) wide, it led to the site of the Great Pyramid of Khufu*.

(2) The various trade routes[2] developed where goods were transported from their source to a market and were often named after the goods which travelled upon them. For example, the Amber Route led from Afghanistan through Persia and Arabia to Egypt, and the Silk Route stretched 4,000 miles (approx. 6,500 km) from China across Asia. However, carrying bulky goods with slow animals over rough, unpaved roads was a time-consuming and expensive thing.



(3) Around 1115 BC the Assyrian Empire* in western Asia began to build roads[3], and continued for 500 to 600 years. Since the Assyrians were trying to dominate that part of the world, they had to be able to move their armies, supplies and equipment effectively. But the best road builders of ancient time were the Romans*, who built best-engineered and most complex network of roads in the world. The Romans built about 53,000 miles (over 85,000 km) of roads, which covered[4] almost all England, most of Western Europe, radiated throughout the Iberian Peninsula*, and encircled and crisscrossed the entire Mediterranean* area.

(4) Under Roman law, the public had the right to use the roads, but the district through which a road passed was responsible for the maintenance of the roadway[5]. This system was effective as long as a strong central authority existed to enforce it. Unfortunately, with the decline of the Roman Empire the roads gradually came into disuse all across Europe and Great Britain.

(5) On the other side of the Atlantic Ocean, several centuries after the fall of the Roman Empire, the Inca Empire* began to rise in South America during a period that corresponded with the Middle Ages in Europe. The Incas recognized the need for a system of roads that would enable them to extend their conquests and to govern their empire. As they had no wheeled vehicles[6], their roads could have steep[7] inclines[8]. They also built over swamps, and constructed a causeway[9] 24 feet (over 7 m) wide and 8 miles (approx. 13 km) long, which had a paved surface[10] and stone walls. Unfortunately, their system of roads ultimately assisted in their downfall as the invading Spaniards used the Incas' own roads to move Spanish armies, weapons and supplies.

Notes:

* BC – before Christ – до нашей эры
* The Pyramid of Khufu – пирамида Хеопса
* The Assyrian Empire – Ассирийская империя
* The Romans – римляне
* The Iberian Peninsula – Пиренейский полуостров
* Mediterranean area – Средиземноморье
* The Inca Empire – империя Инков

Text 2. Roman Roads

I. Read the words and learn their meanings:

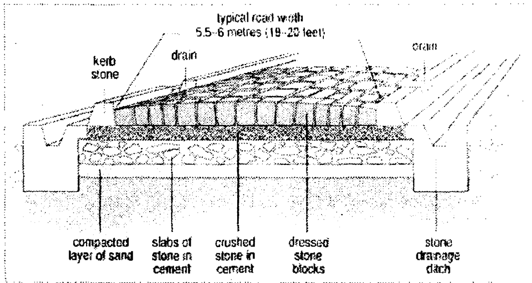
1. span *v* – простираться, охватывать
2. highway *n* – большая дорога
3. expertise *n* – знания и опыт
4. accommodate *v* – приспосабливать
5. terrain *n* – местность
6. plow *n* – плуг
7. trench *n* – ров, борозда
8. roadbed *n* – полотно дороги
9. foundation *n* – фундамент, основание
10. mortar *n* – строительный раствор
11. clay *n* – глина
12. concrete *n* – бетон
13. crushed stone – щебень
14. sophisticated *adj* – сложный
15. resurface *v* – заменять покрытие

II. Read text "Roman Roads" and speak on the following points:

What did the Romans originally design their roads for?
What tools did Roman builders use to construct their roads?
How long did roads built by the Romans remain sophisticated?

(1) The engineers of ancient Rome built an unparalleled network of roads. Approximately 53,000 miles (85,000 km) of roads spanned[1] the Roman Empire, spreading its legions, culture and immense influence throughout the world. The old saying "all roads lead to Rome", simply couldn't have been truer. Rome was the centre of commerce, trade, politics, culture and military might in the Mediterranean.

(2) The original functionality of Roman roads was mainly designed for military exploitation. Starting with local roads, Rome was connected first to Latium*, Ostia* and surrounding areas. By the mid 4th century BC, as Romans pushed south into Samnite* territories and Campania*, longer highways[2] were developed to give Roman legions an advantage over its adversaries.



(3) Like most major Roman fortifications and public works, Roman roads were primarily built by the legions themselves, as they stretched the borders. Engineers were regular members of the Roman army and their expertise[3] in roads, forts and bridge building was an invaluable asset unmatched by any other culture for 2 millennia. As the empire expanded the cost responsibility for building and maintaining the roads were borne by local population rather than by the Roman treasury itself.

(4) There is no single standard of construction of Roman roads. The Romans varied the road construction to accommodate[4] local materials and the terrain[5]. The workmen aligned the road with a groma* and ran levels with chorobates*. A plow[6] was used to loosen the soil and mark the trench[7] margins. Workmen dug trenches for a roadbed[8] with a depth of 6 to 9 feet (1.8 to 2.4 m relatively), carrying away the dirt in baskets.

(5) The earthen bed was tamped firm. The foundation[9] of lime mortar[10] or sand was laid to form a level base. Next came stones of about 4 to 5 inches (10 to 12 cm) in diameter, cemented together with mortar or clay[11]. This layer could be from 10 inches to 2 feet (25 to 60 cm) deep. The next course was 9 to 12 inches (22 to 30 cm) of concrete[12] filled with crushed stone[13]. The top course constituted blocks of stone that were 6 inches (15 cm) or more thick and carefully fitted. The use of paving stones was rare on country roads.

(6) Famous for their straightness and design the Roman roads remained the most sophisticated[14] until the advent of modern road-building technology in the late 18th and 19th centuries. Many of their original roads are still in use today, although they have been resurfaced[15] numerous times.

Notes:

* Latium – Лациум (древняя область в Италии)
* Ostia – Остия (древний город в Италии)
* The Samnites – Самниты (союз воинственных племен в древней Италии)
* Campania – Кампанья (область в Италии)
* Groma – измерительный инструмент
* Chorobates – хоробат, инструмент для определения уровня воды

Text 3. Appian Way

I. Read the words and learn their meanings:

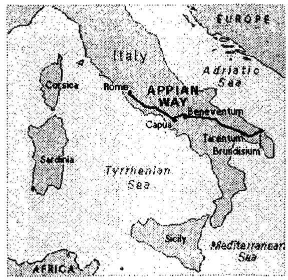
1. censor *n* – цензор
2. extend *v* – удлинять
3. course *n* – направление и длинна
4. highway *n* – большая дорога
5. curator *n* – надзиратель, смотритель
6. convex *adj* – выпуклый

7. drainage *n* – дренаж
8. lime mortar – известковый строительный раствор
9. polygonal *adj* – многоугольный
10. milestone *n* – камень с указанием расстояния в милях

II. Read text "Appian Way" and speak on the following points:

Who was the Appian Way named after?
What was the total length of the Appian Way?
Why was the Appian Way an important route in ancient Italy?

(1) The Appian Way* (lat. Via Appia) is the first and one of the most famous of the ancient Roman roads, running from Rome to Brundisium* (modern Brindisi). The Appian Way was begun in 312 BC by the censor[1] Appius Claudius Caecus*. At first it ran only 132 miles (212 km) from Rome south-eastward to ancient Capua*, in Campania, but by about 244 BC it had been extended[2] another 230 miles (370 km) south-eastward to reach the port of Brundisium (Brindisi), situated in the "heel" of Italy and lying along the Adriatic Sea.



(2) From Rome southward the Appian Way's course[3] was almost straight until it reached Tarracina* on the Tyrrhenian Sea*. The road then turned inland to the southeast to reach Capua. From Capua it ran east to Beneventum* (modern Benevento) and then south-eastward again to reach the port of Tarentum* (modern Taranto). It then ran east for a short distance to terminate at Brundisium.

(3) The Appian Way was celebrated by Horace* and Statius*, who called it the Queen of long-distance roads. As the main highway[4] to the seaports of south-eastern Italy, and thus to Greece and the eastern Mediterranean, the Appian Way was so important that during the empire it was administered by a curator[5] of praetorian rank. The road averaged 20 feet (6 m) in width and was slightly convex[6] in surface in order to facilitate good drainage[7]. The road's foundation was of heavy stone blocks cemented together with lime mortar[8]; over these were laid polygonal[9] blocks of lava which were then smoothly and expertly fitted together. The lava blocks formed a good travelling surface and proved to have extraordinary durability over the centuries. The first few miles of the Appian Way outside Rome are flanked by a striking series of monuments, and there are also milestones[10] and other inscriptions along the remains of the road.

Notes:

* The Appian Way – Аппиева дорога
* Brundisium – Брундизий, портовый город в др. Италии, конечный путь Аппиевой дороги (ныне Brindisi)
* Appius Claudius Caecus (лат. caecus – слепой) – Слепой Аппий Клавдий
* Capua – Капуя
* Terracina – Террачина
* Tyrrhenian Sea – Тирренское море
* Beneventum – Беневент, город в др. Италии к востоку от Капуи (ныне Benevento)
* Tarentum – Тарент, город в др. Италии (ныне Taranto)
* Horace – Гораций
* Statius – Статий

Text 4. Sweet Track

I. Read the words and learn their meanings:

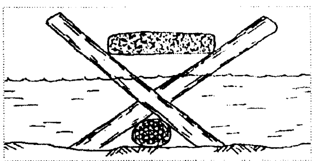
1. track-way *n* – тропинка, дорога с колеёй
2. drainage ditch – дренажная канава, кювет
3. plank *n* – толстая и широкая доска
4. contrive *v* – придумывать, изобретать
5. drive into *v* – вбивать
6. angle *n* – угол
7. fit into *v* – вставлять
8. carpentry *n* – плотничные работы
9. surveyor *n* – землемер
10. lay out *v* – разбивать, трассировать
11. flint *n* – кремень
12. startling *adj* – потрясающий, поразительный
13. radiocarbon dating – определение возраста по углероду
14. cohesion *n* – сплочённость
15. huge *adj* – огромный

II. Read text "Sweet Track" and speak on the following points:

How did the Sweet Track come to light?
How did ancient people construct the Track?
What analysis let archaeologists date the Sweet Track?

(1) The Sweet Track* (named after Raymond Sweet, the man who discovered it) is the oldest prehistoric track-way[1] found in Britain. It is in southwest England between Exeter* and Bristol* and it was constructed nearly 6000 years ago, four millennia before the Romans occupied that region.

(2) The track came to light in 1970 when Raymond Sweet was cleaning drainage ditches[2] in a peat bog as he struck a wooden plank[3] deep in the peat. The wrong thing in the wrong place! The peat was acidic enough to kill the bacteria that degrade wood that's why it was well-preserved. So he took it to John Coles at Cambridge University and a major research was begun.



(3) Six thousand years ago Neolithic* dwellers contrived[4] this walkway to get across the swamp below their village. First they laid long rails of 4-inch-diameter (10 cm) poles on the underwater soil. Then they drove[5] 5-foot (4.5 m) pegs into the soil at 45-degree angles[6]. The pegs crisscrossed over the poles, forming X-shaped brackets every few feet. Finally, they fitted[7] wide planks into the upper arms of the X-shaped brackets, while the poles below carried their weight.

(4) The result was a walkway a foot above the water. Tool-marks on the wood already show a fine command of carpentry[8]. The boards were shaped by people with better tools than we would have imagined. And it took sophisticated wood-splitting technique to make them. Excavation even turned up surveyor's[9] stakes that had been used to lay out[10] the path for its builders.

(5) Moreover, artefacts dropped along the walkway (among these were flint[11] and stone axe heads and the occasional pot), show that those not-so-primitive people made pottery, they had invented glue, and they traded with distant tribes for flint. The most startling[12] artefact is an axe head, shaped from European jade. These forgotten people clearly owned some mysteries.

(6) Radiocarbon dating[13] originally gave a range of dates for the track. Then new tree-ring dating techniques let archaeologists narrow it down to the winter of 3807 and 6 BC, when the wood was felled. So the path reveals social cohesion[14]. It shows how these ancestors put their wills and minds together and produced a huge[15] and unique project for the common good. The track might well have been erected in a single day by a crew of ten using precut wood.

(7) Artefacts finally showed that Medieval* times were a far less Dark an Age than we once thought. And, with items like this old road turning up, we see that the Stone Age* included some very civilized ancestors.

Notes:

* The Sweet Track – Свит Трек
* Exeter – Эксетер
* Bristol – Бристоль
* Neolithic – неолитический
* Medieval – средневековый
* Stone Age – каменный век

Text 5. How to Build a Road: A 19th Century Primer[1]

I. Read the words and learn their meanings:

1. primer *n* – букварь; учебник для начинающих
2. stump *n* – пень
3. boulder *n* – валун, глыба
4. entirely *adv* – полностью
5. debris *n* – мусор
6. levelling *n* – нивелирование
7. hoe *n* – мотыга
8. survey *v* – межевать
9. elevation *n* – высота
10. sight line – линия визирования
11. measuring rod – измерительная рейка
12. erode *v* – разрушать(ся)
13. wheel rut – след колеса
14. cover *n* – покрытие
15. sledge *n* – кувалда, молот

II. Read text "How to Build a Road: A 19th Century Primer" and speak on the following points:

What was a distinguishing mark of a 19th century road?
What device was used to measure distance of a road in the early 19th century?
Why did roads badly need a stone top cover?

(1) In the 19th century building a road involved simple technology and heavy labour. The first task to clear the road was usually the most difficult. Stumps[2], boulders[3], bushes and trees had to be cleared. Usually, this was done entirely[4] by hand or with the help of horses. When a stump-puller was invented seven men and a team of horses could pull forty stumps in a day using this device. Considering the density of forest through which many roads ran even this was slow progress indeed.

(2) Once debris[5] was cleared, levelling[6] began. This was the distinguishing mark of an improved road, separating it from paths for foot travel or animal migration. Using hand-held rakes, hoes[7] or sometimes horse-drawn scrapers, farmers and rural labourers supervised by township officials created a surface amenable to wagon and stagecoach travel.

(3) The land also had to be surveyed[8] by a professional to determine the most efficient route between two points. Distance, direction and elevation[9] – all had to be measured. Through the early 19th century, distance was measured with an iron chain 66 feet long known as Gunter's chain*. Eighty chains equalled one mile; ten square chains equalled an acre. To calculate distance, Gunter's chain was simply stretched between two points as many times as necessary.

(4) Direction was measured with a magnetic compass which allowed a surveyor to determine how much a sight line[10] diverged from magnetic north-south. Most elevation measurement was done with a simple level – a flat device containing a glass cylinder of water with a small air bubble. Elevation changes were determined by attaching the level to a sight, placing a vertical measuring rod[11] some distance away, and then reading through the sight the relative height of the second location. Changes in elevation were extremely important in road building; in the interest of efficient travel.

(5) Cleared, flattened and graded, a road could be finished at this point. However, builders found that these sorts of roads eroded[12] quickly. Drainage ditches were added to stop the erosion process and avoid wheel ruts[13], but a permanent road badly needed a top cover[14] of stone. In 1799, an anonymous road builder published "Directions for Making Roads" in the Philadelphia Magazine and Review. Here is his advice on laying stone:

> *"The stones should be spread equally over the surface, and settled with a light sledge[15]; over this a layer of small stones, not larger than eggs, should be scattered and settled with hammers between the interstices of the largest. Over this a small quantity of any hard clay, just sufficient to cover the stones, should be spread; if mixed with gravel it will be better. In a month or two [of traffic], the clay and gravel will be worn away, and the corners of the large stones will appear – men should now be employed to break the stone with sledges, weighing about two pounds and a half. After another month, the road must be broken, with care, in the same manner."*

Notes:

* Gunter's chain – землемерная или геодезическая цепь Гантера

Unit II

Great Road Engineers of the Past

Text 1. John Metcalf (1717–1810)

I. Read the words and learn their meanings:

1. construction *n* – строительство
2. turnpike road – дорога с взиманием сбора за проезд
3. road making – дорожное дело
4. contractor *n* – подрядчик
5. work out *v* – разрабатывать
6. gravel pit – гравийный карьер
7. foundation *n* – основание, фундамент
8. convex *adj* - выпуклый
9. design *v* – проектировать, конструировать
10. roadbed *n* – полотно дороги

II. Read text "John Metcalf" and speak on the following points:

Why did John Metcalf become famous?
What was the first project John Metcalf was engaged in?
What kind of roads did John Metcalf design?

(1) John Metcalf* was one of the first professional road builders to emerge during the Industrial Revolution in Britain. He became famous as the builder of roads and bridges using techniques that in the 18th century were revolutionary. Blind from the age of six John Metcalf also known as Blind Jack of Knaresborough* had an eventful life which was well-documented just before his death.

(2) In 1765 the English Parliament passed an act authorising the construction[1] of turnpike road[2] between Harrogate* and Boroughbridge*. At that time the art of road making[3] was not much understood and there were only few people around with road building experience. There was hardly any chance for a contractor[4] to find a person capable of executing the necessary work in a remote country place such as Knaresborough.

(3) John Metcalf was born in Knaresborough and he realized the significance of roads in that area better than anyone else. So he seized an opportunity to try his hand at road construction. He won a contract to build a three-mile (5 km) section of Harrogate–Boroughbridge road between Minskip* and Ferrensby*. He explored that section of countryside and worked out[5] the most practical path. The materials for making the road were to be obtained from one gravel pit[6] for the whole length. This was only the first of a vast number of similar projects in which Metcalf was afterwards engaged extending over a period of more than thirty years.

(4) Metcalf believed that a good road should not only have rigid foundation[7] and smooth convex[8] surface but also be well drained. He understood the importance of good drainage because he knew it was rain which caused most of the problems on the road. John Metcalf designed[9] and built firm, three-layer roads. First he placed large stones on the bottom layer, then he took the materials excavated from the roadbed[10] such as smaller rocks and earth and used them for the middle layer, and finally he spread a layer of gravel on top. He also worked out a way to build a road across a bog using a series of rafts made from ling and heather tied in bundles as foundation.

(5) During the period 1765–1792 John Metcalf built about 180 miles (300 km) of turnpike road throughout the then counties of Lancashire*, Derbyshire*, Cheshire* and Yorkshire*. His roads could be used without repairing for several years. He acquired an unequalled mastery of his trade with his own accurate method of calculating and constructing.

Notes:

* John Metcalf – Джон Меткалф
* Knaresborough – Нэрсборо
* Harrogate – Харрогит
* Boroughbridge – Боробридж
* Minskip – Минскип
* Ferrensby – Ферренсби
* Lancashire – Ланкашир
* Derbyshire – Дербишир
* Cheshire – Чешир
* Yorkshire – Йоркшир

Text 2. Pierre-Marie Jerome Tresaguet (1716 – 1796)

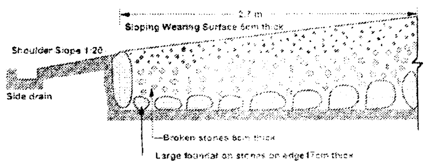
I. Read the words and learn their meanings:

1. paving – мощение улиц
2. road construction – дорожное строительство
3. quarried stone – камень, добытый из карьера
4. shape *v* – придавать форму
5. cambered – выпуклый, выгнутый
6. pavement *n* – дорожное покрытие
7. wedge in *v* – вклинивать
8. broken stone – щебень
9. trench *n* – канава, борозда
10. surface *n* – поверхность
11. impervious *adj* – водонепроницаемый
12. pressure *n* – давление
13. bumpy *adj* – ухабистый
14. subject to *v* – подвергать (воздействию, влиянию)
15. rut *n* – колея, борозда

II. Read text "Pierre-Marie Jerome Tresaguet" and speak on the following points:

What were the characteristics of Tresaguet's method of road construction?
Why was Tresaguet's decision to keep road running surface level with the surrounding countryside questionable?
What were Tresaguet's important contributions to the art of road making?

(1) Pierre-Marie Jerome Tresaguet* was the first person to bring sound science to road making. A Frenchman, he came from a strong engineering family and worked in Paris on paving[1] matters between 1757 and 1764. For the next eleven years he was chief engineer of Limoges* where he was involved in some 700 km



of road construction[2] and had an excellent opportunity to develop new, better and cheaper method of road construction. The need was certainly there: contemporary attempts to copy Roman practice were proving costly and ineffective.

(2) The Tresaguet pavement employed pieces of quarried stone[3] about 200 mm in size. The pieces were shaped[4] to have at least one flat, narrow side, which was placed on a cambered[5] formation. The pavement[6] structure thus resembled a cobbled road rather than a stack of flat stone slabs. Hammers were then used to wedge[7] smaller pieces of broken stone[8] into the spaces between the larger stones. Next, a further thickness of broken stone was applied to produce a level surface. Finally, the running surface was made with a layer of smaller 25 mm broken stone. The broken-stone running surface performed two functions. First, it permitted a smoother profile to be produced by adjusting the thickness of the layer. Second, it protected the larger stones in the pavement structure from the action of iron wheels and iron-shod hooves.

(3) All this well-engineered structure was placed in a trench[9] to keep the running surface[10] level with the surrounding countryside. This last – very questionable decision – created major drainage problems which were counteracted by making the surface as impervious[11] as possible cambering the natural formation and providing the deep side ditches. Tresaguet was certainly aware of the need to keep the natural formation dry.

(4) Tresaguet's important contributions were to recognize the importance of controlling the pressure[12] applied to the underlying natural formation and then to develop ways to assess its ability to resist those pressures. A common observation of the time was that the use of randomly placed large stones within the pavement structure was inappropriate. They not only provided a bumpy[13] surface but also caused high local contact stresses on the surface of the natural formation, thus resulting in large differential settlements. Tresaguet avoided this by placing large stones over the entire formation, thus ensuring that the formation was subjected[14] to a reasonably uniform and low stress. The system had its problems. The large stones still concentrated the load, mud worked up between them and they tended to separate laterally. Nevertheless, the method came to be widely used throughout central Europe, Sweden and Switzerland.

(5) Tresaguet also introduced a system of continuous road maintenance, initiating the roadman method still used today in many parts of the world. In this technique the roadman was responsible for the maintenance of his length of the road. Writing in1876, W.H. Wheeler said, "The object of the roadman is to so manage his road that ruts[15] are never formed."

Notes:

* Pierre-Marie Jerome Tresaguet – Пьер-Мари Жером Трезаге

* Limoges – Лимож

Text 3. Thomas Telford (1757 – 1834)

I. Read the words and learn their meanings:

1. civil engineer – инженер-строитель
2. gradient *n* – подъём
3. bend *n* – поворот
4. camber *n* – изгиб
5. convex *adj* – выпуклый
6. edge *n* – край, граница
7. camber *v* – выгибать, гнуть
8. encourage *v* – способствовать
9. suspension bridge – висячий мост
10. canal – канал (искусственный)

II. Read text "Thomas Telford" and speak on the following points:

Why is Thomas Telford among the greatest engineers of the past?
What was Thomas Telford's method of road building?
What structures is Thomas Telford famous for?

(1) Thomas Telford came from Scotland and started work as a stonemason but eventually became one of the greatest civil engineers[1]. He built canals, docks, bridges and excellent roads. Telford built many turnpike roads in Scotland, having been commissioned by Parliament to do so but his greatest achievement was the construction of the 310 mile (500 km) road from London to Holyhead*. The road was 33 feet (10 m) wide and so perfectly built that parts of it are still used at present time. He took care to avoid steep gradients[2] and sharp bends[3] on his roads. He made the camber[4] across the road gently convex[5], instead of resembling the side of an orange as in the older roads. Telford was very particular about the way his roads were built. Contractors had to carry out Telford's strict requirements.

(2) Telford developed a method of road building which required a foundation of heavy stones, varying in size from 7 inches (17 cm) near the edges[6] to a maximum size of about 9 inches (22 cm) at the centre of the width of a road. The road was then built up with a layer of stones of smaller size near the edges and larger size near the centre with total thickness reaching about 15 inches (38 cm). The surface was cambered[7] to encourage[8] drainage. Telford proposed provision of cross drains at intervals of about 98 yards (90 m). This method provided an excellent quality but it was expensive concerning materials and labour. The vast majority of trusts could not afford to adopt this method with only limited funds at their disposal.

(3) Employed by the government to assist in the development of the Scottish Highlands, Thomas Telford was responsible for the Caledonian Canal*, harbour works at Aberdeen*, Dundee* and the building of more than 900 miles (1,450 km) of roads, including many bridges. Subsequently, in the course of improving the roads from Chester and Shrewsbury* to Holyhead, he built his two famous suspension bridges[9] over the River Conwy* and the Menai Strait* in Wales.

(4) Telford was then employed in improving and building canals[10] to meet the threat of railway competition. This work included a new canal from Wolverhampton* to Nantwich* and a new tunnel at Harecastle, Staffordshire*, on the Trent and Mersey Canal*. Among Telford's other works were the St. Katharine Docks in London, roads in the Scottish Lowlands and the bridges over the Severn at Tewkesbury* and Gloucester*. He also acted as a consultant for the Göta Canal in Sweden. Telford was the first president of the Institution of Civil Engineers.

Notes:

* Holyhead – Холихед
* Caledonian Canal – Каледонский канал (соединяет Северное море с Атлантическим океаном)
* Aberdeen – Абердин
* Dundee – Данди
* Shrewsbury – Шрусбери
* Conwy – Конви
* Menai Strait – Пролив Менай (отделяет остров Англси от Уэльса)
* Wolverhampton – Вулвергемптон
* Nantwich – Нантвич
* Staffordshire – Стаффордшир
* Mersey Canal – канал Мерси
* Tewkesbury – Тьюксбери
* Gloucester – Глостер

Text 4. John Loudon McAdam (1756 – 1836)

I. Read the words and learn their meanings:

1. trustee *n* – попечитель
2. maintenance *n* – эксплуатация
3. broken stone – щебень
4. surface *n* – поверхность
5. pavement *n* – дорожное покрытие, тротуар
6. stress *n* – нагрузка
7. subsequent *adj* – последующий
8. performance *n* – характеристика работы, эксплуатационные качества
9. spread *v* – распределять
10. water table – водная поверхность

II. Read text "John Loudon McAdam" and speak on the following points:

What made McAdam look for alternative methods of road construction?
Why did McAdam depart radically from the Telfordian use of stone blocks as a road base?
How did McAdam's technique avoid road-drainage problems?

(1) John Loudon McAdam* was born in Ayr* in 1756, the youngest of ten children and second son of the impoverished baron of Waterhead. He became involved with roads when he was made a trustee[1] of the Ayrshire Turnpike in the Scottish Lowlands in 1787. Road making then became his hobby. Over the next seven years, his daily involvement increased and his hobby became a passion.

(2) Concerned by the generally low level of road-making knowledge and by the pavement degradation caused by coaches with narrow, iron-tired wheels and relatively high speeds, McAdam had looked for alternatives to the then-current methods of road construction and maintenance[2]. In his empirical observation of many roads, McAdam particularly noted the effectiveness of using small pieces of broken stone[3], the disruption caused by large pieces of stone and the efficiency of breaking large stones into smaller pieces. He realized that 250 mm layers of well-compacted, broken, angular pieces of small stone would provide the same strength and stiffness as, and a better running surface[4] than a more expensive pavement[5] based on a foundation of carefully made and placed large stone blocks. Further, this course of broken stone would reduce the stresses[6] on the natural formation to an acceptable level, provided the formation was kept relatively dry and drained.

(3) It's possible that McAdam's initial radical departure from the Telfordian use of stone blocks as a base was due to the lack of suitable stone for block-making in this part of England. Smaller pieces of stone would have been used out of necessity, and subsequent[7] observation of their performance[8] would then have shown that the blocks were unnecessary. Stone size was an important element in McAdam's method. By keeping stones smaller than the tire width, a good running surface could be made, which could both carry the surface loads and spread[9] them to an acceptably low stress on the natural formation, always assuming that the natural foundation was kept dry.

(4) McAdam's technique also avoided many road-drainage problems because he insisted that the surface of the natural formation be cambered and elevated above the water table[10]. Indeed, good drainage was essential to the success of his method. McAdam's roads were as durable as those of Telford, but much cheaper and easier to construct. Some engineers depreciated his work because of this, but by 1823 his methods were accepted and generally adopted.

Notes:
* John Loudon McAdam – Джон Лаудон МакАдам
* Ayr – Эр (город в Шотландии)

Text 5. Edward de Smedt

I. Read the words and learn their meanings:

1. asphalt *n* – асфальт, битум
2. sheet asphalt pavement – гладкое асфальтовое дорожное покрытие
3. asphalt rock – песчаник, пропитанный битумом
4. crude oil – неочищенная нефть
5. hydrogen *n* – водород
6. nitrogen *n* – азот
7. sulfur *n* – сера
8. oxygen *n* – кислород
9. asphalt cement – асфальтовое вяжущее вещество
10. ribbon *n* – лента

II. Read text "Edward de Smedt" and speak on the following points:

What is Edward de Smedt famous for?
When and where was Edward de Smedt's asphalt pavement laid for the first time?
What is asphalt cement made of?

(1) Professor Edward J. de Smedt invented modern road asphalt[1] in 1870 at Columbia University in New York City after emigrating from Belgium. He patented it and called it "sheet asphalt pavement[2]" but it became known as "French asphalt pavement". A natural rock known as asphalt had been used to construct buildings for many years. In 1824 large blocks of natural asphalt rock[3] were placed on the wide boulevard in Paris known as the Champs-Élysées*. This was the first time this type of rock was used for a road.

(2) On 29 July 1870, the first sheet of Edward de Smedt's asphalt pavement was laid on William Street in Newark, New Jersey. He then engineered a modern, "well-graded", maximum-density road asphalt. The first uses of this road asphalt were in Battery Park and on Fifth Avenue in New York City in 1872. Five years later 54,000 square yards of sheet asphalt from Trinidad Lake were used on Pennsylvania Avenue, Washington D.C.

(3) Today almost all the roads in developed countries are surfaced with de Smedt's man-made asphalt. Asphalt comes from the processing of crude oil[4]. The word asphalt comes from the Greek "asphaltos," meaning "secure". Everything that is valuable in crude oil is first removed and put to good use. Then what remains (hydrogen[5] and carbon compounds with minor amounts of nitrogen[6], sulfur[7] and oxygen[8]) is made into asphalt cement[9] for pavement.

(4) Not much is known about the life of Edward de Smedt and pictures of him are extremely rare – perhaps his fame has been occluded by such famous engineers of the road construction industry as John Loudon McAdam and Thomas Telford, but experts on the history of road construction will always give a special place to Edward de Smedt, without whom our roads would not simply be the same as today.

(5) Ribbons[10] of firm, well-drained, smoothly paved roads and highways are ready to take you and your family anywhere you want to go, thanks to the construction methods pioneered by three Scottish engineers and the invention of Edward de Smedt's man-made asphalt. In the year 1900 there were less than 15 miles of paved road in the world. Today, we have millions of miles of paved roads and streets.

Notes:
* Champs-Élysées – Елисейские поля

Unit III

Building Materials for Road Construction

Text 1. Asphalt

I. Read the words and learn their meanings:

1. asphalt *n* – асфальт
2. adhesive *adj* – связывающий, липкий, клейкий
3. bitumen *n* – битум
4. viscous substance– вязкое вещество
5. hydrocarbon *n* – углеводород
6. tarmac *n* – дёгтебетон
7. by-product *n* – побочный продукт
8. crude oil – неочищенная нефть
9. caulking – уплотнение
10. fractional distillation – фракционная перегонка

II. Read text "Asphalt " and speak on the following points:

Asphalt is not a new material, is it?
What is asphalt composed of?
How is crude oil refined today?

(1) Though a vast majority of today's roads are constructed using asphalt[1], its use has been traced back hundreds and even thousands of years. This naturally occurring substance is used for a number of applications due to its adhesive[2] and waterproofing properties. Though the substance is so common today that it is not usually given a thought, asphalt is all around us in the form of roads, airport runways, roofs, tennis courts, parking lots, batteries, adhesives and more.

(2) Asphalt is a dark brown or black substance composed primarily of bitumen[3]. Bitumen is a broad term referring to a natural or manufactured viscous substance[4] composed of a mixture of hydrocarbons[5]. Asphalt, also referred to as hot-mix asphalt, blacktop, asphalt concrete, tarmac[6], bituminous concrete or macadam, can be naturally occurring but today is more commonly produced as a by-product[7] of the refining process in the petroleum industry. Seepage at the surface of the earth in certain areas gave people access to bitumen many years before contemporary methods made extracting crude oil[8] from within the earth possible.

(3) Around the year 1595, Sir Walter Raleigh* discovered a naturally occurring lake of asphalt on the Island of Trinidad, and quickly found use for the substance in caulking[9] his ship. By the early 1900s, asphalt production as a by-product of petroleum refining had become the primary source of the substance. Oil companies developed the ability to produce asphalt superior to that imported from the naturally occurring lakes. Today, crude oil is refined through the process of fractional distillation[10], which yields bitumen separated from other petroleum components such as gasoline, kerosene, petroleum gas and other products.

(4) An increasing need for quality roadways aligned with the proliferation of the thousands of automobiles produced after World War I. Additionally, World War II brought about a need to improve upon runway technology as planes became heavier and more abundant. Continually improving road building technology has led to miles of bituminous roadways that are central to the lifestyles today.

Notes:
* Sir Walter Raleigh – Сэр Уолтер Рэли

Text 2. Asphalt Quality

I. Read the words and learn their meanings:

1. asphalt cement – асфальтовое вяжущее вещество
2. fluidity *n* – растекаемость, текучесть, подвижность
3. soluble *adj* – растворимый
4. flammable *adj* – воспламеняющий, огнеопасный
5. solvent *n* – растворитель
6. foam *v* – пениться
7. hazard *n* – опасность, риск
8. fume *n* – газ, дым, копоть
9. flashpoint *n* – точка воспламенения
10. ductility *n* – тягучесть, вязкость, пластичность

II. Read text "Asphalt Quality" and speak on the following points:

What factors affect the quality of asphalt cement?
How can the purity of asphalt cement be tested?
How is ductility of asphalt cement measured?

(1) The quality of asphalt cement[1] is affected by the inherent properties of the petroleum crude oil from which it was produced. Different oil fields and areas produce crude oils with very different characteristics. The refining method also affects the quality of the asphalt cement. For engineering and construction purposes, there are three important factors to consider: consistency, also called the viscosity or the degree of fluidity[2] of asphalt at a particular temperature, purity, and safety.

(2) The consistency or viscosity of asphalt cement varies with temperature, and asphalt is graded based on ranges of consistency at a standard temperature. Careless temperature and mixing control can cause more hardening damage to asphalt cement than many years of service on a roadway. A standardized viscosity or penetration test is commonly specified to measure paving asphalt consistency. Purity of asphalt cement can be easily tested since it is composed almost entirely of bitumen, which is soluble[3] in carbon disulfide. Refined asphalts are usually more than 99.5 per cent soluble in carbon disulfide and any impurities that remain are inert. Because of the hazardous flammable[4] nature of carbon disulfide, trichloroethylene, which is also an excellent solvent[5] for asphalt cement, is used in the solubility purity tests.

(3) Asphalt cement must be free of water or moisture as it leaves the refinery. However, transports loading the asphalt may have moisture present in their tanks. This can cause the asphalt to foam[6] when it is heated above 100°C, which is a safety hazard[7]. Specifications usually require that asphalts not foam at temperatures up to 175°C. Asphalt cement, if heated to a high enough temperature, will release fumes[8] which will flash in the presence of a spark or open flame. The temperature at which this occurs is called the flashpoint[9], and is well above temperatures normally used in paving operations. Because of the possibility of asphalt foaming and to ensure an adequate margin of safety, the flashpoint of the asphalt is measured and controlled.

(4) Another important engineering property of asphalt cement is its ductility[10], which is a measure of a material's ability to be pulled, drawn or deformed. In asphalt cements, the presence or absence of ductility is usually more important than the actual degree of ductility because some asphalt cements with a high degree of ductility are also more temperature sensitive. Ductility is measured by an extension test, whereby a standard asphalt cement briquette moulded under standard conditions and dimensions is pulled at a standard temperature (normally 25°C) until it breaks under tension. The elongation at which the asphalt cement sample breaks is a measure of the ductility of the sample.

Text 3. Road Surfacing: Why Does It Matter?

I. Read the words and learn their meanings:

1. although *adv* – хотя; несмотря на то, что
2. vehicle *n* – транспортное средство
3. comply *v* – выполнять
4. rolled asphalt – укатанный асфальт
5. chippings – мелкий щебень
6. skid resistance – сопротивление заносу
7. constituent *n* – составная часть
8. dire *adj* – ужасный
9. friction *n* – трение
10. protrude *v* – выпирать, торчать

II. Read text "Road Surfacing: Why Does It Matter?" and speak on the following points:

What is one of the most common materials used for road surfacing today?
Which components does hot rolled asphalt consist of?
What are the two main types of high friction surfacing material?

(1) Not all roads are the same. Although[1] drivers rarely set foot on the road surface as they move by in their vehicles[2] there is actually huge variety in what their tyres are making contact with. Underneath the car or lorry there are many different types of road surfacing material each of which is chosen for a particular site depending on countless variables. The ingredients that make up the road surface can be influenced by the type of road, the volume and speed of traffic, and its location among others.

(2) Getting these variables right and applying the correct surface option can literally be a matter of life and death, especially on fast roads. One of the most common materials used for road surfacing today is stone mastic asphalt (SMA) sometimes also referred to as thin surface course. SMA consists of variably graded aggregate mixed with a bitumen binder. The production of SMA is predominantly carried out in batch mixing plants to provide as close to uniform consistency as possible in order to comply[3] with specification guidelines. The SMA is laid by a paving machine which is able to evenly spread the material to the required thickness. This is a highly skilled process which must be performed properly to ensure the quality of the driving surface.

(3) An alternative material is hot rolled asphalt[4] (HRA). HRA consists of two components, the surface course mixture and pre-coated chippings[5]. The surface course mixture consists of a bitumen-based binder mixed with intermediate quality small aggregate. This course is laid to the required thickness using a paving machine. Once a section of surface course is laid a chipping spreader passes over it distributing high quality aggregate chippings onto its surface to produce texture and a skid resistant[6] surface. After the chippings have been spread they must be compacted into the surface course using a heavy roller. However care must be taken when compacting. If the surface course is too hot the chippings may be pressed too deep into the material effectively losing their purpose as a high friction surface layer. If compacted whilst the surface course is too cold the chippings may not stick to the course adequately and may become detached by passing traffic again compromising their purpose as a high friction surface layer.

(4) Certain areas of road, like the approach to traffic lights, may require surfaces with higher friction values than can be achieved by the methods outlined above. In such situations a high friction surfacing material may be used. There are two main types of this material. One which is laid hot consists of a resin binder with thermoplastic properties and a coarse aggregate. These

constituents[7], initially solid, are reduced to their fluid state in a temperature controlled hot-pot. Once in the fluid state the material is poured from the outlet-shoe of the pot onto the road where it is manually spread to the desired thickness by the construction team. A material which is laid cold consists of a resin which is mixed with a hardener in a large container using a paddle before being poured and spread onto the road manually. High quality aggregate is then spread over the resin and any excess swept away when the product is dry.

(5) For the road user skidding is an undesirable effect of heavy braking or harsh sudden changes in direction. During a skid the driver may lose control of their vehicle which can end with dire[8] consequences. An important factor in road design is therefore how to reduce the possibility of skidding. Skidding is closely related to friction[9]. This however must be achieved without causing too much damage to the tyre, erosion to the surface and whilst maintaining a suitable ride quality for the road user.

(6) This is achieved using bituminous material combined with aggregate chippings. The spacing between chippings and the height to which the chippings protrude[10] make up the surface's macro-texture. The closer the surface chippings are situated to one another and the higher they protrude from the surface the greater the friction they create between the road surface and the passing tyres. Over time, passing traffic causes the surface aggregate to become polished reducing its micro-texture and consequently reducing its friction/skid resistance ability.

Text 4. Concrete Revolutionizes Road Construction

I. Read the words and learn their meanings:

1. energy efficient – энергосберегающий
2. pot-hole *n* – выбоина
3. recycle *v* - повторно использовать
4. roller-compacted concrete – бетон, уплотненный (дорожным) катком
5. fibre *n* – волокно
6. energy consumption – затрата энергии
7. consolidation *n* – уплотнение
8. compatible *adj* – совместимый
9. challenge *n* – сложная задача
10. guideline *n* – принцип, норма

II. Read text "Concrete Revolutionizes Road Construction" and speak on the following points:

What does roller-compacted concrete consists of?
Which consolidation method does the new concrete material use?
What was the initial challenge with roller-compacted concrete?

(1) A new type of concrete for road building has been developed as an alternative to asphalt or traditionally made concrete in pavements. The material is more energy efficient[1], means less pot-holes[2] and maintenance, is cheaper to make and is ready for use immediately after it has been laid helping to reduce road closure times and traffic jams. Another key benefit is that, when it is disused, the material can be taken away, crushed and recycled[3] for use in a new pavement.

(2) The new roller-compacted concrete[4] (RCC), which has been developed by researchers at the University of Sheffield and EU researches, consists of dry mix concrete reinforced with recycled steel fibres[5] from waste tyres. It is cheap and it also reduces construction time by 15 per cent, bringing a 40 per cent reduction in energy consumption[6] over its lifetime.

(3) The new concrete material uses a very different consolidation[7] method, roller compaction, which means that the dry mix requires less cement than conventional concrete and is stable

enough for light traffic straight after being laid. Finding a suitable reinforcement material that would also be compatible[8] with roller compaction technology (such as fibre reinforcement) was the initial challenge[9]. The researchers undertook a number of successful demonstrations in different countries to ensure the technology could operate under a range of climatic conditions. Concrete laid with roller compaction technology utilises a similar technology as that of asphalt construction, making it ideal for future construction projects.

(4) This success has meant that the team were developing new guidelines[10] that assume the benefits of fibre reinforcement and allow the design of thinner pavements. It could also lead to tyre recycling plants that produce tyre wire for these new concrete applications, which would have the advantage of increasing the profitability of tyre recycling and helping the industry comply with EU landfill directives. However, work still needs to be done to convince the construction industry to introduce new codes of practice that accept fibre-reinforced RCC. The researchers are aware that they need to develop their guidelines so that they can be used in codes. The next focus for their research will now move to recycled aggregates, as they are suitable for fibre reinforcement and would help reduce costs further.

Text 5. Pavement Quality

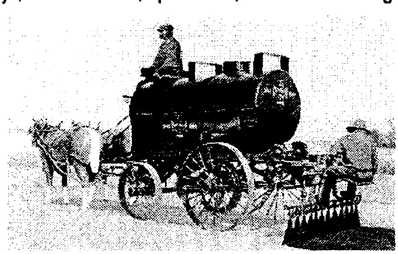
I. Read the words and learn their meanings:

1. durability *n* – долговечность, прочность
2. shedding – сброс
3. rock asphalt – песчаник, пропитанный битумом
4. tar *n* – деготь, смола, гудрон
5. tarmacadam *n* – щебеночное покрытие
6. solely *adv* – единственно, только, исключительно
7. binder *n* – вяжущее вещество
8. automobile *n* – автомобиль
9. deplorable *adj* – прискорбный, плачевный
10. runway *n* – (*здесь*) поверхность дороги
11. come up with – нагонять
12. obsolete *adj* – устарелый, изношенный

II. Read text "Pavement Quality" and speak on the following points:

What are the desirable qualities of pavement?
Which building materials did highway builders of the late 1800s depend on?
What kind of challenge in road construction did the U.S. Corps of Engineers face?

(1) Desirable qualities of pavements include durability[1], smoothness, quietness, ease of cleaning and a non-slippery surface. The requirements conflict to a degree so no material is ideal in all respects. The foundation of a pavement must be crowned, or slightly arched, for rapid shedding[2] of water. It must be strong enough to withstand heavy dynamic loads, but capable of responding to temperature changes. It has been estimated that some 27,000 tons of water fall annually on one mile of road.



(2) Early in the 19th century, rock asphalt[3] and natural asphalt were being used as building products. These asphalt products had already been used for the past 7,000 years for waterproofing. Hot tar[4] was used in England as early as 1820 to bind the broken stones together. This type of mix, known as tarmacadam[5], was patented in 1910 by Warren Brothers. This company later became one of the largest asphalt mix companies in the United States.

(3) The highway builders of the late 1800's depended solely[6] on stone, gravel and sand for road construction. Road surfaces could be stabilized by adding water to the surface sand to form a binder[7], which would support horse-drawn traffic. Mud and dust did not become a major problem until the introduction of the automobile[8]. The deplorable[9] conditions of the nation's roads became a great public concern in the late nineteenth century with the invention of the bicycle and later the motor car. In the early 1890's bicycle clubs in the United States pushed hard for road improvements.

(4) The U.S. Corps of Engineers, which had not previously been involved in pavement matters prior to World War II, was charged with military road and runway[10] construction. Faced with the production of larger and heavier airplanes, the Corps needed to come up with[11] pavement thickness design methods for runways that could handle wheel loads greater than 5,600 kg. Not only did they meet the huge military demand for heavy-duty pavements, but they would continue to influence all aspects of asphalt paving long after the war was over.

(5) In 1956, the Federal Aid Highway Act was established, creating an infrastructure highway program unmatched by any other in the world. President Dwight D. Eisenhower stated that the Interstate System would establish "a grand plan for the rebuilding of our obsolete[12] road and street system". The basis of the system was a 65,983-km highway network connecting major cities in the Unites States. One component of this plan was that for every five miles of road, one mile would be straight – for use as an airplane landing strip in time of need.

(6) The network design task was given to the U.S. Bureau of Public Roads and the State Highway Departments. While many state highway departments requested asphalt for their part of the interstate system, concrete was also used despite its higher cost of construction.

Unit IV

Highway Engineering

Text 1. Road Construction Technique

I. Read the words and learn their meanings:

1. obstacle *n* – преграда
2. deforestation *n* – вырубка леса
3. roadway *n* – проезжая часть дороги
4. sediment *n* – осадочная порода, отложение
5. compaction *n* – уплотнение
6. depression *n* – углубление, выбоина (дороги), впадина
7. huge *adj* – огромный
8. equipment *n* – оборудование
9. slope *n* – наклон
10. admixture *n* – примесь

II. Read text "Road Construction Technique" and speak on the following points:

What does the process of modern road construction involve?
What does the process of earthwork include?
Why is road construction in challenging conditions not a difficult task anymore?

(1) Modern road construction involves the removal of geographic obstacles[1], and the use of new construction materials that are far more improved and durable. The process is initiated by the rock and earth removal by explosion or digging. Subsequently, the embankments, tunnels, and bridges are constructed, and the vegetation is removed by deforestation[2], if necessary. Finally, the pavement material is laid by using a range of road construction equipment. Roadways[3] are basically designed and constructed for use mainly by the vehicles and the pedestrians. Storm drainage and the ecological considerations should be considered seriously. Sediments[4] and erosion are controlled to avoid damaging effects. The drainage systems are constructed so that they should be able to carry the essential upstream flow to a waterway, stream, river, or the sea.

(2) Earthwork is one of the major works involved in road construction. This process includes excavation, material removal, filling, compaction[5] and construction. The moisture content is controlled, and the compaction is done according to the standard design procedures. Normally, rock explosion at the road bed is not encouraged. While filling a depression[6] to reach the road level, the original bed is flattened after the removal of the topsoil. The fill layer is distributed and compacted to the designed specifications. This procedure is repeated until the desired compaction is reached. The fill material should not contain organic elements, and possess a low index of plasticity. The fill material can include gravel and decomposed rocks of a particular size, but should not consist of huge[7] clay lumps. The area is considered to be adequately compacted when the roller movement does not create a noticeable deformation. The road surface finish is reliant on the economic aspects, and the estimated usage.

(3) The bulldozer is one of the most important items of equipment[8] used in road construction. Bulldozers are extremely useful for road construction where it is possible to throw and waste the excavated material on the road sides. Bulldozers may only be used if the slopes[9] at the sides are not excessively steep. However, work on steep slopes can be accomplished by a bulldozer by using special techniques and expertise.

(4) Construction of roads in challenging conditions is not a difficult task anymore because the binding agents and admixtures[10] make it possible for the roads to last long and carry the heavy loads without cracking under challenging loads and tough environmental conditions. Use of recyclable materials for the construction of roads has added balance to the environment too.

Text 2. Highway Engineering

I. Read the words and learn their meanings:

1. highway engineering – дорожное строительство
2. traffic *n* – движение (уличное, железнодорожное, автомобильное)
3. capacity *n* – допустимая нагрузка
4. lane *n* – полоса движения
5. adverse *adj* – неблагоприятный
6. noise pollution – шумовое загрязнение
7. exhaust *n* – выхлоп
8. braking – торможение
9. traffic sign – дорожный знак
10. intersection *n* – пересечение дорог, перекрёсток
11. interchange *n* – транспортная развязка
12. stream *n* – (транспортный) поток
13. amber *n* – жёлтый свет (светофора)
14. stake out *v* – разбивать (линию трассы, дороги)
15. viscous *adj* – вязкий, густой, клейкий

II. Read text "Highway Engineering" and speak on the following points:

Which stages does the process of highway engineering include?
What factors does highway capacity depend on?
How can the likelihood of traffic conflicts and crashes be decreased?

(1) Highway engineering[1] is a branch of civil engineering that includes planning, design, construction, operation, and maintenance of roads and bridges to ensure effective movement of people and goods.

(2) Highway planning involves the estimation of current and future traffic[2] volumes on the road network. Highway capacity[3] is the maximum theoretical traffic flow rate that a highway section is capable of accommodating under a given set of environmental and traffic conditions. The capacity of a highway depends on factors such as the number of lanes[4], lane width and effectiveness of traffic control systems.

(3) Highway facilities often cause adverse[5] effects on the environment, such as noise pollution[6] and ecological impacts. Tire–pavement interaction, vehicle exhausts[7], and engines cause traffic noise. Highway engineers strive to predict and mitigate all possible impacts of highway systems.

(4) The most appropriate location, and shape of the highway are selected through highway design. Highway design involves the consideration of three major factors: human, vehicular and roadway, and how these factors interact to provide a safe highway. Human factors include reaction time for braking[8] and steering, visual acuity for traffic signs[9] and signals and car-following behaviour. Vehicle considerations include vehicle size and dynamics that are essential for determining lane width and maximum slopes. Engineers design road geometry to ensure stability of vehicles and to provide adequate sight distances.

(5) Intersections[10] and interchanges[11] occur where two or more highways cross each other at the same level. Since various vehicle manoeuvres (turning, crossing) occur within a limited area there is increased likelihood of traffic conflicts and crashes. One way of reducing such danger is to use channelization to limit each stream[12] to a unique path. In high traffic volume areas, movement of streams can be separated in time using multi-phased traffic signals.

(6) Traffic signals are the most important traffic control devices. The typical traffic signal for an intersection displays a sequence of green, amber[13] and red. One complete signal sequence is called a cycle. Traffic signals are either pre-timed or demand-actuated. Flow-concentration controllers are capable of sensing detailed demand information and responding to it by revising the cycle length and phasing patterns of the signal.

(7) Highway construction usually follows planning and design, and involves such facilities as pavements, drainage structures and traffic control devices. Road construction is often preceded by detailed stakeout[14] surveys and preparation of the sub-grade.

(8) Pavement design is the process of selecting pavement layer types and thicknesses in order to withstand expected traffic loads in a cost-effective manner. Each pavement layer usually consists of mineral aggregates such as natural river or pit sand, natural gravel and crushed rock. For rigid pavements, Portland cement is mixed with water and aggregates to produce a viscous[15] concrete mix that is poured into prepared forms.

(9) There are generally three types of pavements specified for pavement design:

1. Gravel pavement is the simplest type of pavement and is often designed for lightly travelled roads.
2. Flexible pavement is a multilayered structure that includes a sub-base, a base and an asphaltic wearing course.
3. Rigid pavement consists of a plain or steel-reinforced Portland cement concrete slab laid on a prepared crushed-stone base course.

Text 3. Road Junctions and Intersections

I. Read the words and learn their meanings:

1. road junction – соединение дорог, скрещение дорог, узел дорог
2. intersection *n* - пересечение (дорог), перекрёсток
3. collision *n* – столкновение
4. traffic stream – транспортный поток
5. cloverleaf junction – пересечение дорог в разных уровнях (по типу кленового листа)
6. roundabout *n* – кольцевое пересечение автомобильных дорог
7. sufficient *adj* – достаточный
8. pedestrian *n* – пешеход
9. converging – двигающийся по сходящимся направлениям
10. value *n* – ценность

II. Read text "Road Junctions and Intersections" and speak on the following points:

What does the term "road junction" mean?
How can road junctions be classified?
Where are flyover junctions chiefly developed?

(1) A road junction[1], as the term is generally used, is the point at which one road meets another; an intersection[2] is the point at which two or more roads cross each other. Both junctions and intersections are, of course, the worst danger spots in a road system. The problems of reducing danger at these points are those of cost and space. If junctions and intersections are such that all classes of traffic meet each other at the same level, there is a danger of collision[3], not only between cars of the same class but between those of different classes. Almost complete segregation of different classes can be achieved, and the need for users of the same class to cross traffic streams[4], the most dangerous process of all, can be avoided.

(2) The perfect example of complete segregation of different classes of traffic and of the avoidance of crossing traffic streams is the clover-leaf junction[5], at which no collision can occur between vehicles if the drivers of those leaving the junction can manage to avoid those already on the road which they are approaching – which is a difficult thing. All forms of road junction can be classified into three groups: multi-level junctions, roundabouts[6] and flyover-junctions.

(3) **Multi-level junctions.** The clover-leaf, the most typical of these, has already been mentioned. There is need for multilevel intersections where three conditions are fulfilled: only a small percentage of traffic must turn left or right, the major volume of traffic is travelling on a fast through route and the volume of traffic would otherwise be sufficient[7] to justify the provision of a roundabout.

(4) **Roundabouts.** Unlike multi-level intersections, roundabouts do not enable traffic to cross without dropping speed but pedestrians[8] and cyclists cannot be segregated unless costly over- or under-passes are constructed. The success of a roundabout depends greatly upon the ease with which vehicles using it can "weave" or pass from one traffic lane to another. The greater the length of the road in which the weaving can be carried out and the smaller the angle of approach of converging[9] streams of traffic, the more easily can weaving be performed. The angle should not be greater than 30 degrees. The greater is the diameter of the island the smaller is the angle of convergence.

(5) **Flyover-junctions.** These have been developed chiefly at places where there are no pedestrians (and cyclists are few, if any). These "flyovers", which enable high speeds to be maintained, are extremely expensive, costing about ten times as much as roundabout, so it is much better to have ten roundabouts at ten dangerous junctions than a single flyover at a single junction. A combination of roundabout and flyover bridge can be of great value[10].

Text 4. Road Maintenance

I. Read the words and learn their meanings:

1. deteriorate *v* – разрушаться
2. oxidation *n* – окисление
3. pot-hole *n* – выбоина
4. maintenance *n* – техническое обслуживание
5. monitor *v* – осуществлять мониторинг, проводить (регулярные) наблюдения
6. profilometer *n* – измеритель шероховатости (поверхности); профилометр
7. curvature *n* – кривая, кривизна
8. asperity *n* – шероховатость
9. rejuvenating – восстановление
10. distress *n* – растрескивание
11. void *n* – полость
12. consolidation *n* – затвердение
13. patching – ямочный ремонт (дорожного полотна), мелкий ремонт
14. grout *n* – жидкий строительный раствор
15. saturation *n* – впитывание

II. Read text "Road Maintenance" and speak on the following points:

Which factors cause road surface deterioration?
How do agencies monitor the road surface condition?
What are the reasons for void occurrence?

(1) Like all structures, roads deteriorate[1] over time. Deterioration is primarily due to accumulated damage from vehicles; however environmental effects such as frost heaves, thermal cracking and oxidation[2] often contribute. Pot-holes[3] on roads are caused by rain damage and vehicle braking or related construction works.

(2) Virtually all roads require some form of maintenance[4] before they come to the end of their service life. Pro-active agencies use pavement management techniques to continually monitor[5] road conditions and schedule preventive maintenance treatments as needed to prolong the lifespan of their roads. Technically advanced agencies monitor the road network surface condition with sophisticated equipment such as laser/inertial profilometers[6]. These measurements include road curvature[7], cross slope, asperity[8], roughness, rutting and texture. This data is fed into a pavement management system, which recommends the best maintenance or construction treatment to correct the damage that has occurred.

(3) Maintenance treatments for asphalt concrete generally include crack sealing, surface rejuvenating[9], fog sealing, micro-milling and surface treatments. Failure to maintain roads properly can create significant costs to society. Distress[10] and serviceability loss on concrete roads can be caused by loss of support due to voids[11] beneath the concrete pavement slabs. The voids usually occur near cracks or joints due to surface water infiltration. The most common causes of voids are pumping, consolidation[12], sub-grade failure and bridge approach failure.

(4) Slab stabilization is a non-destructive method of solving this problem and is usually employed with other concrete pavement restoration methods including patching[13] and diamond grinding. The technique restores support to concrete slabs by filling small voids that develop underneath the concrete slab at joints, cracks or the pavement edge. The process consists of pumping a cementitious grout[14] or polyurethane mixture through holes drilled through the slab. The grout can fill small voids beneath the slab and/or sub-base. The grout also displaces free water and helps keep water from saturation[15] and weakening support under the joints and slab edge after stabilization is complete. The three steps for this method after finding the voids are locating and drilling holes, grout injection and post-testing the stabilized slabs.

Text 5. Road Surface Testing

I. Read the words and learn their meanings:

1. void *n* – полость
2. sub-base *n* – основание; подстилающий грунт
3. pozzolan-cement – пуццолановый портландцемент
4. spalling – отслаивание
5. gauge *n* – измерительный прибор (напр. уровнемер, манометр)
6. deflection *n* – прогиб
7. dowel bar – соединительный штырь
8. rod *n* – арматурный стержень
9. sealant *n* – уплотнительный материал; герметик
10. installation *n* – установка

II. Read text "Road Surface Testing" and speak on the following points:

How can voids in road surface be revealed?
What are the common stabilization materials?
What is the purpose of joint sealing?

(1) Ground penetrating radar pulses electromagnetic waves into the pavement and measures and graphically displays the reflected signal. This can reveal voids[1] and other defects. The epoxy/core test detects voids by visual and mechanical methods. It consists of drilling a 25 to 50 millimetre hole through the pavement into the sub-base[2] with a dry-bit roto-hammer. Next, a two-part epoxy is poured into the hole dyed for visual clarity. Once the epoxy hardens, technicians drill through the hole. If a void is present, the epoxy will stick to the core and provide physical evidence.

(2) Common stabilization materials include pozzolan-cement[3] grout and polyurethane. The requirements for slab stabilization are strength and the ability to flow into or expand to fill small voids. Colloidal mixing equipment is necessary to use the pozzolan-cement grouts. The contractor must place the grout using a positive-displacement injection pump or a non-pulsing progressive cavity pump. A drill is also necessary but it must produce a clean hole with no surface spalling[4] or breakouts. The injection devices must include a grout packer capable of sealing the hole. The injection device must also have a return hose or a fast-control reverse switch, in case workers detect slab movement on the uplift gauge[5]. The uplift beam helps to monitor the slab deflection[6] and has to have sensitive dial gauges.

(3) Joint sealing, also called joint and crack repair is used to minimize infiltration of surface water and incompressible material into the joint system. Joint sealants are also used to reduce dowel bar[7] corrosion in concrete pavement restoration techniques. Successful resealing consists of old sealant removal, shaping and cleaning the reservoir, installing the backer rod[8] and installing the sealant[9]. Sawing, manual removal, plowing and cutting are methods used to remove the old sealant. Saws are used to shape the reservoir. When cleaning the reservoir, no dust, dirt or traces of old sealant should remain. Thus, it is recommended to water wash, sand-blast and then air blow to remove any sand, dirt or dust. The backer rod installation[10] requires a double-wheeled, steel roller to insert the rod to the desired depth. After inserting the backer rod, the sealant is placed into the joint. There are various materials to choose for this method including hot-poured bituminous liquid, silicone and preformed compression seals.

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