Министерство образования Российской Федерации
Владимирский государственный университет

С.В. Николаева

Учебное пособие

по обучению чтению и устной речи на английском языке
для студентов II курса архитектурно-строительного факультета
по теме:

«ТЕХНОЛОГИЯ СТРОИТЕЛЬНОГО ПРОИЗВОДСТВА»

Владимир 2002

Оглавление

ББК 81.2 Англ.
Н 63

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Печатается по решению редакционно-издательского совета
Владимирского государственного университета.

Николаева С.В.
Н 63 Технология строительного производства: Учеб. пособие на англ. яз./
/ Владим. гос. ун-т; Владимир, 2002 92 с.
ISBN 5-89368-308-0

Цель пособия – развить навыки чтения и устной речи на основе изучения и переработки информации оригинальных текстов на английском языке.

Предназначено для студентов II курса дневного отделения специальностей 290300 – промышленное и гражданское строительство и 291000 - автомобильные дороги и аэродромы.

ББК 81.2
Англ.

ISBN 5-89368-308-0

ИНОСТРАННЫЙ ЯЗЫК В ВУЗЕ

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В данной книге используются материалы из английских и американских источников и разработана система коммуникативных заданий, обеспечивающая переработку содержащейся в текстах информации.

Автор стремился к тому, чтобы студенты не только получили информацию о своей будущей специальности, но также научились высказывать свое собственное мнение по поставленным проблемам.

Учебное пособие состоит из двух разделов: часть I – «Здания и сооружения» и часть II – «Мосты». Тематика текстов внутри разделов следующая: технология строительных работ при возведении зданий и сооружений, фундаменты и улучшения несущей способности грунта; технология строительства и ремонта мостов и виадуков.

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Автор благодарит профессора кафедры строительного производства, доктора технических наук А.С. Жива за консультативную помощь при работе над книгой.

Министерство образования Российской Федерации

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ПРАКТИКУМ

по английскому языку для студентов ИСФ специальности ПГС по теме «Технология строительного производства»

Николаева С.В.

Владимир, 2001 г.

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PART I. BUILDINGS AND STRUCTURES

UNIT I. CONSTRUCTION TECHNOLOGY

I. Read and memorize the following words and phrases.

1. rubble (n)	бутовый камень
2. mortar (n)	строительный раствор, растворная часть бетона
3. pole (n)	мачта, столб, стойка
4. walling	стеновые конструкции
5. roofing	кровля покрытия крыши
6. film (n)	пленка
7. cob walls	стены из уплотненного связного грунта
8. permafrost (n)	вечная мерзлота
9. dead load	постоянная нагрузка, собственный вес
10. structural design	строительное проектирование, статический расчет
11. ribbed floor	ребристое перекрытие
12. solid floor	монолитное бетонное перекрытие
13. buckling (n)	продольный изгиб
14. core (n)	ядро
15. soffit (n)	нижняя поверхность, софит
16. vent (n)	вентиляционное отверстие (канал)
17. mould (n)	форма, конус для определения консистенции бетонной смеси
18. stanchion (n)	стальная колонна, стойка, подпорка
19. suspend (v)	подвешивать
20. run off (n)	сток

II. Translate the following pairs of words paying attention to the suffixes of nouns. Fill in the table. Can you give your own examples?

Fail-failure, thick-thickness, lay-layer, construct-construction, blow-blower, press-pressure, protect-protection, reduce-reduction, vary-variation, treat-treatment, calculate-calculation, obstruct-obstruction, direct-direction, generate-generation, ventilate-ventilation, manufacture-manufacturer, mix-mixer, durable-durability, equip-equipment, stabilize-stabilization.

-ure	-ness	-er	-tion	-ment	-ity
pressure					
			reduction		

III. Translate the following pairs of words paying attention to the suffixes of adjectives. Fill in the table. Can you give your own examples?

-ent (-ant)	-able	-ous	-ful	-al	-ive
		dangerous			
				natural	

Differ-different, suit-suitable, danger-dangerous, waste-wasteful, rely-re1iable, structure-structural, graph-graphical, consruct-conctructive, notice-noticeable, nature-natural, horizon-horizontal, protect-protective.

IV. Match adjectives in A with nouns in B and translate the phases into Russian. Can you use these phrases in the sentences of your own?

A. 1. structural. 2. different. 3. protective. 4. horizontal. 5. suitable. 6. essential. 7. solid. 8. dead. 9. natural. 10. thermal. 11. ancient. 8. internal. 13. suspended.

B. 1. structures. 2. part. 3. mass. 4. design. 5. buildings. 6. pressure.

7. load. 8. environment. 9. measures. 10. conditions. 11. floor.
12. information. 13. completion.

V. Write in the missing word in each of the following sentences. Use each word only once.

1. floor. 2. advantages. 3. design. 4. roofing. 5. film. 6. vents.
7. foundation. 8. walling.

1. In permafrost areas ice is used for ... and ...
2. An unusual method of construction is the use of air-inflated ... .
3. The roof was light and the reservoir need no ... .
4. Every structural design includes the foundation ... .
5. The most important member which the engineer designs is the ... .
6. Fresh air-flow is achieved by trickle ... .
7. The use of precast units offered particular ... .

VI. Rewrite the sentences defining the type of subordination (object/ attribute). Translate the sentences into Russian.

1. A common feature of these buildings is the exposed concrete slab soffit that provides thermal mass to moderate the internal environment.
2. A. structure is a part of a building that carries its weight.
3. In two suspended structures that were built in London, there is only one column in the centre of the building.
4. They are also suitable for regions which suffer earthquakes.
5. The few trees which grow in this area are too small for construction.
6. There is an upward load at the edges which must be held down by anchoring or weighting the edges.

7. The energy savings result from a reduction in the range of temperature to which the outside of the building is subjected.
8. The pebbles and shells which the blocks contain are arranged in a peculiar way.
9. Analysis of samples suggests that old cements last much longer.

VII. Can you transform the following sentences dividing them into shorter ones? You can do it either by eliminating a subordinating word, or by adding a few words to a phrase.

Pattern: For water engineers and municipal engineers structures are not always an important part of their work though even a road or a pipe is a structure since they both carry load:

a) For water engineers and municipal engineers structures are not always an important part of their work;
b) A road or a pipe is a structure;
c) They both carry load.

1. For a common structure such as a building frame, many methods have been developed for analysis, so that the design and analysis will be relatively easy and may need to be performed only once or twice.

a) .... c) ....
b) .... d) ....

2. For the typical multi-storey structure in a city whether it is to be used for offices or dwellings, the most important member which the engineer designs is the floor - for two reasons: it repeats all the way up the building, and it has the greatest effect on the dead load of the building.

a) .... d) ....

b) .... e) ....

c) ....

VIII. Before reading the text try to identify the meaning of the following notions. Match the words and phrases in A with their definitions in B.

A	B
1. dam:	1. a structure built along a shore line, for ships to tie up at, and load and unload.
2. pier:	2. a mixture like mud, usually made of cement, sand and water, which ties together the bricks or stones in a wall.
3. quay:	3. a wall built to hold back water .
4. breakwater:	4. in buildings, the electricity, gas, telephone, water, air conditioning, heating and so on, but not the structure.
5. wall tiling:	5. a hole through the ground, open at both ends, which can take a railway or a road or pass a fluid or cable, etc.
6. ducting:	6. a structure built out from a bank for ships to tie up at , or to protect the shore from scour.
7. services:	7. covered channels built into a structure so as to allow pipes or cables to be passed easily in and to allow them to be inspected and repaired when the building is occupied.

Окончание таблицы

A	B
8. lift:	8. very thin sheet, often thinner than paper and made of plastics.
9. mortar:	9. the force from a gas or a liquid.
10. cob:	10. a machine which raises or lowers people or loads from one floor to another in a building.
11. permafrost:	11. a wall built out into the sea to break the force of the sea and to protect ships.
12. tunnel:	12. earth used for walling
13. film:	13. a large container built on the ground, to hold water.
14. reservoir:	14. ground which is frozen all the year round, as in northern Canada, Siberia, or Antarctica.
15. stabilized soil:	15. earth which has been strengthened or made waterproof by mixing it with some material like cement or oil or by coating it with a skin of tar, often for building a road cheaply.
16. pressure:	16. flat glazed slabs about 15 cm square, stuck to the walls in bathrooms or kitchens to make a clean, washable surface.

IX. Read and translate the text.

Text 1 A. Some Old and New Construction Methods

An earthy American, who was probably a civil engineer said an engineer is a man who can do for one dollar what any fool can do for two. This is particularly true for civil engineering or building structures. For civil engineering structures like dams, piers, quays, breakwaters (Fig.1), roads or air-fields, the cost of the structure may well be 90-100 per cent of the total cost. For building structures it is usually not more than a half, except in non-industrial countries, but for a hospital or similarly comp-licated building, the pro-portion of the cost of the structure can easily drop to 20 per cent of the cost of the buil-ding without its mechanical equipment, because of the high cost of wall tiling, ducting for services, lift structures and so on.

Fig. 1

It is important for engineers to have an idea of the different ways that things can be built in different countries. Earth, for example, which was once used in England, for buildings of one or two storeys is not now used there, but in hot, dry countries like Arabia or Peru, it is perfectly suitable. Large churches have been built of earth in South America, and earth buildings of four storeys have stood for a century in, for example, Jeddah, Arabia (Fig. 2.).

The Arabian method is of special interest because in many ways it would be a dangerous failure in a wet, European climate. The walls, about 60 cm. thick, are built of rubble (unshaped stones) laid in a mortar made of mud. At intervals of 1-3 m throughout their height they are interrupted by a layer of round poles laid for the full thickness of the wall. Where two walls join, these layers of poles cross each other and thus tie the two walls together. The few trees which grow in this area of Arabia are too small for construction so all building wood is imported, and this seemingly wasteful use of wood must have been felt to be truly essential, and seems to have been reliable. In a wet climate the timber would rot in forty years or less and in Britain its use in walls in this way has been forbidden for many years. For single-storey buildings, mud walls even without stone or wood are stand for centuries if the part next to the ground is of stone so that it does not get washed away by the rainstorms. In dry parts of the United States and Australia, mud walls are accepted as normal construction and may be called cob walls.

Fig. 2

In permafrost areas in Canada or Alaska, ice has been used effectively for walling and roofing. In Sweden water power stations have been hollowed out of the rock, a method which has been found to be cheeper than normal construction. Since the power station of a water power scheme is at the foot of the dam it is usually convenient to place it in rock, and this is why has been found cheap to put the water power plant in a tunnel.

Another unusual method of construction which has been used recently is the use of an air-inflated film. A small air blower keeps a slight pressure inside the film. The film is anchored to the ground, and the pressure holds it up very cheaply. Balloon structures of this type have been successfully used as temporary structures in Britain to provide urgent protection from the weather.

They are also suitable for regions which suffer earthquakes. For instance in California, a reservoir was built in about 1962 with a permanent air-inflated roof. This roof was not only light and therefore needed no foundations, it was also cheap. In fact if an air-inflated roof is not tied down it will lift off the ground and lose air pressure. At the edges there is an upward load which must be held down by anchoring or weighting the edges.

The construction of most buildings starts from the ground floor and proceeds upwards to the roof. But in one unusual method of building - the jackblock method - building starts with the roof and proceeds downwards. The roof and each floor are built at ground level and gradually jacked, or pushed up, into position.

The building is supported by a central core of concrete blocks. This is built on top of the jacks. The roof of the building is cast first and jacked upwards. This is done by lowering each jack in turn and inserting a concrete block. When a full layer has been laid, the whole core is jacked up and another layer inserted.

Workmen move in to finish off the building as the structure moves upwards from level to level. They divide up the floors, put in pipes, plaster the walls and do the painting. A floor is in almost its final state by the time it is five storeys high. By enclosing the five storeys in elastic sheeting, construction can continue in all weathers.

One way of constructing tall buildings quickly is by using the lift-slab method. In this method all the floors of the building are cast on the ground and then lifted into position one by one. This is much cheaper and easier than casting them above ground.

Foundations are laid in the normal way. Then columns to support the building are built upwards from foundations to the required height. All the floors and finally the roof are cast in turn at ground level, separated by layers of thick paper. Powerful jacks on the tops of the columns lift first the roof and then the floors into position.

X. Translate the following phrases into Russian. Can you think of sentences with some of them?

1. useful use of wood. 2. single-storey buildings. 3. power station of a water-power scheme. 4. air-inflated film 5. balloon structures. 6. temporary structures. 7. regions which suffer earthquakes. 8. earlier sheltered buildings. 9. precast concrete roofing.

XI. Pair work. Ask your classmate if he or she knows the answers to the following questions. Change the questions to a more polite form using the following pattern:

Ann: Do you know how ...?

Nick: Yes,(No), I (don't) know how ... .

Ann: Could you tell me how ..., please?

Nick: ....

1. What is the Arabian method of building?
2. Why is the Arabian method of building of special interest?
3. Why is all building wood imported in Arabia?
4. What method of construction is used in Arabia to provide durability for single-storey buildings with mud walls?
5. What method of construction is used in permafrost areas?
6. What unusual methods of construction have been used recently?
7. Where can balloon structures be used?

8. What do you know about the jackblock method of construction?
9. What method of construction is ised for tall buildings?

XII. Read the following passage and agree or disagree with Professor Davidovits. Ask your partner if he (she) is of the same opinion.

Here are some phrases you can use:

I think ... In my opinion ... . Well, I must say that ... . Would you agree with ...? I am with you there ... I am of the same opinion ... No, I don't think that ... . This is not the way I see it.

Scholars have always believed that the Egyptian pyramids were built of natural stone. Professor Joseph Davidovits, of the Geophysical Institute in France, thinks they are wrong. According to him, the pyramids were built with man-made mixture of cement and aggregate - in other words, concrete.

The pebbles and shells which the blocks contain are, he says, arranged in a way that would not be found in natural rock. Professor Davidovits also cites an ancient hieroglyph that was recently been deciphered. The components of synthetic cement are listed, by the hieroglyph.

Whatever the truth of Professor Davidovit's claim, there is little doubt about the durability of ancient concrete mixtures. Analysis of samples dating back as far as 7000 B.C. suggests that old cements last much longer than modern versions. Modern cement used to restore Roman or Greek buildings can be seen to erode much faster than the original material. According to Professor Davidovits, the durability of ancient mixtures makes them ideal for tackling a particularly modern problem: nuclear waste. The Professor is not alone in thinking this: the Harwell Atomic Energy Laboratories in England are currently investigating ancient materials for use in nuclear waste disposal. We may still have a thing or two to learn from our ancient ancestors.

XIII. Have you ever heard of moving houses? Read the passage that follows and ask as many questions as you can to cover the information given in it.

In 1898, engineer Otto Fedorovich organized the first 'move' of a Russian house. The building was a two-storey stone mansion that was obstructing the path of a Moscow railway. As the administration of the Nikolayevskaya Railway would not sanction the sum normally necessary, Fesorovich decided to do it in this way. He used old waggon axles instead of beech or hornbeam rollers and used a few hand winches and jacks instead of the 200 jacks that had been considered necessary. Old rails took the place of the I-beams. To place the building onto the movable frame, the house was not raised; instead silts were made in the walls at ground level and the frame was inserted under the house. What was left of the walls was then broken off and the house was taken away.

Until the 1930s this was the only recorded moved house in Russia. At this time, during the reconstruction of Moscow's centre, builders became interested in moving buildings on a large scale. A special organization for disassembly and moving buildings was set up in the capital and the staff accumulated wealth of experience in a comparatively short time. Buildings weighing up to 25,000 tons were moved. Before the war started 50 houses were moved, but the war ended this peaceful activity.

In the 1970s the first building to be moved was a valuable historical landmark - the old pavilion in the Krasnopresnensky Park of Culture and Rest. A total of some 40 buildings are to be re-cited in keeping with the new Master Plan for the development of Moscow.

XIV. Read the passage and the questions that follow. Choose the one best answer (A,B,C or D) for each question. Base your aswer choices on what is stated or implied in the passage.

This recently constructed building in Vancouver, British Columbia, utilizes both direct-gain and indirect-gain solar heating. Cast-in-place Trombe walls (30 cm thick) are provided on the south side of the building. The wall of each unit is painted a different dark shade. Double glazing is provided in front of the walls. These walls heat or cool the ground floor by convection and radiation and the second floor bedroom by radiation. The air circulates by way of closable vents at first floor ceiling and floor levels. A movable insulating shade is provided between the Trombe wall and the double glazing. The shade rolls up into a case above the wall when not in use. It can either operate automatically in response to heating conditions or can be manually operated. The Trombe walls also insulate the townhouses from traffic noise from the adjacent busy road.

Direct-gain heating is obtained through south-facing skylights in the second floor south bedroom and also through a window provided in the Trombe wall. Thermal storage is provided by the concrete walls and floors. The skylights are inclined at 60 deg to the horizontal. A smaill fan draws warm air from this bedroom and circulates it to the north side of the house.

1. What does the passage mainly discuss?

A. The uses of energy-efficient buildings.

B. The inhabitants of the building.

C. Utilization of solar-heating systems.

D. The Trombe wall design.

2. What kind of heating is used in the building?

A. Solar. **B.** Central. **C.** Gas. **D.** Electricity.

3. Are the problems discussed here ...?

A. social. **B.** engineering. **C.** political. **D.** human.

XV. Read the following passage and reproduce the information in English. Can you express your opinion on the matter?

There is increasing interest in earth sheltered buildings from the view-point of energy conservation. They include both completely underground buildings and buildings partly or wholly covered by earth mounded above the natural ground level.

The energy savings result from a reduction in the range of temperature to which the outside of the building is subjected. This is due to the thermal mass of the earth surrounding the buiding. The energy required both for heating and cooling an earth sheltered structures would be greatly reduced. In addition, infiltration losses are also greatly reduced. Even when the building is not below the natural ground level, savings will occur if the building is covered with earth to the same depth and is surrounded by berms with 30-deg slope.

Most earth sheltered residential buildings are also designed to utilize solar energy. All or part of the south side of the building is exposed so as to allow the use of passive or active solar heating. Windows on this south side also make the buildings more pleasantly livable.

A market exists for precast concrete in earth sheltered construction, even in the case of single family homes. This is because the loads to be carried by the roof and walls of the structure are much greater than in the case of an above-grade building. Precast concrete roofing units are well able to support these loads and also provide additional thermal mass to further moderate temperature variation in the building.

The walls of earth sheltered buildings have to serve as retaining walls resisting earth pressure.

XVI. Is there anything in the descriptions that can help you to identify the notion? Match the descriptions in A with the words they define in B.

A	B
1. a length of a column from the point of view of design to prevent buckling:	1. structural design
2. a structure that hangs from one or more very large columns:	2. structural member
3. determining by calculation the sizes and locations of the members of a structure:	3. Mathematical
4. finding out the forces in the members of a structure by calculation or by drawing:	4. graphical
5. description of a structure that does not overturn under its full load:	5. stable structure
6. a metal upright, usually nowadays of steel, designed mainly to carry weight through to the ground:	6. load
7. a description of anything done by calculations:	7. suspended structure
8. in the structural sense, any force such as weight, compression, tension, bending or twisting:	8. staunchion

A	B
9. a steel which has a high safe strength in tension:	9. buckling
10. the bending in the middle of a column that carries too much weight or bending:	10. effective length
11. connected with drawing rather than with calculation:	11. high tensile steel.

XVII. Read the dialogue and complete it using the information from the passage that follows. Make use of the following patterns:

I wonder.. I'd like to know ... I am interested to know ... /if /whether/ how/ where/ when/ what/ which/

Tell me about ... please.

Is ...? Does ...? Did ... ? Have you ever ...?

Dialogue

Ann: I wonder if you know what a structure is.

Ben: As far as I know, it is part of a building that carries its weight.

Ann: So, anything built is a structure, isn't it?

Ben: That's right. A structure may be a dwelling house, or a pyramid in Egypt, or a dam built by beavers. A building is a structure with a roof.

Ann: In short, structures are most of civil engineering.

But I think that for water engineers, sewage treatment engineers, and municipal engineers, structures are not always an important part of their work.

Ben: I agree. They have to do with roads and pipes.

Ann: Right you are. But don't forget that a road or a pipe is a structure since they both carry load.

Ben: If I am not mistaken, every structural design includes the foundation design.

Ann: It surely does. But mind that the structural design itself includes the design of the structure and the analysis of this structure.

Ben: Have you ever done such an analysis?

Ann: I have, once. And I should say that for a common structure such as a building frame the design and analysis are relatively easy.

Ben: But I think that for any unusual structure the analysis is not that easy.

Ann: Of course not, because it requires a lot of calculations to make sure that a design is strong, stable and lasting.

Ben: And cost-efficient?

Ann: Yes, it is very important since a costly structure will probably be not built. But cheapness does not enter into the quality of the design.

And now read for some more information:

For the typical multi-storey structure in a city, whether it is to be used for offices or dwellings, the most important member which the engineer designs is the floor - for two reasons: it repeats all the way up the building, and it has the greatest effect on the dead load of the building. The dead load, in fact, can be fairly exactly calculated by assuming that the floors are the only dead load.

These floors are generally of reinforced or prestressed concrete because they resist fire better than steel or wood, an important consideration for a tall building. There are two main types, the solid floor and the hollow-tiled (or ribbed) floor (Fig.3). In the ribbed floor, as the drawing shows, part or the lower half of the slab is hollow, a great advantage because this concrete would not strengthen the floor but would be heavy.

Fig. 3.

Ribbed floors are therefore lighter than solid floors, but it is more difficuIt to cast them with holes through them unless these holes are carefully planned beforehand. It is generally safe to cast a hole through a solid slab by adding a few extra bars of 12 mm diameter in the concrete all round it, though when there is time, holes should be properly designed.

Suspended structures are among the most interesting (Fig.4). In the suspended structures, the columns or staunchions are made fewer and

Fig. 4

larger so as to reduce the buckling effects on them and to increase their effective length. In two suspended structures that were built in London, there is only one column in the centre of the building, and this is a hollow concrete tower some 12 m square which carries the lifts, stairs, ducts, pipes and cables within it or attached to its wall. The tower may be called the core of the building and on its top is a bridge overhanging in all directions, from which high-tensile steel bars drop to carry the floors below. These bars are very thin and can be hidden in a door frame or window frame so that for such a building there need be no noticeable obstruction to sight or horizontal movement in any direction outwards from the core (Fig. 4).

XVIII. Read the following passage and ask as many questions as you can to cover the information given in it.

Building construction is one example of civil engineering with which we are all familiar. Tall skyscrapers and large blocks of flats and offices are being built in towns throughout the world. It is on these building sites that most of us see civil engineering in action.

We can see the great machines at work - bulldozers, excavators, cranes, and pile-drivers. We can observe the different stages of construction - from the initial surveying of the site to the casting of the floors and. walls. This gives us a very good idea of the kind of work that must be carried out in the construction of other kinds of structures.

The first stages of building are to survey the site and to drill holes at various points to find out how firm the soil is. If there is firm soil near the surface, excavators remove the upper layers of earth. Concrete foundations can then be laid on a firm base. Sometimes, however, the firm soil is a long way down, and excavating would not be practical. Then piles are driven down from the surface to firm soil or rock to support the foundations.

When the foundations have set, work can begin on the upper part of the building. The first job is to build the frame that will support it. The frame may consist of reinforced concrete or steel beams, which are lifted into position by cranes and bolted together. Or it may consist of reinforced concrete cast in position in formwork, or wooden molds.

The walls and floors, too, may be cast in position or they may be precast in a factory and lifted into position by cranes.

More modern and quicker methods of construction include lift-slab and jackblock methods.

In the usual method of building, say, a block of flats, the floors and walls are cast in forms in their final positions on each level. But in the panel method the floors and walls are made in a factory and assembled on the building site. These panels are made to fit together exactly, with holes for doors, windows, and water pipes. At the site the panels are lifted into position by cranes and cemented together.

XIX. What is your opinion of the block? Can it be called a convenient home? Read the passage that follows and see for yourself.

Kentmanni 15 is located in the heart of the Estonian capital on one of the most prestigious residential streets (Fig. 5).

There are 12 apartments available, two of them being penthouses with balconies. Standard layout has three bedrooms on the floors 2 to 6 and two bedrooms in the penthouses on the seventh floor. Exteriors are completed with solid wood sliding exterior shade screens, and eastward facing French patios.

Each floor layout is comprised of two apartments, each having private entry from the elevator. The apartments are finished with hardwood floors and doors, triple glazed solid wood windows with aluminium exterior frames.

There is modern security system that not only allows for protection against intrusion and fire, but also allows for viewing of both the building entrance and the parking lot.

The building has a spacious foyer on the first floor with open railed stairs leading up to the apartments and down to the cellar level.

A unique double-entry elevator offers secure and direct access from the car park and foyer to the apartments. There are also large full height windows on both sides allowing plenty of natural light into the building.

Sports and recreation facilities are provided on the ground level.

Fig. 5

The lower level features a large amount of storage space and access to the car park.

The block has a special one-key system which allows opening all the common doors in the building as well as operating the elevator and opening your apartment door with just one key.

XX. What are the good points of mobile buildings? Read the text that follows and choose the relevant information.

Text 1 B. Portable and Mobile Buildings

The development of portable and movable buildings accompanied the growth of the building and contracting industries, when it became apparent that taking temporary offices, toilets and refreshment rooms from one site to another was more economical than the costly business of erecting separate buildings.

On location such mobile buildings are immediately ready for use and just as easily they can be transported from one site to another.

Rollalong Limited have contributed in this field. They take a big interest in mobile accomodation for commercial and industrial use - site cabins, movable offices, toilets, showers and so on. The company's range of units is extensive - from wheeled mobile dental surgeries for the UK to mobile radio-graphic dark rooms for use in Korea and toilets and changing rooms for the army in Northern Ireland.

They have supplied insulated store cabins for meteorological surveys, Admiralty workshops for siting in jungle clearings by helicopter, laboratories for oil rigs and refineries and mobile kitchens for Libya catering for more than five hundred people at a time.

The groups's most outstanding developments have been with mobile hospitals for use overseas - self-contained units comprising clinics, surgeries, operating theatres, x-ray units, laboratories, nursing wards, kitchens and staff accomodation, complete with power supply, water purification and air-conditioning plant - all built and fully equipped in their factory at Ringwood and shipped to such countries as Libya and Iran.

Their latest development is a floating hospital for the river Nile and its tributaries in the Southern Sudan. Swamp conditions and deplorable roads take overland travel almost impossible, so the company built two complete hospitals onto barges. The units are floated up and down the water ways and beached on the banks, where they are instantly ready to dispense medical and surgical aid to isolated communities. The idea has caught on, and enquiries are now being received from other parts of the world, particularly South America.

For the industrial and commercial markets Rollalong's instant lift-off units are used for extensions to schools, offices and factories and for site accomodation on building contracts.

The modular system provides a considerable degree of flexibility. Units can be supplied as shells only or fitted out as required in small or large complexes, all capable of further extension or modification. Sections are carried by lorry and sited and levelled on legs using a simple crowbar and shoe device. Site preparation is minimal and site levelling is unnecessary.

The construction of modular units is strong, they can easily be dismantled and transported to other sites at short notice.

The mobile building is rapidly becoming accepted as an answer to many of our building problems in industry, commerce, education and housing, primarily for reasons of mobility, stock availability and overall economy.

XXI. What do you think of the design of the building? Read the text and give the summary of it in English.

Text 1 C. Vertical Manufacturing Facility

Located in the Chinatown section of Boston, Massachusets, this high technology, electronics manufacturing facility was designed in response to the owner's desire to provide jobs for the inner city minorities of this large metropolitan area (Fig. 6).

Since only a small area was available in the desired location, a vertical design concept had to be developed.

This approach is unique in that, historically, most nanufacturing faci-lities are large, one storey buildings with work stations connected by horizontal conveyor systems. The vertical design of this 100,000 sq ft (9290 m^2) building is made feasible by the use of a computerized, dumb-waiter-like coveyor system for carrying equipment and products from floor to floor. Thus, seven of the ten floors are dedicated solely to manufacturing functions while the remaining three stories house administrative and support facilities.

Fig.6

Architectural precast concrete was chosen as the building material because the appearance of the panels projected an image of elegance and permanence. In addition, use of precast concrete also offered the following advantages:

- Consistency of color and surface texture.
- Ease of achieving complex configurations with a minimum number of pieces and joints.
- Speed of manufacturing by the use of repetitous shapes cast with a minimum number of forms.
- Speed of erection and ease of attachment to structural steel.
- The innate impermeability and durability of the material.
- The economy of precast concrete, especially compared with other materials.

Aesthetically, the exterior of the building was designed to conform to the height and appearance of the old leather and textile district. The area's white limestone classical architecture is reflected in the buildings's design. Since the building neighbours the city's modern financial district, the design also reflects the high-tech elegance of that area. It was because of this historic-modern setting that the design team chose architectural precast concrete as the most suitable material for attaining the design objectives, while positively reflecting the neighborhoods.

Once the basic design philosophy of the exterior facade was determined, the number and dimensions of the precast units were established. The next step was to translate the design into practical and manageable sizes, shapes and thickness of precast concrete. A total of 477 individual precast concrete pieces were required.

Some of the more intricate shapes include the segmental half arches that surround the round-headed windows. These pieces average 110 sq ft (10.2 mm^2) surface area. Due to the repetitive and modular nature of the facade elements, it was possible to reduce these round-headed units to four specific types, plus their opposite-hand counterparts.

Other individual shapes include rectangular pieces.

To further enhance the appearance of the building, bronze anodized aluminum window sashes and bronze-tinted insulating glass were employed. In addition, manufacturing is confined to the inner portion of each floor and corridors line the perimeter.

XXII. Translate the following abstracts from English into Russian (A, B, C) with the help of the dictionaries. Pay attention to the structural details in the pictures.

A. Accrington Covered Market, Lancashire (Fig. 7). Accrington covered market occupies an area 255 ft long by 250 ft wide and is constructed almost entirely of reinforced and prestressed concrete. Two halls comprise the market, each 139 ft long, 60 ft wide and, on average, 20 ft high. The ground floor sales areas have been planned for maximum flexibility and are covered by a series of umbrella concrete shells which require only two central column supports in the entire floor area of each hall. The 3 in. thick shells are carried on arched reinforced concrete ribs of 60 ft span at two levels, and these are in turn carried at their roots by 15 1/2 in, x 18 in. prestressed tie beams extending around the perimeter of each hall. The tie beams are supported on six main and twelve subsidiary columns and were post-tensioned by the PSC Mono-Wire System with two 8-wire cables in the side beams and one 12-wire cable in each end beam.

The tie beams were post-tensioned before the construction of the shells and arch ribs. In addition to acting as ties, the beams have to support the roof and glazing and are therefore subject to bending and torsion as well as direct tension.

Fig. 7

The amount of reinforcement necessary to resist these stresses without prestressing would have been excessive.

B. Blackwall Tunnel, ventilation building, London (Fig. 8). *The ventilating building takes the form of two shafts - outlet and inlet - which are elliptical on plan, placed side by side and merge at the base to form a figure-of-eight prestressed concrete 'skirt'. The shafts are reinforced concrete 'Gunite' shells and are supported at their base by a 3 ft thick reinforced concrete gallery slab. Bel-*

Fig. 8

low the gallery slab, the 4 in. thick

shells flare out into the prestressed skirt, edged at the base with a reinforced concrete ring beam. The skirt is post-tensioned on the PSC Mono-Wire System with 0.276 diameter wire at 12 in. centres to eliminate tensile stresses.

C. Teachers' Training College, Walsall, Staffordshire (Fig. 9) The structural system of this teaching block is based on a series of cantilevered cross walls carried by two spine walls - the whole supported at ground level by the central core and four columns. Prestressing is applied at the junctions of floors and walls. The building is 76 ft x 98 ft on plan. The first floor slab and the whole of the building above are cantilevered out

13-25 ft beyond the ground floor columns. The cantilevers are in the form of 9 in. thick concrete cross walls generally one storey high and irregularly placed, dividing the classrooms. The floor spans vary from 8-29 ft with reinforced concrete slabs either bearing upon or suspended from the walls.

Fig. 9

As a circulation space was required at each floor level around the central core the cantilevered walls could not be continuous across the building, resulting in high concentrations of tensile stresses at the cantilever roots. In order to avoid cracks in these places, the structure was post-tensioned with 192-in. diameter CCL strand cables, mostly placed at the junctions of floor slabs and walls**.** The whole structure acts as a 'space' system, which meant that prestressing had to be done as one continuous operation after the reinforced structure was complete.

D. East Kilbride Swimming Pool, Lancashire (Fig. 10) *This swimming pool is the first to be built in Scotland to Olympic standards (165 ft x 45 ft). Structurally, the main interest lies in the roof which covers*

Fig. 10

an area 252 ft x 96 ft in a single span without intermediate supports. The 232ft length is spanned by five prestressed concrete parabolic arch ribs at 24 ft centres which support elliptical reinforced concrete shells. The ribs have pinned supports. From the supports to the main abutments, the ribs fan out as raking struts, giving a total structural length of 324 ft between abutment foundations.The main arch ribs have a rise of 26 ft from hinges to crown and are 3 ft deep, each was post-tensioned with three longitudinal 7.5 in. strand CCL cables. The main longitudinal arch thrust is resisted by six prestressed concrete ties which pa

ss under the pool and are fixed to the abutment foundations. The ties are 379 ft long and were post-tensioned in situ with 1/2 in. strand tendons before the ends of the ties were built into the abutments.

UNIT II. FOUNDATIONS AND SOIL IMPROVEMENT

I. Read and memorize the following words and phrases.

1. base (n)	фундамент, основание
2. abutment (n)	пята (арки свода)
3. timber (n)	строительный лес
4. joist (n)	балка (перекрытия потолка, покрытия)
5.encased structures	конструкции из металических труб, заполненных бетоном

6. plain concrete — неармированный бетон
7. reinforcernent (n) — арматура
8. breakwater (n) — волнолом, мол, внешнее заградительное сооружение
9. load (n) — нагрузка
10. pad foundation — столбчатый фудамент
11. strip foundation — ленточный фудамент
12. bearing pressure — опорное давление
13. raft foundation — плитный фундамент
14. slab (n) — плита
15. settlement (n) — усадка

16. crack (v) — трескаться
17. sink (v) — погружаться
18. span (n) — шаг колонн; расстояние между опорами

II. Translate the following pairs of words paying attention to the suffixes of nouns. Fill in the table.Can you give your own examples?

-tion	-(s)sion	-(a)ence	-ment	-age	-ness
			movement		
					thickness

Reduce-reduction, impress-impression, allow-allowance, construct-construction, move-movement, light-1ightness, float-floatation, maintain-maintenance, shrink-shrinkage, resist-resistance, except-exception, penetrate-penetration, damp-dampness, drain-drainage.

III. Fill in the table with the words formed with the use of suffixes (adjectives, adverbs, nouns).

Adjective	Noun	Adverb
reasonable		strongly
	application	

Reinforcement, reasonable, excavation, advisable, special, thickness, compressible, pressure, strongly, settlement, various, obviously, structural, designer, development, calculation, exactly, application, sinkage, contraction, uniformly, porous, dangerous.

IV. Read and translate the following related words. Can you give synonyms or antonyms for any of them?

Separate-separation-separetly; apply-application-applicable; probable-probability-probably; safe-safety- safely; dense-density-densely; deep-depth-deeply; quick-quickness-quickly; reason-reasonable-reasonably; relative-relativity-relatively; differ-different-differently; vary-various-variously.

V. Can you form the words of tne opposite meaning? Use the prefixes (un-, in-) according to the model.

Model: sufficient-insufficient; evenly-unevenly.

Probable - ...; usually - ...; possible - ...; reasonable - ...; desirable - ...; shinkable- ...; different - ...; compressive - ...; stable - ...; movable - ... .

VI. Match adjectives in A with nouns in B. Can you use the phrases in the sentences of your own?

A. 1. special. 2. industrial. 3. practical. 4. scientific. 5. additional.

6. economical. 7. dangerous. 8. various. 9. different. 10. probable.

B. 1. shifts. 2. space. 3. methods. 4. enterprises. 5. structures.

6. movement. 7. material. 8. construction. 9. depth. 10. study.

VII. Write in the missing word in each of the following sentences. Use each word only once.

1. soils. 2. sink. 3. load. 4. columns. 5. slab. 6. settlement. 7. pressure.
8. footings.

1. Foundations spread a vertical ... over the ground.
2. Combined ... carry the load from more than one row of columns.
3. In the raft foundation all the ... are combined into one reinforced concrete ... .
4. The buoyant raft is built in fluid ... .
5. The design of a multi-storey building on compressible ... is difficult.
6. A correct foundation design will apply a higher bearing ... to the smaller foundations.
7. For various reasons some foundations may ... .
9. The main problem in the design of foundations is to keep the total ... within reasonable limits.

VIII. Transform the following complex sentences dividing them into shorter ones, either by eliminating a subordinating word or adding a few words to a phrase. Underline the words that you added.

Model: Even if all the foundations are designed for the same bearing pressure, the largest foundation will sink the most because it has the largest load, and the smallest foundation will sink the least.

a) The largest foundation will sink the most.

b) The largest foundation has the largest load.

c) The smallest foundation wil1 sink the least,

d) The foundations may be designed for the same bearing pressure.

1. One solution, which is rather expensive because it may involve a deep excavation, is to dig out a quantity of soil which weighs as much as the dead load of the building plus the quantity of live load which is likely to be on it.

a) … c) …

b) … d) …

2. It must be said that the foundation designer before he starts the design, should know the safe bearing pressures which are advisable at every level possible for the foundation.

a)… c)…

b)… d)…

3. Excavations are made down through unstable materials until a stratum of soil or a bed of rock is reached which has bearing power sufficient to sustain the loads.

a) .....   c) .....

b) .....

VIII. Before reading the text try to identify the meaning of the following notions. Match the words and phrases in A with their definitions in B.

A	B
1. joist:	1. the load on a foundation divided by the area of the foundation
2. hydrostatic pressure :	2. heavy stones dropped under water to protect a surface from scour. The stones usually weigh more than 20 kg each.
3. bearing pressure:	3. a soil which sinks much when loaded.
4. excavation:	4. the useful load applied in design calculations (or in reality) to a structure in addition to its dead load.
5. topping:	5. a metal upright, usually nowadays of steel, designed mainly to carry weight through to the ground.
6. abutment:	6. a smail beam, often a piece of timber 20 by 5 cm, get on edge to carry the floor boards in a dwelling house. In steel it is any small rolled

Продолжение таблицы

	section used for a beam or column, but always of H-or T-shape.
7. rip-rap:	7. the concrete or mortar about 5 cm thick which is laid on to a concrete slab after it has hardened, so as to give it a smooth surface.
8. staunchion:	8. a raft designed to float
9. strip foundation:	9. a single foundation for a row of columns.
10. pad foundation:	10. a floor just below ground level.
11.footings:	11. the gap covered by a bridge or a beam or a floor or a roof.
12. mat:	12. the weight of the structure itself.
13. buoyant raft:	13. a foundation which resists horizontal load.
14. multi-storey:	14. a description of a building with many storeys.
15. settlement:	15. a concrete floor whose weight is reduced by the inclusion of hollow boxes in the slab. These concrete or burnt clay or plywood boxes are located in areas where the concrete would not strengthen the slab.
16. compressible soil:	16. a continuous foundation which carries all the loads from a structure.

Окончание таблицы

A	B
17. dead load:	17. sinking of the ground surface or of a foundation.
18. live load:	18. an isolated foundation for a column.
19. span:	19. digging out soil or rock, or a hole dug out.
20. hollow-tile floor:	20. either a raft or a 10 cm thick layer of rough

	concrete placed over a soil before it is concreted, to make a clean base for the main concrete and its steel.
21. basement:	21. the force per unit area, which any still fluid applies to a solid in it.
22. raft:	22. a foundation.

IX. Before reading the text answer the question:

What types of foundations do you know?

Then read the text and see if you know much.

Text 2 A. Foundations

Foundations (footings) are bases, usually of concrete placed on the ground so as to spread a vertical load over it. Bases which carry horizontal load, for example under arches, are usually called abutments.

A foundation may be built in one of many different materials. It may be of timber (below ground water level) or of steel joists encased in concrete, of reinforced concrete (r.c.) or plain concrete without reinforcement, or for a breakwater in the sea merely of rock tipped from a barge. Structures built on strong rock generally need no foundation since rock is usually as strong as concrete, and goes much deeper. All that is needed on rock is a little concrete or mortar to make the surface level.

One of the comnonest foundations is that for a concrete column or a steel stanchion. It is generally designed for the same maximum load, as the column, and usually is an independent (pad) foundation (Fig. 11).

Fig.11

Where the pads in one row become so large that they nearly touch, it is convenient to join them into a continuous (or strip) foundation which generally will be cheaper to dig and to concrete than the same foundations built separately as pads.

Combined footings are those in which the pads would also be so large that they nearly touch, but unlike strip footings, they may carry the load from more than one row of columns. The final development of the combined footing is the raft (or mat or mattress) foundation in which all the pads are combined into one reinforced concrete slab which may vary in thickness, but is usually of the same thickness throughout its area.

The buoyant raft is a special raft foundation, built in fluid silt which has such a low safe bearing pressure that the structure has to be designed like a boat, to be supported by the hydrostatic pressure from the soil considered as a liquid.

The main problem in the design of the foundations of a multi-storey building under which the soil settles is to keep the total settlement of the building within reasonable limits, but specially to see that the relative settlement from one column to the next is not great. If one column settles much more than its neighbour, the building will certainly crack and may look as if it is breaking in pieces. Obviously every structural designer wishes to avoid this impression, even if it is a wrong one, as it often is.

The design of a multi-storey building on compressible soil is difficult and therefore extremely interesting. Compressible soils are like a sponge, sinking most where the pressure is greatest and the load is largest.Thus even if all the foundations are designed for the same bearing pressure, say 1 ton/m^2, the largest foundation will sink the most because it has the largest load, and the smallest foundation will sink the least. A correct foundation design will therefore apply a higher bearing pressure to the smaller foundations and a lower one to the larger foundations. The exact calculation of these different bearing pressures is extremely difficult but at least this is now the aim of foundation designers.

One solution, which however is rather expensive because it may involve a deep excavation, is to dig out a quantity of soil which weighs exactly as much as the dead load of the building plus the quantity of live load which is likely to be on it. This depth of dig should be such as to make sure that the loaded building has zero theoretical settlement. Since the ground will be carrying no more load after the structure has been put up than it carried before, there will in theory be no general settlement. In fact, however for various reasons, some foundations will sink.

It must be said that the foundation designer before he starts the design, should know the safe bearing pressures which are advisable at every level possible for the foundation. He will usually obtain these figures from the organization which makes the soil mechanic survey for the site. He must also know the probable load from the structure.

For most multi-storey buildings, because of the high cost of the land in a city, the structure itself is in a very early stage of design at a time when the foundations must be designed very quickly. The building design must, however, have progressed so far that at least the positions of the columns are known, and therefore the floor spans will be fixed. The probable floor thickness can then be worked out. This will vary only slightly if at all from floor to floor, and it must be calculated as closely as possible including the topping. Generally an allowance of 13 cm of dense concrete will be enough, plus 5 cm for the topping and floor surface, making 18 cm in all. The weights of the beams, columns and stairs can be regarded as included in the floor thickness allowance. If the floors are to be built with hollow tiles or with lightweight aggregate, a reduction for this should be made.

X. Ask your classmates if he or she knows the answers to the following questions. Change the questions to a more polite form using the following pattern:

Ann: Do you know how foundations are built?
Nick: Yes, (No), I (don't) know how foundations are built.
Ann: Could you tell me how foundations are built?
Nick: Of course (Sure. Certainly). There are many .....

1. What bases are called abutments?
2. What materials may a foundation be built of?
3. What structures need no foundations?
4. What is one of the commonest foundations?
5. What load do combined footings carry?
6. What is the main problem in the design of foundations of a multi-storey building?
7. What should the foundation designer know before he starts the design?
8. Under what conditions will the building certainly crack?
9. Why is it difficult to design a multi-storey building on compressible soil?

XI. Read the following passage and exchange your opinions on building pile foundations. Can you give an example?

Here are some phrases you can use:

I think ... In my opinion ... Well, I must say that ... . Would you agree with ...? I am with you there ... I am of the same opinion ... . No, I don't think that ... This is not the way I see it.

Pattern:

Ann: I think that piles provide strong support for the structure. Are you of the same opinion?

Nick: Yes, I am with you there. I think that ... For example, ...

One way of building strong foundations on soft grounds is by using steel or concrete columns called, piles. These piles extend from the surface down to rock or firm soil so that any structure built upon them will be strongly supported. Some piles have to be 30 metres or more in length to reach firm soil.

There are several different piling methods. One is to force a precast concrete or steel pile directly into the ground, by hammering. Another is to bore a hole in the ground and fill it with concrete.

Pile boring has found wide application. A bore hole is first filled with steel framework, then with concrete, and the pile is ready.

Piles without using building materials for that purpose have been developed. At the depth of 16-18 m a hole is drilled. A special burner is then inserted. At 1,400 ^{o}C the earth fuses. It then hardens and becomes a bearing pillar. Building erected on such "piles" proved very effective.

XII. Read the dialogue and try to reproduce it working in pairs. Can you give your own examples of using pile foundations in ancient times? Discuss your examples with your classmates.

Dialogue

Ann: Were piles used in ancient times? I mean in Russia.

Nick: Sure. I know that Ivan the Creat's Bell Tower stands on a peculiar pile foundation. The base is comprised of round, closely bound upright logs from 120-to-180 cm high.

Ann: I wouldn't say that they were long, rather short.

Nick: Yes, they were short because in those days there were no mechanisms to drive in piles.

Ann: No, there were not. But today pile-drivers are used to force the piles into the ground. Some work by steam, some by compressed air, and some by diesel. Do you know what a pile-driver is?

Nick: As far as I know, it consists of a heavy weight that moves up and down a steel tube. The end of the tube rests on the pile. The weight hits the pile as it falls.

Ann: There must be a lot of noise during this operation. Are there any other methods?

Nick: I think there are. I know that some piles are driven in by pushing devices called jacks. In this method there is little noise or vibration.

XIII. There are sheet piles, also widely used in construction. Where are they used? Read about sheet piling and summarize the main information in English. Discuss it with your classmates.

The chief difficulty connected with dry soil excavation is the tendency of the earth sides to fall to the bottom of the pit. This tendency is greater in loose sand and gravel than in cohesive soil, such as hard clay, but in all cases, when the digging extends to any depth, protection should be maintained against possible cave-ins. The type of protection depends on the size and shape of the excavation.

For spread footings, which are generally rectangular or trapezoidal in plan, sheet piling consisting of wood planks or steel sheets driven on end into the soil ahead of the digging is employed. The wood sheet piling is composed of 2-to-8 in. planks about 12 in. wide and may be used in single thicknesses side by side or bolted together in three layers so arranged that a tongue is fomed on one side of the section and a groove on the other. This type is less likely to buckle than the single planks and provides a tight joint between sections. Steel sheet piling has come into general use. It consists of lengths of steel plate about 1/2 in. thick and 12 to 16 in. wide provided with interlocking joints along the sides. Two types of sections are made, the arched web, and the straight web, the former being stiffer against buckling. Steel sheeting is higher in first cost but is easier to drive and can be reused more often. When the conditions are not too difficult and the piling is to remain in place wood sheeting is probably still the cheapest.

In all cases borings should be made to determine the depth to which the steel piling is to be driven.

Wood and steel sheet piling is largely used for holding the banks of basement excavations. Such sheeting must be strongly braced to withstand the earth pressure, especially in crowded cities where any settlements or cave-ins would be most dangerous for adjoining buildings and streets.. The bracing may be set horizontally between opposite banks or consist of sloped shoring with the heels of the braces held by temporary piles driven in the basement bottom. If the pressure is very great, two lines of sheeting are sometimes used or a trench is dug at the building line or the sidewalk curb line before excavation begins. This trench, is then filled with concrete to form the wall and the basement is dug inside. Bracing must be introduced to hold the walls in place as the excavation proceeds and before the columns and girders are in place.

Moderate amounts of water encountered in the excavation of basements and cellars may be drained to a sump pit from which it is pumped to the sewer. When the water occurs in large quantities that cannot be eliminated through sumps the excavation is enclosed with some type of cofferdam.

XIV. This is an example of using piles in construction. Read the following passage and sum up the main information in Russian.

The South Mall in Albany, New York (now called "Empire State Plaza")

is the largest state government complex ever built and one of the most ambitious construction projects (Fig.12).

Fig. 12

The project consists of 12 major structures, including: a 44 - storey office tower; four 23-storey agency buildings; a nine-storey legislative office building; a nine-storey motor vehicle building. There are also many special structures.

The acquired site included a lot of sub-standard dwellings and several commercial and industrial enterprises. About 3700 families, housed in 1150 structures, had to be - and were relocated.

The site soil is a medium-to-stiff clay averaging 100 ft (30 m) in thickness. Underlying this is a compacted glacial till, 6 to 30 ft thick (1.8-9.1 m). This layer is underlain by a shale bedrock.

Tests showed a high capacity for H-piles driven into the glacial till layer. Accordingly, steel piles driven into that layer were used to support all but one structure.

The depths of basement floors for new buildings in the Mall were limited, because of existing basement levels of nearby structures; this depth limit was insurance against soil movement and damage to these adjacent buildings.

Since nearby structures are supported on mat or spread footings, lowering of the ground water would cause general area subsidence. Accordingly, a groundwater cutoff wall, made of sheet piles, was constructed around the construction site. In many areas, tile sheet pile cofferdams needed for foundation excavation were made a part of this groundwater cutoff wall. As an additional precaution,groundwater observation wells were installed on the periphery of the construction site and monitored throughout construction.

XV. Is there anything new for you in these passages? Read them carefully putting down the new information. Compare your notes with the notes of your classmates. Are they the same?

A. Pyramidal piles are a progressive design of piles used in building. These piles have the shape of an enlarged pyramid; they are rammed into the ground acute end first.

Unlike prismatic piles, pyramidal piles pack the soil along the sides while sinking into it, thus enhancing the mechanical quality of the soil, and subsequently conveying the load of the whole side surface upon the packed base.

Such distinctive features of the work of prismatic and pyramidal piles in the soil ensure the possibility to enhance the bearing capacity of pyramidal piles with respect to prismatic piles by 1.5-2 times.

Pyramidal piles are used in the bases of building and constructions for various purposes and designs. They are especially effective when packed soil lies on the upper part of the base from 3 to 5 m deep, while loose soil can lie underneath.

In this case pyramidal piles must work as single piles. When pyramidal piles are arranged in groups and joined by a low foundation raft, the depth of the loose soil should be taken into consideration as well as the number of piles in the group. If the base is made up of packed soil along the whole depth, the number of piles in the group is not limited.

The structural design of pyramidal piles is carried out in accordance with the deformations, proceeding from the equality of the work of external and internal forces. The volume of the stabilization zone should not exceed the volume of the consolidation while conveying the load to the pile.

B. In order to distribute a column load over the foundation bed, steel grillage is occasionally used instead of a reinforced concrete footing. This usually consists of two layers of beams. The beams are encased in concrete not less than 4 in. thick as a means of protection, and the lower tier rests upon a bed of concrete to distribute the column load to the foundation bed. Since the grillage beams must be completely encased in concrete, the bearing areas of the grillage foundation and a reinforced concrete footing are practically the same. Therefore, it is usually expedient to use the reinforced concrete fooing. In this case the concrete resists bending, shearing, and bond stresses instead of merely being a protecting material for the steel grillage beams.

XVI. What is your idea of the job of the foundation engineer? Read the passage and make use of the information when expressing your opinion on the matter.

Why does the Leaning Tower of Pisa lean? The answer is that its foundations were not soundly laid. From earliest times, architects and engineers have been aware of the problems involved in laying a building’s foundation; but they have not always realized to what extent the earth can be pressed down by the weight of a building. Too little allowance has sometimes been made for the possibility of a heavy structure’s sinking unevenly.

If the earth is stable, laying the foundations of small buildings possess few problems. But in a tall modern structure the load may be very heavy indeed; and the foundation engineer has an extremely important job to do. To begin with, he must have a thorough understanding of soil mechanics, which entails a scientific study of the ground to see what load it can bear without dangerous movement.

Trial pits are dug, or holes are bored, in order to collect undisturbed samples of earth from various depths. By examining these, the engineer can forecast the probable shifts in the earth during and after building, according to the sort of foundation he designs. Thus he comes to the most important decision of all in the building’s construction: he decides whether the earth is of the type that can best support each column on a separate concrete block, or whether he must aim at lightness and, as it were, "float" the building on hollow foundations.

These foundations take the form of a vast, hollow concrete box. This box is divided into chambers that will house heating and ventilating plants as well as provide garage and stroge space for the building.

Luckiest of all are those foundation engineers whose buildings stand on hard rock like granite or ironstone. For them neither piles nor floatation need be used.

XVII. Read the text and get it as a whole.

Text 2 B. A Breakthrongh in Construction Techology

Atlas Copso have produced a simple and extremely flexible method which can effectively eliminate many of the problems in laying foundations, installing anchors and soil improvement. It is based on the Expander Body (E.B.) element (Fig.13).

The E. B. element is made from 1 mm steel sheet. This is folded length-wise to form a rectangular bar. The bar is sealed at the "bottom" and left open at the "top". It is installed in the soil, by driving, jacking or predrilling. Cement grout is then pumped into the open end of the element, causing it to expand to about five times its original diameter. The soil around the E.B. elements becomes compacted and preloaded during the expansion.

Fig. 13

This new technique not only makes soil stabilization quicker and cheaper, but also greatly increases safety and structural stability. For example, because it is constrained by the expandable steel sheet, the cement grout can be directed exactly as planned and hardens without uncontrolled spreading.

Measurements of the grout pressure during the expansion of the E.B. element provide information relating to the loadbearing capacity of the soil, which allows smaller safety margins.

The use of E.B. elements in place of conventional methods means that the depth of piles and anchors can be considerably reduced. This not only cuts costs but also avoids the use of certain heavy equipment. This, in turn, makes the installation of construction elements easier, especially on sites with difficult access.

Tests and experience from several construction projects have established that the E.B. element is considerably faster and simpler than conventional methods. In addition, it makes construction possible on sites which would previously have been considered physically or economically not viable. It is particularly suitable where bedrock or load-bearing strata are far below the surface, or in soft soil, such as clay, where conventional stabilization can be extremely expensive.

A construction project carried out in a spinning mill in Halmstad, Sweden provides an example of this. New foundations were required to support a new and higher roof. The construction work was carried out while the factory continued its normal three-shift production routine.

Over a hundred piles were required and they had to be driven from inside the existing building, working between the operating looms. Furthermore, the piling method had to be sufficiently "clean" so as not to violate the high environmental requirements of the spinning process.

Soil conditions consisted of relatively loose soil down to about 20 m. The general conditions from the surface down were 5 m silt, 5 m clay, another 5 m of silt and then 5 m of sand. Below this was dense non-cohesive soil consisting mainly of sand to a great depth. The shear strength of the clay was between 30 and 440 kPa.

Despite these demanding conditions, the use of E.B. elements instead of conventional methods enabled this project to be carried through not only satisfactorily from a civil engineering point of view but also with great savings of time and cost.

Because of the relatively difficult piling conditions, a somewhat heavier pile-driver than normal was used. It was mounted on an electric fork-lift truck. The test piles were first expanded and load tested in order to establish that the correct depth had been selected. This was done while the main piling work went ahead. During expansion some of the piles were reinforced to withstand tension forces. Reinforcement bars were inserted through the pile tubes down into the E.B. elements at the bottom.

The bars were then tensioned from top plates on the surface. Finally the new footings were cast, reinforced, and attached to the piles. The use of conventional piling techniques on this site would have required piling to a depth of 30 to 40 m, i.e. down to the dense sand layer. By using E.B. elements it was possible to reduce this depth by nearly 20 m. This constitutes a saving of between 1 to 2 km of piles.

XVIII. Read the text and try to get it as a whole.

Text 2 C. Fixing Foundations

When Tennessee Eastman Co. decided to start manufacturing a different product in part of its plant in Kingsport, Tenn., the changeover required extensive structural modifications that increased column loading significantly. Unacceptable settlements would have resulted without some type of foundation remediation. Conventional underpinning was considered, but instead the specialty contractor, Hayward Baker, Inc. (HB), Odenton, Md., used jet grouting to strengthen the foundation soils.

Jet grouting is one of several innovative soil improvement techniques applicable in plant modifications or new construction. It can be applied as a mixing or remove-and-replace system that creates an in situ mass of cemented Soilcrete.

Jet grouting can be used in almost all soil types, including silts and some clays, it is capable of creating very high strengths and is considered, a permanent improvement.

To accomodate the new equipment, two 60 ft by 40 ft pits had to be constructed adjacent to and beneath the elevation of the building column footings in the west end of the basement. Column loads to the footings at the east end also rose substantially. Loads were further increased by construction of an additional access level to the structure and the need to provide for removal of existing building columns to create a larger, column-free operating area in the next expansion.

Tennessee Eastman commissioned a sub-surface investigation by Westinghouse Environmental and Geotechnical Services, Inc., Blountville, Tenn, which showed relatively uniform soils made up of sand, gravels and a thin layer of silt before reaching solid shale bedrock about 11 ft down. Ground water was present 3-6 ft below the slab, making high flow rates likely. For the underpinning system, they recommended an allowable soil bearing pressure of 8-12 ksf in the hard silt stratum and 60 ksf for bedrock.

Given the soil types, the foundations at the east end of the building would have settled l/4 - l/2 in. due to the increased bearing pressures of the new machine loads, with most of it occuring shortly after installation of the equipment. But the projects mechanical engineer reported that this would affect the operation of the machinery, which is sensitive to settlement. To reduce the potential settlement, the foundation loads had to be transferred through the soil layers to the shale bedrock.

HB proposed triple-rod jet grouting as a solution. This method satisfied all the design requirements, providing underpinning to support the added loads and reduce settlement, as well as ground-water control during excavation. It also saved time, cutting an estimated six to eight weeks from the construction schedule.

Soilcrete elements 3 ft and 3.5 ft in diameter were created beneath each footing to support the existing columns. The elements are interconnected to act as a grouted mass and extend into the silt stratum just above the shale. Around each proposed pit excavation, a continuous Soilcrete wall of 3.5 ft diameter column supports the lateral loads. Design calculations confirmed sliding stability, stability from overturning and Soilcrete quality (Fig. 14).

To inject the grout beneath the building foundations, 6 in. dia-meter access holes were core drilled through the floor slab and column footings before the operation began, Jet-grout dril-ling extended from the underside of the slab or footing to approximately 6 in. go into bed-rock, Soilcrete columns were formed from the bedrock up to the appropriate elevation. Where shear key connector was required, a No. 4 reinforcing bar was inserted into the drilled hole after grouting was completed to increase stability. The work was sequenced to provide sufficient support until the Soilcrete had hardened overnight.

Fig. 14

Quality control measures included taking four to eight Soilcrete waste samples per production shift, which were tested for unconfined compressive strength. Cored samples retrieved from production columns were tested to confirm the in-situ Soilcrete quality. The average compressive strength of the cores was 1,435 psi after seven days. Gauges installed on building columns to check the movement showed settlements under 0.125 in., which was the acceptable limit.

Work was completed in five weeks. The pits were excavated in a dry condition, with no movement of the Soilcrete wall.

✧✧✧

PART II. BRIDGES

UNIT I. MAINTENANCE AND REPAIR OP HIGHWAY BRIDGES

I. Read and memorize the following words and phrases.

1.superstructure (n)	пролетное строение моста
2. texture (n)	текстура, структура
3. spandrel arch	сквозная арка
4. hinge (n)	шарнир
5. cornice (n)	карниз
6. formwork (m)	опалубка, опалубочные конструкции
7. temporary (a)	временный
8. project (v)	выступать

9. tie (v) скреплять
10 tendon (n) напрягаемый элемент
11. tension (n) растяжение, напряжение, растягивающее усилие
12. position (v,n) место, положение, состояние; размещать, устанавливать
13. plate (n) пластина, плита, лист
14. strip (n) лента
15. in-place concrete монолитный бетон
16. anchorage (n) закрепление (пучкой арматуры), оттяжка
17. space место, пространство, промежуток, зазор
18. slab (n) плита
19. grillage (n) ростверк, решетка
20. reinforcing bar арматурный стержень
21. granular (a) зернистый
22. flexure (n) изгиб, прогиб
23. three-dimensional пространственный
24. deteriorate (v) разрушать
25. gilded позолоченный
26. transverse (a) поперечный
27. longitudinal (a) продольный
28. aggregate (n) заполнитель

II. Translate the following pairs of words paying attention to the suffixes of nouns. Fill in the table. Can you give your own examples of nouns formed this way?

-ness	-tion	-(s)sion	-ant	-ity	-ment
					placement

		corrosion			

Unique - uniqueness, aggravate - aggravation, corrode - corrosion, deteriorate - deterioration, inhabit - inhabitant, granular-granularity , demolish - demolition , prefabricate - prefabrication, place - placement, separate - separation, reinforce - reinforcement.

III. Fill in the table with the words formed with the use of suffixes . Translate this words into Russian. Which adjectives and nouns can go together? Can you give your own examples?

adjective			noun		adverb	
-al	-ive	-able	-tion	-ity	-ly	
	decorative					
				plasticity		

Essential, reconstruction, exactly, projection, plasticity, decorative, carefully, erection, composition, lavishly, equality, competition, approximately, inauguration, continuity, completely, ornamentation, traditional, direction, favorable, flexibility, deformation, reduction, prediction.

IV. Transform the following complex sentences dividing them into shorter ones, either eliminating a subordinating word or adding a few words to a phrase. Follow the example.

These decorative elements, all prefabricated, serve as formwork and are anchored with projecting bars to the subsequently poured concrete.

a) These decorative elements are all prefabricated.

b) They serve as formwork.

c) <u>They</u> are anchored with projecting bars to the concrete.

d) <u>The concrete</u> was poured subsequently.

1. After a comparison of the results, each arch component was represented by a polygonal one-dimensional element while a three-dimensional frame has been used to depict the global behavior of the complete structure.

a) .... c) ....

b) ....

2. When a complete row of three arches has been positioned and the corresponding zone of the pier heads has been concreted, the temporary ties are removed and the arches rest on the piers and abutments.

a) .... c)………

b) .... d)………

3. Once the cast-in-place concrete has hardened, a very stiff and interconnected structure is created which acts like a box-section spandrel arch in the longitudinal direction.

a) .... c)………

b) .... d)………

V. Try to identify the meaning of the following notions. Match the words and phrases in A with their definitions in B .

A	B
1. aggragate:	1. a support built up from a river bed to carry a bridge beam.
2. superstructure:	2. a heavy beam.
3. span:	3. description of a beam that forms a single structure across several spans and therefore will bend upward at the supports.
3. formwork:	4. a cable or wire or any other steel member, usually buried in the concrete, but always applying prestress.
4. tendon:	5. a pulling force.
5. tension:	6. the part of structure that is above ground.
7. pier:	7. the boxes or other containers into which concrete is cast. They are usually removed after it has hardened.
8. slab:	8. sand and sized stone for making concrete.
9. girder:	9. the gap covered by a bridge or a beam or a floor or roof.
10. box-section:	10. in the structural sense, any force such as weight, compression, tension, bending or twisting.
11. load:	11. a structural member, thin, but of large area like a wall or a floor and made of the same material throughout.
12. continuous beam:	12. a cross-section suitable for a beam or column. It is square or rectangular and often has no projecting flanges.

VI. Read and translate the following phrases.

Urban landscape, physical deterioration of the structure, erosion of the vaults, surface damage, vertical planes, internal cracking, spandrel arch bridge, temporary anchorages, mild steel, adjacent plates, transverse diaphragms, continuous slabs, generals transverse flexure, rigid frame, thin-wall structure, irreparable damage.

VII. Can you give examples of historical bridges? Name them, if you can.

VIII. Read and translate the text.

Text 3 A. Renovation of the Historic Bridge

San Sebastian - a charming city of about 180,000 people is situated in the picturesque Spanish Basque country. The urban architecture of the city evolved along traditional lines. The city has many historic buildings, monuments, and other structures which reflect the uniqueness of Spanish culture and architecture. Therefore, when it came time to renovate the famous Maria Cristina Bridge, the San Sebastian City Council was very careful to preserve this tradition. Since its official inauguration on January 20, 1905, the bridge has become an important part of life for the city's inhabitants and an essential element of the San Sebastian urban landscape.

Despite the bridge's initial strength, time took its toll and the physical deterioration of the structure became alarming. The very aggressive marine environment and lack of municipal funds had led to the complete structural deficiencies. The erosion of the vaults, including surface damage and internal cracking, was very disturbing. This damage consisted of several large openings along the vertical planes coinciding with the placement of the steel lattice arches, some of which were completely missing due to steel corrosion. Thus, the supposed increase of strength Ribera sought to achieve by using such steel reinforcement had, in reality, been the main factor in the bridge's structural deterioration. This problem was further aggravated by the use of concrete with a rather open granularity, i.e., an excess of large gravel stones and a lack of medium and small size aggregates.

Conscious of the irreparable damage to the bridge, the Municipality of San Sebastian launched a contest for the demolition and reconstruction of the entire superstructure. The main design requirement stated that the new bridge should offer exactly the same volume and external form, including texture and color, as the original bridge.

The winning solution was offered by contractor Femandez Constructor.The new design comprised a spandrel arch solution by using almost total prefabrication of the various load resisting elements. Each spandrel arch rests on the pier heads through two plastic hinges. The external arch also includes the top cornice and the lateral ornamentation (gilded dragons and projecting oars). These decorative members, all prefabricated, serve as formwork and are anchored with projecting bars to the subsequently poured concrete.

Erection of the Maria Cristina Bridge superstructure began with the placement of the precast spandrel arches. These members were then provisionally tied with two prestressing tendons tensioned between temporary anchorages placed at the arch ends in order to produce a force equal to 53 and 47 Mp for the external and internal arches, respectively. When a complete row of three arches has been positioned and the corresponding zone of the pier heads have been concreted, the temporary ties are removed and the arches rest on the piers and abutments in accordance with the final static scheme.

Next, the precast, curved bottom plates, 16 cm in depth, are placed between the arches. Two longitudinal separation strips 40 cm wide are then poured between the plates and neighboring arches and the mild steel reinforcement from both the plate and arch is crossed and anchored.

Transverse joints between adjacent plates are also crossed by some reinforcement. By pouring in-place concrete along these longitudinal and transverse joints the initial I section transformed into a U or equivalent section.

In the next step, transverse precast reinforced concrete beams are placed, over the transverse diaphragms of the arches at spaces of one-eighth of the arch span. Continuity is obtained between the transverse girders and arch diaphragms by pouring concrete at the joints where the projecting reinforcement crosses. In this manner, transverse frames are created which are tied at the bottom by the lower plates.

Next, 20 cm thick precast top slabs are placed, over each cell of the rectangruiar frame composed by the longitudinal arches and transverse girders. Longitudinal channels, 1.20 m wide, and transverse channels, 20 cm wide, are formed over the arches and transverse girders, respectively.

Transverse top reinforcing bars projecting from the top slabs are crossed over the first channel to ensure resistance to continuity negative moments. Also, longitudinal top and bottom bars projecting from the top slabs are crossed on the transverse channels. Without the need of any formwork, the pouring of in-place concrete in this grillage of channels makes the entire deck monolithic.

Once the cast-in-place concrete has hardened, a very stiff and interconnected structure is created which acts like a box section spandrel arch in the longitudinal direction. Local flexure is resisted by the rectangular top plates acting as continuous slabs in both directions and general transverse flexure is taken by the rigid transverse frames. In this manner, an efficient three-dimentional structure is created.

IX. Write in the missing words in each of the following sentences.

Use each word only once.

1. anchorages. 2. abutments. 3. concrete. 4. plates. 5. frame.
6. ornamentation. 7. cornice. 8. deterioration. 9. tendons.

1. The physical… of the bridge was alarming.
2. The external arch includes the top … and the lateral … .
3. The members were tied with two prestressing … .
4. Temporary … were placed at the arch ends.
5. The arches rest on the piers and … .
6. Continuity is obtained by pouring … at the joints.
7. Each cell of the rectangular…is composed by the…arches and transverse….
8. Local flexure is resisted by the rectangular top…acting as continuous slabs.

X. Match adjectives in A with nouns in B.

Can you use the phrases in the sentences of your own?

A. 1. internal. 2. initial. 3. structural. 4. various. 5. external.
6. temporary. 7. total. 8. longitudinal. 9. transverse. 10. continuous.
11. local. 12. negative. 13. rectangular. 14. plastic.

B. 1. hinges. 2. direction. 3. slabs. 4. deterioration. 5. girders. 6. plate.
7. strength. 8. elements. 9. cracking. 10. flexure. 11. arch.
12. prefabrication. 13. moments. 14. anchorages.

XI. Ask your classmate if he or she knows the answers to the following questions. Change the questions to a more polite form using the following pattern.

Pattern.

Ann: Do you know where San Sebastian is situated?

Nick: Yes, (No), I (don't) know where San Sebastian is situated.

Ann: Could you tell me where it is situated?

Nick: Of course (Sure, Certainly). ....

1. Why was the renovation of the historic Maria Christina Bridge so important for the inhabitants of the city?
1. What factors led to the complete deterioration of the bridge?
3. What did the main design requirement for the bridge reconstruction state?
4. What did the new design comprise?
5. What did the erection of the Maria Christina Bridge superstructure begin with?
6. What does the external arch include?

XII. Read some more about the reconstruction of the Maria Christina Bridge.

The precasting yard was located about 1.6 km from the bridge site. Using only one piece of wood formwork and simple scaffolding on the ground, the contractor produced six external and nine internal arches. After tensioning its temporary tie, each arch was stripped from the formwork and prepared for transportation to the project site.

The entire set of bottom curved plates, transverse girders and top slabs, including also the various decorative pieces, were produced by the contractor in the same yard. The molds for fabricating the lion heads, oars, dragons, and other sculptures were obtained by the contractor from the originals still remaining on the old bridge (Fig.15).

Special sculpturing techniques were used to fabricate these ornaments. Initially, a gypsum mold was made from which a clay countermold was produced and covered with a thin layer of wax.

Subsequently, the wax was melted and replaced by an injected plastic mask. This mask served as the prototype for the series of decorative pieces to be made. Because the highway leading from the fabrication yard to the bridge site was narrow with many sharp curves, a major problem arose with regard to the transportation of the precast elements. In some cases the transverse slope of the highway was as much as 6 percent. It was imperative that no significant torsional moments would develop in the arch during transportation.

Fig. 15

To counteract any undesirable stresses from developing, a specially designed steel device was used to act as a connecting member between the front tractor and the rear axle set. The arch element was suspended at both ends from a scaffold in order to allow it to rotate freely along its longitudinal axle in the vertical plane. However, a small restraint was considered necessary so as to avoid excessive movements of the arch during transportation.

XIII. Look through the following passages and explain what kind of information is given and what is not given in it: "The author mentions (explains, points out) how (why, that... etc.), but he does not say..."

A. Tower Bridge, one of the world's most distinctive river crossings is closed, because rust is eating into and weakening the huge box girders beneath its twin towers (Fig.16).

Fig. 16

Chris Stevens, the bridge master, says it is a tribute to the technological skills of the bridge's designers and builders that it has coped so well with the 40,000 vehicles that use it each day.

Many of the four million people who visit the bridge each year believe it to be stone but this is merely cladding because Sir John Wolfe-Barry's extraordinary feat of engineering is constructed of steel.

The bridge took eight years to build at a cost of 1 million pounds. When it was opened by the Prince of Wales on June 50, 1895 it was savaged by the critics. The Builder magazine said:"The whole structure is the most monstrous and preposterous architectural sham that we have ever known . It is a discredit to the generation that erected it. The Times better captured the public mood. "The opening of the Tower Bridge on Saturday was a picturesque and stately ceremonial, perfectly performed under the most favourable conditions. The effect produced on the immense multitude of spectators by the actual opening of the movable roadway was remarkable."

"For a moment the great crowd was hushed and silenced. Then, in a deafening shout of applause, which soared as only a British cheer can roar**...** they gave vent to their admiration and delight at the marvel they had been privileged to see."

The Corporation of London, the bridge's owner, is disappointed that only 500,000 visitors each year pay to enter the bridge to see the coal-powered machinery which was used to operate the two 1,200-tonne bascules which are raised to allow through river traffic.

It will open a 3,25 million pounds exhibition in August which will use video, light, sound and smell to take visitors back in time and the story of the bridge will be told by lifelike animated model guides.

B. After 17 years of service - with long exposure to water and corrosive salts - permanent steel bridge deck form's were recently called into service again when deck sections had to be replaced (Fig.17).

According to the New York State transportation department, which built and maintains the bridge on Interstate 87, the forms were found to be in "excellent condition."

Where portions of the main deck were removed to facilitate replacement of the deteriorated joints the forms were still in good enough condition to support new concrete pourings.

Fig.17

The twin bridge involved in this work is typical of the bridges built in New York State as part of the Interstate System. It carries the Adirondeck Northway over the Mohawk River north of Albany. The bridge is of suspended arch construction. Its single span carries the roadway a distance of 775 ft (235 m) and has three lanes in each direction.

Each deck of the twin bridge consists of a 7-in. (177 m) thick reinforced concrete deck slab and a 4-in. (101-mm) wearing course, covering an area of 27,828 ft^2 (2585 m).

XIV. Read and translate the text trying to get it as a whole. Give your ideas on the points given below and be ready for interruption. Answer each question and go on speaking according to your plan.

1. Main reasons for inspection of bridges.
2. Signs of bridge distress.
3. Examination of the bridge's durability.
4. Examination of the protective coating.

Text 3 B. Why Ispect Bridges?

Highway authorities are responsible for the safety of all structures and this is the main purpose of inspection. Collapses of bridges in use are rare, but nevertheless the consequences in loss of life, limb and property are serious. The inspection procedure must ensure that conditions which might lead to collapse are brought to light as soon as possible and repairs carried out or, if applicable, a suitable protective weight restriction applied. The bridge inspector's role is analogous to a policing operation where it is preferable to prevent crime by routine patrolling than arriving too late at the scene.

The second main reason for inspection is the systematic gathering of information about the condition of various parts of the structure. The purpose of this is to prepare instructions for repair or maintenance work to be carried out. This work may be routine maintenance or more specific special maintenance which involves major expenditure such as waterproofing, concrete repairs, repainting and the like. The information also provides an indication of the rate of deterioration over the years. Systematic inspection also ensures that no part of the structure is overlooked from the safety aspect. As with any organisational function, the usefulness of the information is only as good as the use to which it is put. The inspection must always result in either a clean bill of health or action to remedy defects. Clearly it is not possible to remedy all defects immediately, nevertheless, the action must be at least to systematically schedule repairs for budgeting and policy purposes.

Vehicle accidents, toxic or flammable spilages, flooding and other "Acts of God" will also require special emergency inspections. Vehicle accident damage will require estimates for insurance purposes and often immediate protective work such as temporary barriers, whilst flooding results in damage to foundations.

Having considered the structure's integrity as a whole the inspection should consider the constituent parts - the fabric of construction. The question should be asked "Does the condition of any part of the structure reduce its original ability to take load?" Many concrete bridges built earlier are very prone to spalling of concrete, rusting of reinforcement and consequent loss of section capacity. Concrete degradation must be monitored at an early stage to prevent substantial section loses requiring costly repairs. Small cracks in concrete, if noted at an early stage, may be sealed to prevent ingress of water and consequent spalling.

Steel bridges do not show ready signs of distress, unlike concrete. Steel is an unstable material which will always attempt to return to its stable oxide form - rust. It is the degree of rusting and its locality that must be observed, bearing in mind that rusting involves volumetric expansion and will appear to be worse than perhaps it is. Fatigue cracks may be present.

Prestressed concrete construction is far more durable than reinforced concrete. However, signs of cracking anywhere on a prestressed structure must be given careful consideration as to cause.

The next stage is to examine the bridge's durability and its finishes. In a concrete bridge the main cause of loss of durability is failure of waterproofing and movement joints coupled with porous or poor quality concrete. The flow of water through concrete leaches lime, negates the protective alkaline environment of the steel, induces rusting, causing corrosion products of greater volume, thereby bursting concrete off the steel. It is important that inspection should note signs of inadequate cover, leaching, seepage and joint failures. The latter will not only be a traffic hazard but will allow water to penetrate to bearings, possibly causing corrosion, restraint to movement and secondary stresses.

Steel bridges (except Gorten steel) will always have a protective layer applied at the time of construction. This will take the form of galvanising, metal sprays, paints, bitumen wrapping or a combination of these. Signs of break-down in the protective layer should be noted with sketches showing its extent so that the type of remedial work may be ascertained.

Finally, and perhaps most important of all, is the clear, neat, complete recording of the inspection. An unrecorded inspection trusts information to memory and is therefore unlikely to be retrievable at any time in the future.

XV. Read each of the given series of questions and reproduce each set addressing your classmate. Add a question or two concerning the same problem.

Your partner should formulate the problem: "In a word, you want to know if (how, why, etc...)".

Example:

A. Is the safety of a bridge very important? Are the consequences of collapses of bridges serious? Can the bridge inspector take any preventive measures? Does the bridge inspector gather information about the condition of various parts of the structure?

B. In a word, you are interested to know the main reasons for inspection of bridges.

1. Will vehicle accidents require special emergency inspections' Does protective work include temporary barriers? Does flooding result in damage to foundations? Is it possible to consider all defects immediately?
2. Is spalling of concrete the usual thing with many concrete bridges? Can concrete degradation be monitored at an early stage? Can small cracks be sealed?
3. Is rusting dangerous to steel bridges? Is the degree of rusting important? May cracks be present in steel bridges? Must steel bridges have a protective layer?
4. Is the recording of the inspection important? Must the repairs be systematically scheduled? Is it done for budgeting and policy purposes?

XVI. Make up a short monologue explaining why the systematic inspection of bridges is vital for the integrity of the bridge structure. Include the activities involved.

You should be quite confident of what you say ("For one thing, ...", "Besides,...", "And to finish with,...")

XVII. Read the text and summarize the main information in English. Begin with a one-sentence summary of the text.

Text 3 C. Repair and Maintenance Techniques

The broad stock of bridges is largely made up of three categories: arches, concrete bridges and steel bridges.

Arches. Arches rely on compression to carry load; this compressive strength is provided by brickwork or masonry and the mortar joints between them. The most usual causes of deterioration are spalling due to wetting and freezing, leaching due to percolation of water through the structure and vibration due to heavy wheel loads. The maintenance of the road surface, including the control of public utility excavations, the pointing of mortar joints and repair using frost resistant (low absorption) bricks will all assist in enhancing the durability of the arch.

Most arches were built in the 19th century and, invariably, foundations are at a high level and often consist of a simple timber platform. Too much emphasis cannot be placed on the inspection and protection of foundations and the control of river regrading works. Repair works can range from simple concrete bag pitching for local protection to the provision of RC trough inverts where there has been general erosion of river bed levels.

Where shallow cover or the narrowness of the bridge has caused movement of the spandrels, an expedient measure may be to provide anchored tie bars and low pressure grouting of major distress cracks, particularly if the movement is at an early stage. If movement is serious the only solution is to break back to sound construction and to centre and reconstruct arch, spandrel and wing walls. One problem is that the original bricks are often larger than modern ones making matching of coursing difficult.

Where spans are small and the inherent strength of an arch is low, it is often useful to 'saddle' the arch with an in-situ reinforced concrete slab, provided that the foundations are adequate.

The decision to reconstruct an arch will involve use of scarce resources of manpower, money and materials; it is therefore well worth investigating suitable repair methods as they may present a useful extension of the working life of an arch at low cost.

Concrete bridges rely on the interaction of steel reinforcement and concrete to provide a moment of resistance to applied loads in accordance with well-documented theories of reinforced and prestressed design.

The most usual cause of deterioration is the passage of water through and over concrete surfaces. Salts used for de-icing roads during winter also give rise to degradation of concrete structures.

Most modern bridges have a waterproof membrane either of mastic asphalt or proprietary systems of the hot or cold applied bitumen membrane type which require a protective board to prevent damage from asphalting plant and the temperature of asphalt during laying. Continuity of waterproofing at movement joints is provided by buried joints, being suitable for small movements, where the asphalt is continuous over the joint or by proprietary systems for larger movements irmere there is a physical gap in the asphalt and a preformed seal.

Protection may be afforded to outer faces of a concrete structure by the application of a sealer coat of sprayed epoxy resin or liquid plastic dressing. These are available in various colours, properties and costs and will also enhance the appearance of an old bridge whilst sealing minor cracks.

Steel. Steel bridges, or bridges built with substantial steel elements represent about 15 % of highway bridges. The choice of protection of steelwork is an integral part of the design as is the built-in cost of continued maintenance of the protective system.

The type of maintenance painting depends on the degree of break-down of the existing system. Total failure (general corrosion) will require grit blast cleaning to bare steel and the application of a full six coat paint system. Failure of upper coats of paint may be rectified by low pressure sand-wash blast cleaning, stripping, individual coats of paint and replacing with two or three finish coats. Local failure may be repaired by hand-cleaning, using mechanical abradors, requiring a full six coat system. Before any maintenance painting is carried out , the exact nature of the existing paints must be known to prevent incompatibility of systems which may result in blistering or lifting of lower coats. Whatever the choice of paint system the most important aspects in achieving durability of adhesion are surface preparation and atmospheric conditions.

For bridges, where appearance is not of importance, bitumen paints may be used with the advantage of low cost, high impermeability, tolerance to weather and good durability in thick coats.

XVIII. Look through text C and compare repair and maintenance techniques for arch, concrete and steel bridges. Are they the same? Can you comment on the techniques? Illustrate what you say by examples.

UNIT II. VIADUCTS

I. Read and memorize the following words and phrases.

1. viaduct (n) — виадук
2. terrain (n) — местность
3. boulder (n) — валун, булыжник, галька
4. overlay (n) — слой износа дорожного покрытия

5. precast (a) сборный
6. post-tensioning напряжение натяжением арматуры на бетон
7. assemble (v) собирать, монтировать
8. curvature (n) кривизна, изгиб

9. cast-in-place монолитный
10. drill (v) бурить
11. footing (n) нижняя часть фундамента, основание
12. T-beam тавровая балка
13. curb (n) бордюрный камень мостовой, край тротуара
14. deck (n) настил, плита
15. alignment (n) выравнивание
16. culvert (n) труба под насыпью
17. box girder балка коробчатого сечения
18. grout (n) строительный раствор
19. compressive stress сжимающее напряжение
20. shear stress срезывающее напряжение

II. Translate the following pairs of words paying attention to the suffixes of nouns. Fill in the table. Can you give your own examples?

- (a) tion	- ment	- er	- ity	- ance / ence
construction				
		constructor		

Protect-protection; complex-complexity; require-requirement; attract-attraction; own-owner; align-alignment; except-exception; transport-transportation; preserve-preservation ; form-formation; accept-acceptance; locate-location.

III. Translate the following related words paying attention to the suffixes of adjectives, nouns and adverbs. Fill in the table. Can you form some new words?

Adjectives -able/-ible; -al, -ive;	Nouns -(s)sion, -tion, -ity;	Adverns -ly
progressive	progression	progressively

Accept-acceptance; segment-segmental; structure-structural; protect-protective; progress-progressive-progression; environment-environmental; relative-relativity; vocation-vocational; previous-previously; access-accessibility-accessible; final-finally; alternate-alternative-alternatively; local-location.

IV. Translate the following phrases into Russian. Can you think of sentences with some of them?

Stone-clad curbs; natural scenic beauty; alternate route; natural topography; highway construction; bituminous overlay; waterproofing membrane; access road; curb-to-curb roadway; irreparable damage; decomposed vegetation; spiral curves; retaining walls; adjacent areas; tourist attraction; environmental impact.

V. Before reading Text 3A look through the following passage and see if it gives enough information to answer the following question: Why did the construction. of the viaduct structure become the challenging engineering problem?

The Blue Ridge Parkway, owned by the Unites States National Park Services (MPS), is a unique transportation / recreation network. Built along the crest of the beautiful Blue Ridge Mountains in North Carolina, the 469 mile (755 km) long highway attracts millions of vacationers each year with its beautiful scenery and facilities for camping, hiking and picnicking.

Through the years the NPS has made every effort to preserve the natural beauty of the roadway and to provide access to adjacent areas. All highway construction is in accordance with the "park concept". For instance, fill must be placed, and granite clad retaining walls built before the side of a mountain can be cut. All bridges are built with stone-clad curbs and wing-walls to blend with the surrounding mountain landscape. Bridges must also have open handrails so visitors will have an unobstructed view as they journey through the 479 mile (755 km) park.

Construction of the Parkway began in 1933 and was completed in the late 1950’s with one exception: a 5-mile (8 km) length around privately owned Grandfather Mountain, which is one of the leading tourist attractions in North Carolina. The owner of Grandfather Mountain was insistent that construction of the Parkway must not harm or be obtrusive to the natural scenic beauty found there. Since the owner shared the same philosophy, the Federal Highway Administration, which supplies engineering services for the Parkway, studied alignments and alternate routes and finally, a route which could not be seen from the mountain top was chosen around the eastern mountainside. To minimize construction damage to the area, the roadway alignment was raised above mountainside by use of a viaduct structure.

Since building the viaduct structure by conventional methods of bridge construction would have done irreparable damage to the environmentally sensitive area, the search for an acceptable construction method became a challenging engineering problem.

VI. Read and translate the text.

Text 4 A. Linn Cove Viaduct

The Linn Cove Viaduct is probably one of the most complex bridges ever built. The structure proposed for the project was a precast post-tensioned segmental concrete box superstructure, eight spans in length with both horizontal and vertical curvatures conforming to the natural topography (Fig. 18).

Three major factors contribute to its complexity: environmental constraints and inaccessibility of the site and the vertical and horizontal alignment.

Fig. 18

The site within the limits of the Linn Cove Viaduct is a rugged and steeply sloped terrain with relatively heavy ground vegetation and boulder outcroppings. A natural stream crosses the bridge near the northern edge. The scenic location, with its protruding boulders and the requirement for their protection and preservation were the major factors to be considered in the design.

The bridge was literally built on the side of a mountain which had to remain in its natural state. There was only one way in or out, namely, over the completed portion of the bridge. The horizontal alignment includes spiral curves going into circular curves with radii as small as 250 ft (76 m) and with curvature in two directions, which gives the bridge its S-shape. The Linn Cove Viaduct includes almost every kind of alignment geometry used in highway construction.

The foundations consist of cast-in-place abutments at each end and seven intermediate precast segmental box piers bearing on 20 ft (6,1 m) diameter footings. Both the abutments and pier footings are supported on reinforced 9 in (229 m) diameter microshafts drilled into the underlying rock formations. The bridge is 1243 ft (379 m) in overall length with a curb-to-curb roadway width of 35 ft (11 m). The final roadway surface is 2 in (51 mm) bituminous overlay with waterproofing membrane.

To minimize the environmental impact on the construction site, the major portion of the bridge was to be built without the use of access roads. The only permitted construction road was from the south abutment of the second pier, a distance of approximately 260 ft (79 m). From this pier to the end of the bridge, the construction was to be from the previously completed portion of the deck.

No trees other than ones directly beneath the bridge were allowed to be cut. Each tree had to be evaluated separately and approved for cutting. All foliage adjacent to the bridge had to be protected by a silt fence located along the entire length of the bridge. Any construction debris on the outside of the silt fence had to be immediately retrieved.

Nine of the boulders could be defaced during construction, except in instances of rock bolting. The boulders were covered to prevent concrete, grout or epoxy stains.

The streams flowing across the bridge alignment were protected from siltation or other contamination. Water quality was constantly monitored.

Because of the severe environmental restrictions, the bridge could not be constructed by conventional methods and a system was devised in the design to construct it from the top. This required a progressive scheme which enabled segments of the bridge to be transported across the previously built deck and assembled into final position.

Precast concrete was chosen over cast-in-place segments because the region has a relatively short construction season by choosing precast concrete, production of the segments could continue during the winter. Additionally, the precast segments were made under plant-controlled conditions which led to high-quality concrete.

The progressive scheme is considered feasible and structurally satisfactory for span ranges of from 150 to 200 ft (46 to 61 m). For these span lengths, a constant depth box girder has proven to be the most economical. After visits to the site and analysis of the possible locations of piers and temporary supports, the maximum span length was established at 180 ft (55 mm). Spans were determined after locating piers to avoid the natural out-croppings of rock.

Typical box girder bridges have been built with span-to-depth ratios of 18 to 25. Structural aesthetics are generally more pleasing through the use of higher span-to-depth ratios. Considering the beautiful site of Linn Cove, it was decided to use a span-to-depth ratio of 22 to provide a graceful structure. However, after analysis of this cross section, it was decided. to increase the depth of the box and the web thickness bacause the shallower depth structure would have required a significant amount of high strength post-tensioning steel.

Cantilever construction with large equipment weights applied at the free end induces high compressive stresses in the bottom slab. This in combination with shear stresses resulting from the torsional moment and the longitudinal shear force, results in a bottom slab thicker than the usual 12 in. (305 mm) for the typical section and a web width of 18 in (457 mm).

VII. Write in the missing word in each of the following sentences. Use each word only once.

1. alignment. 2. preservation. 3. waterproofing. 4. structure. 5. handrails. 6. siltation. 7. damage. 8. curbs. 9. abutment. 10. access.

1. The requirement for the protection and ... of the natural scenery was the major one.
2. All bridges are built with stone-clad ... .
3. Bridges must have open ... so that visitors could enjoy the scenery.
4. The viaduct includes almost every kind of ... geometry.
5. The foundations consist of cast-in-place ... at each end.
1. The final roadway surface is provided with ... membrane.
7. A viaduct ... was used to minimize construction ... to the area.
8. The major portion of the bridge was built without the use of roads.
9. The streams flowing across the bridge alignment were protected from ... or other contamination.

VIII. Form compound nouns by matching words in A with words in B. Translate the words into Russian.

A. 1. net. 2. rail. 3. hand. 4. land. 5. park. 6. mountain. 7. micro-. 8. wing.

B. 1. rails. 2. scape. 3. side. 4. road. 5. work. 6. way. 7. shaft. 8. wall.

IX. Match adjectives in A with nouns in B and translate the phrases into Russian.

A. 1. vertical. 2. environmental. 3. intermediate. 4. progressive. 5. bituminous. 6. spiral. 7. conventional. 8. natural. 9. sensitive. 10. complex.

B. 1. impact. 2. method. 3. area. 4. pier. 5. overlay. 6. ramp. 7. scenery. 8. bridge. 9. alignment. 10. scheme.

X. Try to identify the meaning of the following *notions. Match the words and phrases in A with their definitions in B. Do you know how to translate these words and phrases? Use dictionaries if necessary.*

A	B
1. boulder:	1. to cast concrete on the ground or in a factory so as to lift it into position after it has hardened.
2. superstructure:	2. a support built up from a river bed to carry a beam.
3. precast:	3. a large stone.
4. radius:	4. a heavy floor, so as that on a bridge or a ship.
5. pier:	5. half a diameter.
6. footing:	6. a road bridge over a small stream, sometimes made by laying a pipe in a trench under the road and filling round the pipe with soil or concrete.

Окончание таблицы

A	B
7. abutment:	7. in bridge design, the additional force from a moving weight, caused by its motion.
8. deck:	8. one of two (sometimes more) possible ways of doing something.

9. impact:	9. a foundation.
10. drill:	10. the part of a structure that is above ground.
11. culvert:	11. a foundation which resists horizontal load.
12. alternate:	12. to make a hole in something.

XI. Ask your classmate if he or she knows the answers to the following questions. Change the questions to a more polite form using the following pattern.

Pattern:

Ann: Do you know where the Linn Cove Viaduct is situated?

Nick: Yes (No), I (don't) know where the Linn Cove Viaduct is situated.

Ann: Could you tell me where the Linn Cove Viaduct is situated?

Nick: Of course (Sure, Certainly). It is situated in a scenic place around Grandfather Mountain.

1. What structure was proposed for the project?
2. What factors contributed to the complexity of the viaduct structure?
3. Where was the viaduct built?
4. Why does the Linn Cove Viaduct include almost every kind of alignment geometry?
5. What do foundations consist of?
6. What can you say about the final roadway surface?
7. What measures were taken to minimize the environmental impact on the construction?
8. What made conventional methods of construction impossible?

9. What do you know about the progressive scheme of construction?
10. What span-to-span ratio was used to provide a graceful structure?

XII. Read the following abstracts paying attention to the construction technology. Are there similar features in the designs?

A. Chester Viaduct, Cheshire (Fig. 19). Each carriage way is supported by an in situ concrete twin-celled concrete box beam. The viaduct is continuous over the thirteen 76 ft spans. Structural continuity is obtained by lapping the seven 0,7 in. diameter strand cables at the quarter point of each successive span. Particular attention has been given to finish and formwork details. This viaduct crosses the railway at a skew angle and as there was insufficient space between the rail tracks for foundations, the pier load of 1,500 tons is carried by three hollow box beams 10 ft 6 in. wide and 8 ft deep spanning 80 ft.

Fig.19

B. Salford Crescent Viaduct, Lancashire (Fig. 20) The 760 ft long viaduct has twenty spans of 35 ft and two of 30 ft. The deck is built from

460 standard bridge be-ams infilled with in situ concrete. These standard beams were introduced by the concrete Prest-resssed Concrete Deve-lopment Group, and ap-proved by the Minister of Transport. The first be-ams were of an inverted T-beam shape with a range of span up to 50 ft for the Ministry of Transport normal and abnormal loading. These standard sections have since been used for longer spans in building work – the range of standard types was increased to include inverted T-beams up to 55 ft, hollow box beams up to 120 and I-beams for use with in situ slabs up to 120 ft.

Fig. 20

C. Wentbridge Viaduct, Yorkshire (Fig. 21). The viaduct is on the Wentbridge Bypass and crosses the River Went at a height of nearly 100 ft. The cellular deck is continuous over three spans, the raking legs being pinned at top and bottom with concrete hinges. The deck was constructed in

situ on staging, 4 ft long shrinkage gaps being left over the legs until just before the prestressing cables of 1 1/8 in. diameter strand were tensioned, using the CCL System. These cables were finally ca-sed in fine concrete to protect them and to bond them to the structure. Provision has been made for jacking the raking legs, should mining subsidence oc-cur. The deck is fixed at

Fig. 21

the south abutment and free at the other. Fourteen hemispherical bearings, lubricated with molybdenum disulphide, allow rotation and resist thrust at the fixed end abutment.

XIII. Read and translate the following abstract writing out the words which are new for you. Discuss the information with your classmates making use of the following phrases.

I wonder ... I'd like to know ... I am interested to know ... /if/, /when/, /whether/, /how/, /what/, /which/, /where/.

Tell me about ..., please.

Is ...? Does ...? Did ... ? Have you ever ... ?

Manucunian Way, Manchester (Fig. 22). The 4,200 ft long viaduct is continuous over the 32 spans which vary from 60 ft to 105 ft. The deck structure has a single box girder for each carriageway, built from precast concrete segments. The supports for the precast units are arranged so that each span is built with the leading end cantilevering one quarter of the span. The first stage of prestressing is then applied so that the beam is self-supporting. The supports are then moved forward for the construction of the next span. The first stage of the prestressing for one span thus becomes the second stage for the previous span. This arrangement simplifies construction, places the anchorages at the point of minimum bending moment and provides full continuity and torsional strength over the supports. Anchorage is provided at the abutments of the two subsidiary ramps and expansion joints are provided at all other abutments. Movement of the structure at points of support other than the anchorage abutments is provided by "Rotaflon" sliding bearings located at the tops of the piers and on the other abutments. Restraints are provided, where

Fig.22

necessary, to control the movement of the structure and eliminate trans-verse displacement due to curvature in plan. The CCL or PSC systems of prestressing are used.

XXIV. Read the text trying to get it as whole. Which of the following is not discussed in the text?

- Segment casting.
- Segmental box pier construction.
- Superstructure segment erection.

Text 4 B. Construction Technology

The precast pier segments were match-cast in the vertical direction. This method involved casting the new segment above the previously cast segment with steel forms used for the side forms and a core form to cast the void in the box. The reinforcing cages (including the vertical tendon ducts) were prefabricated.

The severe geometry requirements of Linn Cove necessitated some unique properties for the superstructure segment casting machine. The system had to be strong enough to support 55 tons (50 t) of concrete and steel; yet flexible enough to seal around the edges to the cast-against segment, which in some instances was severely skewed because of the large degree of curvature to be obtained.

To assist in obtaining adequate sealing to ensure smooth joints, the contractor installed a strip of rubberized material on the edge of the casting machine. This worked very well with the only detrimental effects being occasional pieces of rubber which would stick to the concrete. However, the pieces were easily removed.

The extreme weather conditions on Grandfather Mountain of below zero temperatures and winds ranging to 100 miles per hour (161 km/hr) influenced the contractor to enclose the casing machine and reinforcement cage fabrication area in a building. However, since the box pier segments were relatively few in number, they were cast outside.

All pier footings are 20 ft (6,1 m) in diameter and 5 ft (1,5 m) in thickness. The footings are founded on variable thickness nonreinforced subfootings through which microshaft piles were drilled.

After forming the footings and placing the reinforcement and post tensioning conduits, the first of the precast segments were placed. A steel frame fabricated from rolled sections was placed in the footing simultaneously with the reinforcing bars. The frame provided support for the first box pier segments.

The initial precast segment was placed on shims and flat jacks which enabled proper alignment. The segment had to be aligned to correct for casting variations and actual superstructure position. Movements were achieved by pumping the flat jacks one at a time or in combination. The segment was supported at four points.

The contractor was responsible for aligning the segment and the alignment was subsequently verified by the engineers. After verification, the footing was cast. The top of the footing extended approximately 1 in. (25 mm) above the bottom of the segment and the support beams were lost.

After the footing concrete had hardened, the joint between the cast-in-place concrete and the precast segment was pressure grouted with epoxy. The purpose of the epoxy was to waterproof the joint. The epoxy was not related to strength. The precast box pier segments were delivered over the completed portion of the superstructure which extended to within two segments of the pier location. The segments were lifted over the end of the cantilever by a striffleg crane attached to the cantilever.

The last step in the pier construction was to place the cap and stress eight 12-strand tendons. These tendons extend from the top of the pier down through and out the side of the footing. Once stressing was completed, the tendons were grouted.

Superstructure segments were delivered to the end of the cantilever by a low-boy tractor trailer. Because of the limited access, the truck had to be backed up the access road and backed out into the completed portion of the bridge.

The crane which lifted the segments from the truck and swung them around to the end of the cantilever was an American S-20 stiffleg crane. It was equipped with a 70 ft (21 m) boom and provided a 125 kip (556 kn) lifting capacity at 25 ft (7,6 m) boom radius.

The crane had to be moved forward after each segment was erected. Generaly, it was located two segments behind the segment being erected. The moving operation involved lifting the entire assembly, removing the steel support beams and lowering the assembly into steel rollers. Once the crane was supported on rollers, it was pulled forward by hand-operated winches. Then the lifting process was reversed. The steel support beams were reinstalled and the crane was tied down.

The moving operation cycle took 4 to 6 to complete. Moving the stiffleg crane entirely controlled the erection rate of superstructure segments.

The bridge was completed without a single structural problem. There is not a crack in any of the precast surperstructure or substructure segments. The project is a tribute to what can be accomplished with proper segmental design and construction techniques.

ОГЛАВЛЕНИЕ

Учебное издание

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ТЕХНОЛОГИЯ СТРОИТЕЛЬНОГО ПРОИЗВОДСТВА

Учебное пособие на английском языке

Редактор А.П. Володина
Корректор иностранного текста Л.Ф. Староверова
Верстальщик Г. В. Малышева
Дизайн обложки М. Мельников

ЛР № 020275 Подписано в печать 27.03.02
Формат 60x84/16. Бумага для множит. техники. Гарнитура Таймс.
Печать офсетная. Усл. печ. л. 5.58. Уч.-изд. л. 5, 72. Тираж 100 экз.
Заказ
Владимирский государственный университет.
Подразделение оперативной полиграфии
Владимирского государственного университета.
Адрес университета и подразделения оперативной полиграфии
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