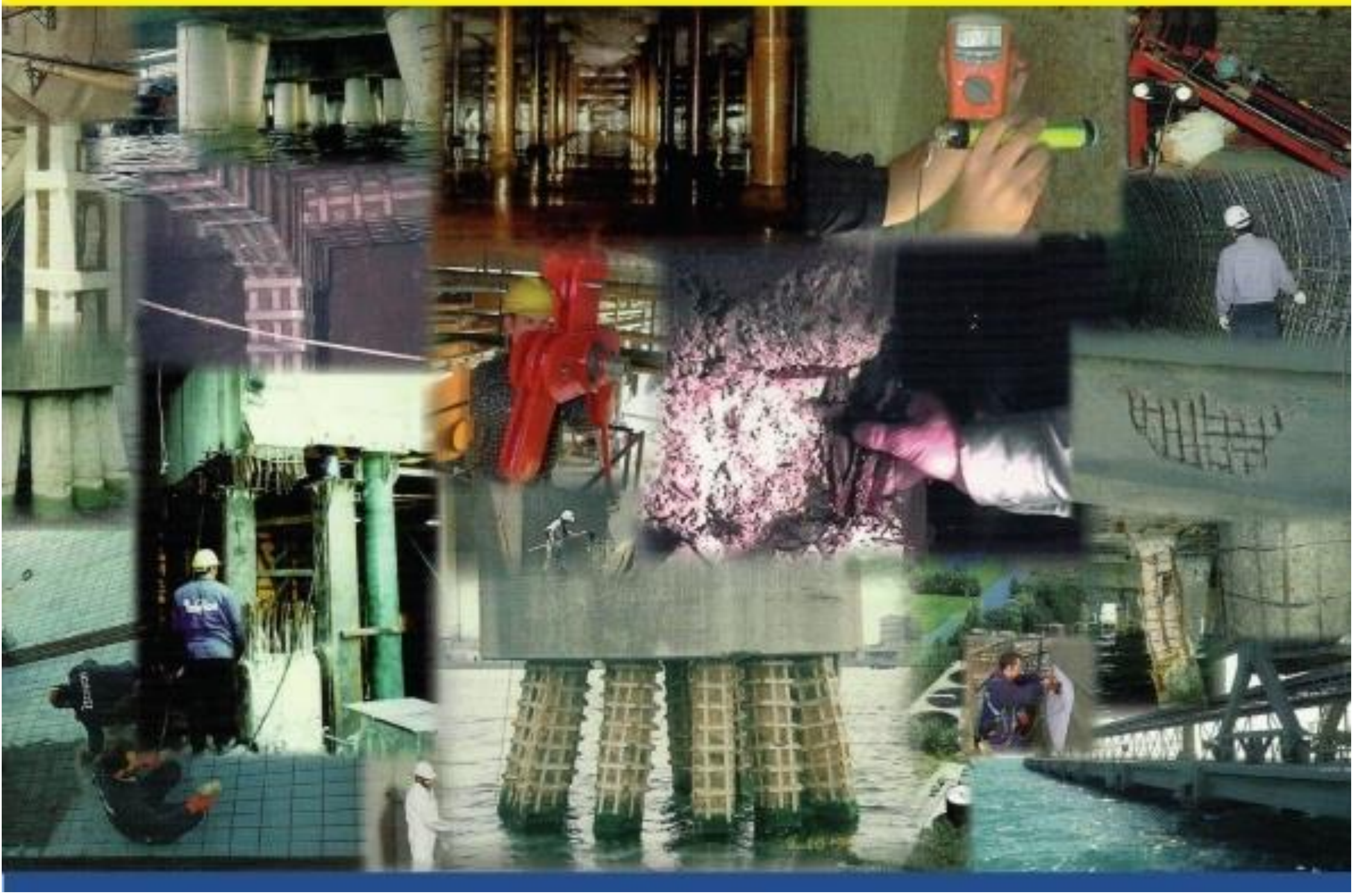
İZO-PST®

Polymer Static Strengthening



ACE

Advanced Corrosion Engineering

Ingredients

ACE
Advanced Corrosion Engineering

What Do We Know About Our Structures?

We frequently encounter corrosion in reinforced concrete structures in our daily lives. Corrosion which we meet from the columns and beams in the basements of the buildings we live and in to the highway bridges we pass under on the way to work every day is one of the most important factors that determine the economic life of our structures. Although this problem does not attract our attention until a piece of the bridge falls on our car, corrosion and structural damages of industrial structures can affect us even stopping production.

What is the economic life of our structures? How can we protect our structure against the problems? How can we extend the service life of our structure? How can we reinforce our sturectures economicly?

Izomas Group of Companies which solve these problems with its applications (know-how) has created a new company within GOSP Technopark in order to bring better solutions to you:

ACE YAPI TECHNOLOGIES RESEARCH AND DEVELOPMENT INDUSTRY AND TRADE INC.

ACE works in the areas of determination of the current state of structures with non-destructive methods, development of reinforce and strengthening methods in line with these determinations, and long-term monitoring of the behavior of structures. Our cooperation ensures harmony between research, development and field applications. Directing our R&D studies according to the problems in our industrial structures has resulted in a great progress in solving the durability and corrosion problems of industrial structures.

Today, when a large part of the building stock is rapidly approaching the end of its economic life, we are taking strong steps towards to the future with our know-how and experience.

Dr. Gürbüz Arıburnu
Chairman of the Board

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Corrosion in Reinforced Concrete Structures

Corrosion is generally defined as a gradual wear or deterioration by electrochemical reactions. The degradation of metals except mechanical is briefly called corrosion. Iron and steel generally corrode in the all areas where are oxygen and water.

Despite corrosion control is a very important issue, it is not emphasized enough in practice and it is the most important factor affecting industrial investment and production costs. Because of the corrosion, the value of lossing energy, material, labor and information of countries is between 3.5% and 5% of the "Gross National Income". This value is estimated to be around 4.5% for our country. This means that the loss is approximately 2.5 billion dollars per year. This means that the protection of iron and steel against corrosion is an indispensable field of maintenance engineers.

Generally, the reinforcement in the concrete does not rust. The high alkaline level of the concrete creates an armor that protects the reinforcement inside against corrosion. For this reason, reinforced concrete structures built under suitable conditions, including many marine structures, are highly resistant to corrosion. Hovewer, whatever the reason, the disappearing of the protective armor is the beginning of the corrosion.

Many concrete structures in various environments in the industry can become contaminated over time due to environmental effects (contact with sea water, salts used to prevent icing, fertilizer residues, etc.). Chloride ions that have entered the concrete structure cause the deterioration of the passive oxide film formed on the steel surfaces. In this case, the reinforcement bars may be corrode. If there is more than 0.7-1.2 kg of chloride in 1 m^3 of concrete, a suitable environment is provided for the continuation of corrosion. Not only steel is lost with the corrosion of reinforcing irons. Chemical compounds (rust) formed as a result of corrosion cause internal stresses and cracks in the concrete due to its much larger volume occupancy than metal. In such a situation, there is a life-threatening danger for concrete. Corrosion in reinforced concrete structures, which are damaged under intense physical and chemical effects, often shortens the service life of the structure and in some cases ends it completely.

Reinforcement corrosion, combined with the chemistry of the cement in the concrete, shows great differences compared to the corrosion in underwater, underground or structures open to the atmosphere. For this reason, when it comes to the corrosion of the reinforcement in the concrete, it is necessary to know this chemistry and its effects before talking about corrosion protection or corrosion repair.

Concrete's pH Level and Carbonation

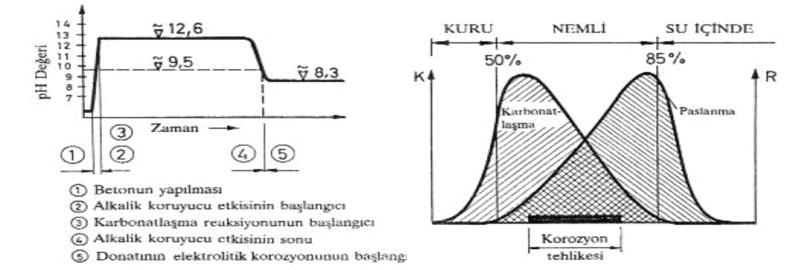
Concrete essentially consists of a mixture of aggregate + cement + water. The main chemical reaction that provides the binding property of cement occurs between water and cement (clinker compounds). Aggregate is used as an inert filler that forms the physical structure of concrete. Clinker compounds react chemically with water to form calcium silicate hydrate and calcium aluminate hydrates. These hydrate compounds crystallize and harden over time.

During the reaction of clinker compounds with water, calcium hydroxide is also formed by hydrolysis of silicates. This hydroxide, which has a strong basic character, remains as a saturated solution in the concrete cavities after the concrete has hardened. As a result of this, and with the effect of the small amount of alkali oxides in the clinker composition, the pH level of fresh concrete rises to 12.5 (13.2 in case of alkali oxides) as in the saturated lime solution. Due to the different clinker composition in different cement types, the pH level of concrete can vary between 12-13. As the concrete ages, a decrease in pH is observed as a result of the diffusion of carbon dioxide in the atmosphere into the concrete. However, even in old concretes, the pH level does not fall very low.

The high pH of the concrete causes the formation of Fe2O3 film on the steel surfaces in the concrete in a short time and the passivation of the metal. In a normal concrete, this oxide film prevents corrosion of the steel for a long time without breaking down.

Carbonation, which is a physico-chemical process, decreases the alkalinity of the environment and causes the destruction of the protective oxide layer. The alkalinity of the concrete is provided by the Ca(OH)2 contained in the hydrated cement and the pH is around 12-13. However, Ca(OH)2 reacts with CO2 in the air over time and transforms into CaCO3, deteriorating the structure of the concrete. While this deterioration in the structure of the carbonation depth is more than 10 cm, since cracks are formed in the defective concrete without any mechanical stress.

In the effect of carbonation, the cement loses its binding property physically and a great decrease is observed in the strength of the concrete. In addition, when the pH of the concrete is low, the detrimental effect of chloride ions on the reinforcing bars is greater.



(a) (b)

a) Beton örtü tabakası içinde pH değeri ile zaman arasındaki bağıntı. b) Karbonatlaşma ve korozyon ilişkisi.

Effect of Chloride in Concrete

As it is known, the chloride in the concrete does not directly cause corrosion. However, it has the effect of increasing the speed of rusting in the reinforcements. Concrete normally creates a good protective environment for reinforcement bars, both chemically and physically. As a result of the reaction of cement with water, calcium hydroxide is formed and the concrete gains a very high alkalinity. The high pH of the concrete causes a passive oxide film layer to form on the reinforcing iron surfaces. This passive layer protects reinforcements against corrosion much more safely than many protective coatings we use today.

If the chlorine in the concrete is below the limit values, it does not cause a noticeable increase in corrosion. If the weight ratio of the salt (Cl^- ion) in the concrete to the cement is more than 0.2% (4.5 kg Cl^-/m^3), corrosion of the reinforcement starts. Prestressed reinforced bars are more sensitive to the chloride effect. The maximum chloride limit for prestressed concrete is given as 0.08%.

Chloride enters concrete in two ways. The first of these occurs by means of sand, gravel and water in the concrete mixture, and the second is caused by other external conditions such as wind or sea water in which the building is located after the concrete has hardened. The amount of chlorine contained in the components in the concrete mixture is quite low. Chloride entering the reinforced concrete due to ambient conditions decreases as you go deeper from the surface. Due to the differences in concrete construction, the chloride density may increase or decrease from place to place.

Corrosion in metals is simply an electric current. In the corrosion of the reinforcement inside the concrete, while the reinforcing irons close to the surface become the anode, the irons that remain at the bottom and cannot reach the chloride ions become the cathodes. An electron current starts from the anode to the cathode via the electrolyte. A corrosion cell is formed between these two reinforcement bars.

Since chloride and therefore voltage density separation occurs between the iron close to the concrete surface and the iron deeper, this situation causes the reinforcement to produce a direct current like a galvanic battery and thus to corrosion due to ionization. The presence of regions with different potentials on the reinforcement also causes the current to be transmitted continuously and therefore the spread of corrosion. Cl^- / OH^- ratio is the factor that determines the rusting rate in reinforcements.

Corrosion in Reinforced Concrete Structures

Some of the chloride ions that initially enter the concrete react with tri calcium aluminate, one of the cement clinker compounds, during the hydration reaction of the cement, forming tri calcium aluminum chloride (Friedel salt) (3CaO. Al2O3 .CaCl2 .n H2O), a water-insoluble compound. Thus, some of the chloride ion is bound. This bound chloride has no deactivation effect. Chloride ions dissolved in the concrete pore water are effective on corrosion. The deactivation effect of chloride ions in concrete is explained as follows:

The chloride ion has with high electro-negativity. For this reason, it is absorbed more robustly than oxygen and hydroxide ions on the metal surface. These absorbed chloride ions combine with the iron ions formed as a result of corrosion and pass into the solution as ferric chloride. Chloride ions in the concrete cause the corrosion of the reinforcement by precipitating Fe(OH)2 on the metal surface by destroying the protective thin oxide layer formed by the chemical effects in the alkaline environment on the reinforcements, and this corrosion progresses continuously in the reinforcement. In this region, the corrosion process now continues as auto-catalytic. Because ferric chloride entering the solution combines with water and oxygen to form rust, while the chloride ion mixes back into the solution. As can be clearly seen from the reactions given below, the chloride ion does not directly cause corrosion. However, it plays a role as a catalyst, increasing the rate of corrosion.

$$Fe = Fe^{2+} + 2e^{-}$$

$$Fe + 2Cl^{-} = FeCl_2$$

$$3FeCl_2 + \frac{1}{2}O_2 + 3H_2O = Fe_3O_4 + 6H^{+} + Cl^{-}$$

Normally, the low permeability of a quality concrete makes it difficult for the components that cause corrosion to penetrate into the concrete and reach the surface of the reinforcing bars. As an electrolyte, the ionic conductivity of concrete is also very low (high electrical resistance). The low conductivity has a debilitating effect on the development of corrosion cells on the reinforcing bars. The conductivity of concrete depends on the moisture content, the ionic composition of the water in the pores and the continuity of the porous structure. Reinforced concrete irons in a normal concrete are in a passive state and the corrosion process of the irons is slow. However, if the concrete quality is insufficient and some harmful components from the environment enter the concrete, the reinforcing bars are corroded more rapidly. Oxygen and water are absolutely necessary for the corrosion of reinforced concrete irons. In other words, reinforced concrete irons do not corrode in dry concrete. In the absence of sufficient oxygen, corrosion does not occur. However, oxygen can easily enter into concrete, which is a porous material. Oxygen can enter concrete in two ways. First, while water saturated with oxygen penetrates into the concrete, it carries the oxygen up to the reinforced concrete bars. This phenomenon is more effective in concretes that are periodically wetted and dried. Secondly, air carries oxygen directly into concrete cracks and cavities. If the concrete voids are not filled with water, this happens very quickly. Otherwise, the oxygen must be dissolved in the water in the concrete cavities and diffused in the solution from there to the reinforced concrete bars. Since the diffusion rate of oxygen in the solution is very low, oxygen transfer in this way is extremely slow. In the corrosion event that occurs in a chloride-free environment, although the iron ions dissolved in the anode region precipitate on the metal surface as iron hydroxide, precipitation and passivation of the metal do not occur in the presence of chloride in the environment. On the contrary, the hydrogen ions released by the anode reaction lowers the pH and corrosion continues accelerating. The corrosion rate comes under the control of the oxygen diffusion rate to the cathode region, and an amount of iron equivalent to the electrons consumed for the oxygen reduction reaction at the cathode passes into the solution. Thus, a severe corrosion event begins in areas that receive less oxygen.Concrete with a high pH (12-13) acts like a cathode and reinforcement acts as an anode. As the water-cement ratio in concrete increases, the porosity of the concrete increases and it becomes easier for oxygen to reach the iron. While corrosion is very low in concrete that is constantly under water, it is more frequent in periodically dry and moist concrete. The solubility of oxygen in water decreases with increasing salinity and temperature.In summary, the quality, porosity and ambient conditions of the concrete (chlorine content, weather conditions, gases in the environment, etc.) affect the corrosion rate in the reinforcements in the concrete. Corrosion of the iron in the concrete gains importance in two respects. The first is that the reinforcement expands several times more than its original volume as a result of corrosion, causing cracks in the concrete parallel to the reinforcement and causing serious damage to the concrete. The resulting cracks also expose the reinforcements to aggressive

external influences more easily. Secondly and more importantly, as a result of the corrosion process of the reinforcements that have turned into anodes, they lose electrons by electrochemical reactions and decrease in their load carrying capacity as a result of the decrease in their diameters.

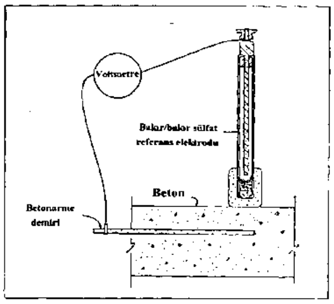
Chloride on the concrete surface can be removed using different methods (ion transport, electrochemical removal of chloride on the surface, cathodic protection). It is possible to partially clean the chloride in the concrete from the concrete surface by washing it with pressurized water. Pressurized water can enter the concrete cavities and dissolve the chloride ions there and carry them out. However, this type of cleaning is only effective on the surface and does not give definite results. However, by removing the rust margin and cleaning the loose material, washing with pressurized water is more effective and allows the chloride that has penetrated under the rust margin to be cleaned. Then, the broken parts should be repaired with polymer modified, non-shrinking concrete repair mortars. The most effective method that provides long-term protection is cathodic protection.

Non-Destructive Tests (NDT) in Reinforced Concrete

The corrosion reaction of the reinforcement leads to the formation and enlargement of different electrochemical potential zones that generate electric current in the concrete. The measurement of these potentials and corrosion currents enables the existing corrosion zones and the current corrosion rate to be found in the reinforced concrete. As long as atmospheric conditions and environment do not change, corrosion damage can be predicted in the future.

In determining the electrochemical potentials of reinforced concrete iron, potential measurements are made with a copper copper sulfate electrode (CuCuSO4). The potential of reinforcement bars is measured according to ASTM C876-91 1991 norm. For this purpose, by using a saturated copper/copper sulfate reference electrode, reinforcement potentials are determined according to this electrode and compared.

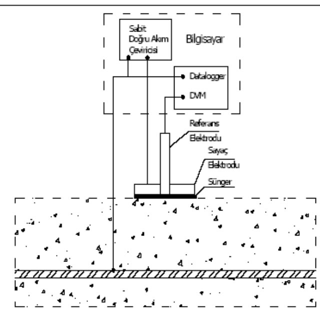
In this method, the reinforcement potential is measured by means of a sensitive voltmeter by making the necessary connections to the uncovered reinforcement. Electropotential measurements are generally called Half-Cell potential measurements and generally allow information about whether the corrosion is active in the reinforcement in the concrete By evaluating the values obtained at the end of the test according to ASTM C-876, the following conclusions can be drawn about the corrosion status of reinforced concrete irons:



a) If the potential value is more positive than -200 mV compared to the copper – copper sulfate electrode, the reinforced concrete bars are in a passive state with a 90% probability.
b) If the potential value is more negative than -350 mV compared to the copper - copper sulfate electrode, the reinforced concrete irons are corroded with a probability of 95%.
c) If the potential value is between -200 mV and - 350 mV, the reinforced concrete bars have a 50% chance of being corroded, but it is not possible to make a definite decision about whether they are corroded or not.

Corrosion Speed

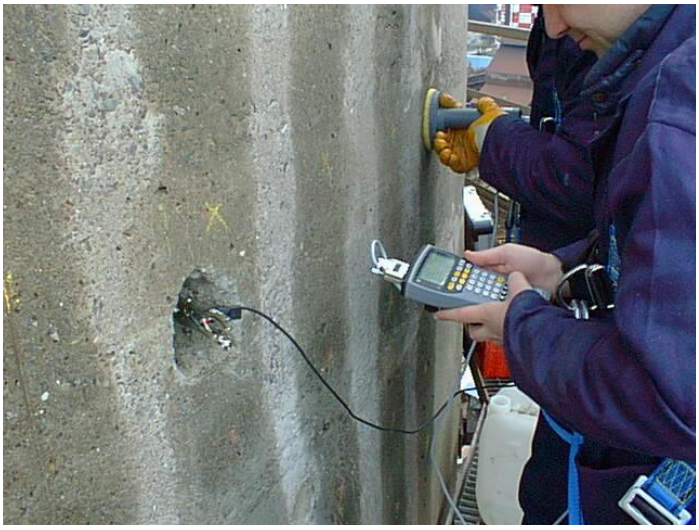
Measuring the corrosion speed is a type of fast non-destructive polarization technique. The galvanostatic current device is used to transfer the measured free corrosion potential, the electrical resistance of the concrete and the corrosion speed of the reinforcement to the PC and make evaluations. The reinforcement is polarized by giving constant small currents for a certain period of time. A galvanostatic short-term anodic current is given from the counter electrode connected to the reinforcement through the reference electrode placed on the points in the determined area on the concrete surface. This current is usually around 25-50 µA and is applied for 10 seconds. In the measurements made after the current reaches the reinforcement, the Resistance (kOhm), Corrosion speed (µm/year), Potential (mV) values are determined and transferred to the PC and drawn as a 3D graphic.



Şelik 1. Galvanostatik Akım Yönteminin Sistemi

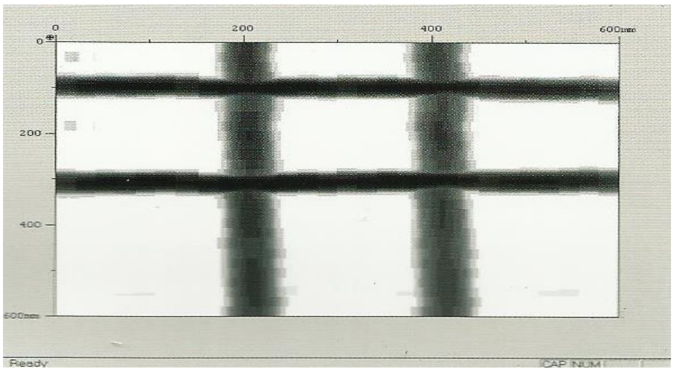
Non-Destructive Tests (NDT) in Reinforced Concrete

In the system used, the electrochemical potential of the reinforcement is recorded by the reference electrode in terms of the change in function of the polarization time. As a result of monitoring this potential change, the corrosion speed can be found if the area of the corroded reinforcement in the concrete is known. The measured corrosion speed is one of the biggest data for us in calculating the economic life of the structure. In this way, the economic life of the examined building can be calculated, as well as the level of damage to be reached by the building in the future



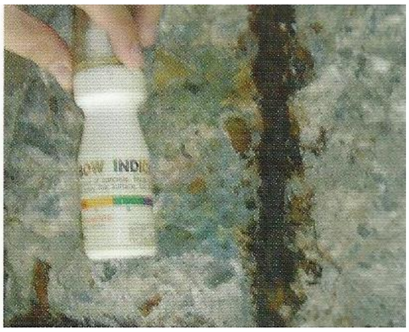
Rebar Condition Detection Without Damage

The location, number, diameter and cover of the reinforcements in reinforced concrete structures can be easily detected non-destructively by a Profometer or a radar (GPR - Ground Penetrating Radar). After these determinations, the data obtained from the structure is transferred to the computer and its current situation is evaluated. Thanks to these devices, the static survey of the existing reinforced concrete structures is extracted and the static system is analyzed in the light of the survey.



pH determination

Determination of carbonation reaction that is caused corrosion in reinforced concrete is made to evaluate ph ratio. The ratio of carbonation concrete decreases from pH 13 to pH 8. The limit value used for carbonation in reinforced concrete is pH 10. The alkali level of the concrete is determined with the indicator sprays used and the carbonation process is carried out.

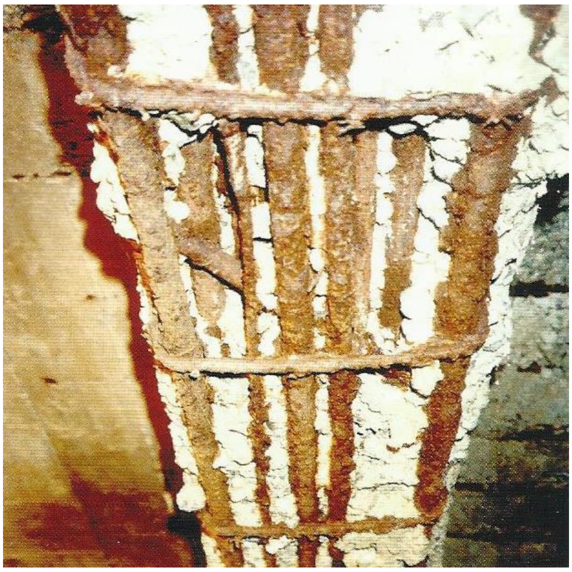


Determination of Chlorine Concentration

The ratio of penetrating chlorine to cement is determined by testing powder samples taken from certain depths in reinforced concrete. When the rate of chlorine exceeds 2% as it gets heavier, a high corrosion is seen in reinforced concrete

Repair of Structures and Protection Against Corrosion

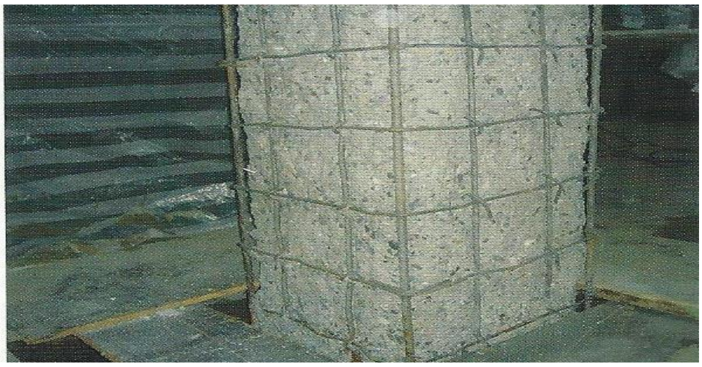
In all repairs and corrosion protection to be applied in structures, firstly it should be known what is the problem and the systems to be applied should be selected accordingly. In these determinations, especially chlorine concentrations, alkali-silica reaction, sulfate attacks and aggressive chemicals in the environment are of great importance.



It should not be forgotten that the main thing is to protect the structure against corrosion before encountering any corrosion damage. The longer the intervention against corrosion in the structure is delayed, the greater the damage and the higher the costs. While it is very economical to protect a new structure against corrosion with appropriate coating, inhibitor or cathodic protection methods, the damaged systems are primarily repaired and the safety of the structure is ensured throughout the future service life by using the appropriate protection method.

Concrete Repairs

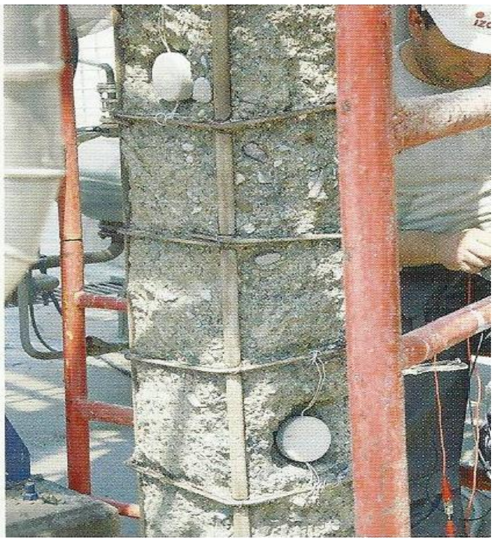
The method used for corrosion repairs in reinforced concrete systems is the Izo-BTS® Concrete Repair system. The places with corrosion damage are broken with the help of mechanical breaking tools and the reinforcements are revealed. The crushing process continues until solid concrete is reached. If there are crevices, cracks, etc. that impair the rigidity of the concrete in the concrete structure, these are filled with epoxy injection material and the monolithic structure of the concrete is restored. The exposed reinforcements are cleaned with high pressure (>500bar) water-jet and wet blasting is done. Protective coating is applied on the cleaned reinforcements to prevent the reinforcement from being affected by corrosion in the future.



After the application of the protective coating, all exposed concrete surfaces are wetted with a polymer additive concrete repair primer. Depending on the type of the surface to be repaired, the damaged part is repaired with a special polymer repair mortar by mold method or trowel work. Among the most important features of these mortars, we can count that they provide high adhesion to the old concrete and do not cause cracking (shrinkage) during setting. In addition, the waterproof feature of the mortar provides an additional feature that delays the corrosion of the reinforcement.

Cathodic Protection

The most powerful of the measures against corrosion is cathodic protection. The basic principles of cathodic protection are based on the theory of electro-chemical corrosion. It has successful applications in almost every field, from pipelines buried in the ground and hundreds of kilometers in length, to hot water preparation facilities used in homes. Moreover, large-surface steel structures (steel pipelines left on the ground and into the water, warehouses, marine transport vehicles, bridge abutments buried in water or ground, piers, etc.)) is an alternative method to protect against corrosion. Cathodic protection requires polarization of corroding metals as cathodes. This can be achieved by pairing the metal to be protected with a more active metal (galvanic anode or sacrificial anode) or by applying an external current. In the first method, the direct current required for protection is produced by the cell formed by the protected metal and galvanic anode pair. Galvanic anodes lose their weight by dissolving at certain speeds during protection. By renewing them at appropriate time intervals, the protection function is given continuity. In the second method, the protected metal and anode pair need not be current generating. Because the current required for protection is drawn from a suitable external source. Materials that are economical as well as slow solubility are used as anode material.



Corrosion Inhibitors

As in all matters, the essential thing in the field of corrosion is the protection of the structures before they are exposed to corrosion. Preserving a new or old structure at risk of corrosion before it is exposed to corrosion is the most economical method compared to possible corrosion repairs. The corrosion inhibitors used in many cases can be applied very easily and slow down the corrosion speed satisfactorily.

Although the corrosion inhibitors used in reinforced concrete do not completely stop the corrosion of the reinforcement in the concrete, they slow down the corrosion of the said reinforcement sufficiently even in environments with intense chlorine, thus ensuring that the structure provides healthy service throughout its service life.

The use of inhibitors during the construction of a new concrete is very simple. Inhibitors, like other additives, are added by dissolving them in the mixing water. During repair, inhibitors may be added to concretes damaged by corrosion and needing repair. If the reinforced concrete iron is exposed, paints containing inhibitor can also be applied to the iron surfaces.

Various inhibitors are used to prevent corrosion of reinforced concrete irons. The most important feature sought in concrete inhibitors is that they do not have a negative effect on the physical properties of concrete.

Mechanism of Inhibitory Effect

Corrosion-reducing effects of inhibitors occur in various ways. Some inhibitors passivate the metal by forming a thin film on the metal surface. Some inhibitors, which precipitate on the metal surface, prevent the reaction between the metal and its surroundings. In some cases, corrosion can be prevented by chemically binding the corrosive component in the environment, for example oxygen, by the inhibitor. Although the aim is to neutralize the corrosion phenomenon, the mechanism of action of each of the inhibitors is different.

Strengthening Existing Structures

Reinforcement of a building is a equation which has many unknowns. Unfortunately, we assume many unknowns of this equation with various estimates and build our solutions on these assumptions. While designing our buildings, we assume the load they will carry, we assume the acceleration that a possible earthquake will apply to the structure, we assume that our building can be exposed to snow, wind or earthquake loads at the same time, and we even assume that how many people will jump on the building at the same time. When it comes to reinforcing our structures built on these assumptions, if we make these assumptions again, in many cases we will encounter false results. For example, how accurate would it be to use the safety coefficients that we use in the bearing capacity of concrete in order to meet possible manufacturing errors, in a finished production, when knowing the actual strength of the concrete.

What is essential in reinforcing an existing building is primarily the examination and study of the existing building. With the non-destructive methods used for this purpose, the actual material properties of the structure are determined. Corrosion reactions are determined and the effect of the structure on the carrier system is calculated. The point where the corrosion can occur during the service life of the structure is determined and the repair and strengthening projects of the structure are based on these foundations. The values obtained in the static analysis of the current state of the structure should be verified with on-site measurements. As a result of the static calculations, the period of the structures, that is, how they will oscillate under earthquake loads is found. This approach is correct when building a project from scratch and, as mentioned above, involves many assumptions. But in existing structure, this approach is not enough. The oscillation values of the structure in question can be easily determined by seismic sensors to be placed in the structure. These values actually show how the structure will move under earthquake loads. Comparing the same values with static calculations informs us of the problems that occurred during the construction of the building, and in many cases, the areas that cause problems can be determined, which can be reduced to per carrier element.

Strengthening Existing Structures


The main purpose of the repair and strengthening project, which will be prepared with the data obtained as a result of these determinations and examinations, is not to change the static system of the structure and not to limit the ductility of the structure. It should not be forgotten that the first rule in earthquake resistance is that the structure absorbs energy with a ductile movement. According to this rule, in the reinforcement made with the Izo-PST® Polymer Static Reinforcement System, the structural elements are not stiffened by enlarging their dimensions, and even the ductility level of the construction elements is increased because of to the confinement. The buildings are brought that they will fully meet the existing earthquake specifications and no additional weight is imposed on the structure. Izo-PST® Polymer Static Reinforcement System is a system developed for adding external reinforcement to reinforced concrete. In the application of the system, the steel elements prepared for this work are adhered to the concrete from the surface to work together with the reinforced concrete, with special epoxy adhesives, and these bonded steel elements work in the same way as the reinforcements in the concrete. All calculations are in accordance with classical reinforced concrete calculation methods


New Technological Methods and Earthquake Safety in Buildings

One of the most surprising developments in the construction industry in recent years is the methods that ensure the earthquake safety of buildings. These methods can often make the building 100% safe against earthquakes. When seismic supports are used in a building, the vibration period increases several times, the energy is not transferred to the structure to a large extent during an earthquake, and the behavior of the structure remains at the linear level and does not reach the yield limit. Most of the energy of the earthquake is absorbed before it is transmitted to the carrier system by the dampers used. In addition, with these systems, the distance in the bearing systems can be increased, the wall and section sizes can be reduced, and very complex architectures can be easily implemented. Although the seismic isolation system is used in new buildings, it can also be easily used in existing buildings. In this way, many reinforcement works are more economical than traditional methods.

Earthquake Behavlor Of Buildings

The main purpose in the design of an earthquake-resistant structure is not to meet the loads on the structure without moving, but to be able to move properly under the loads and absorb the energy of the earthquake. In the event of a load on the columns and beams above the design values during an earthquake, deformations occur in the beams and this excess energy is also absorbed. These deformations are usually permanent and irreversible. However, although the weak beam, strong column principle is essential in our specifications, in many buildings, the columns are also deformed under the earthquake loads in question, causing high damage to the structure and even the structures collapse.


Seismic Isolator System

The seismic isolator system prevents the energy transferred to the structure during an earthquake to a great extent. This means that the structural safety factor increases by the same amount. Seismic isolation is an earthquake resistant design approach based on the principle of reducing the seismic energy coming into the building by prolonging the period of the buildings, instead of increasing the earthquake resistance capacity of the building. Proper applications of this technology allow buildings to behave elastically even during major earthquakes. In other words, during an earthquake, the building shakes with a much softer vibration instead of violent movement. Surprisingly, the principle of this approach is quite simple.

According to researches, a seismically isolated building feels an earthquake measuring 8 on the Richter scale as if it were an earthquake measuring 5.5 on the Richter scale. In new buildings where seismic isolation system will be applied, the total cost of the building will increase depending on the project. However, if we consider the importance factor of the building (hospitals, schools, etc.) and the value of its content (information processing centers, hospitals, laboratories, etc.), this ratio will be very funny considering the damage and loss of function after the earthquake.

Energy Absorbers

In traditional methods, the seismic energy that structures are exposed to during an earthquake is damped in the structural system of the building. This situation; It means the acceptance of the structure being damaged during the earthquake. With the energy absorbing dampers applied in addition to the bearing system, it is possible to consume seismic energy without causing structural damage and to absorbe earthquake vibrations in a short time. Dampers absorbe the seismic energy that the structure is exposed to by converting it into heat energy with the friction principle. This situation can be identified with the braking system used in automobiles. In addition to relieving the bearing system, dampers also play an active role in preventing the loss of life and property caused by the movement of non-structural elements under high accelerations. The use of buildings is becoming increasingly common in countries such as Japan and the USA, with other features such as fulfilling all functions during and after the earthquake, no interruption in service and production, ease of assembly, low cost, and easy monitoring after the earthquake. Dampers; school, hospital, residence, industrial facility, historical building, commercial complex, bridge, viaduct etc. has such a wide range of uses. In addition to being applied during construction, it can also be applied to existing structures much faster and easier than traditional methods.

In addition to being used in the superstructure, dampers are also used at the foundation level together with seismic isolators. In the base isolation method, which separates the building structure from the base and allows the substructure and superstructure to vibrate at different periods, it works in harmony with lead coreless rubber cushions. Dampers, as an energy absorber in the base isolation method, offer an effective solution especially in long-period earthquakes and successfully control high displacements. With this feature, it is also widely used in high-rise buildings. In systems where rubber insulators and dampers are used together, both elements can be monitored separately, earthquake performances can be followed, and it provides a very easy observation opportunity compared to systems that perform the energy absorbing function with lead cores (lead core isolators) located inside the rubber pads.

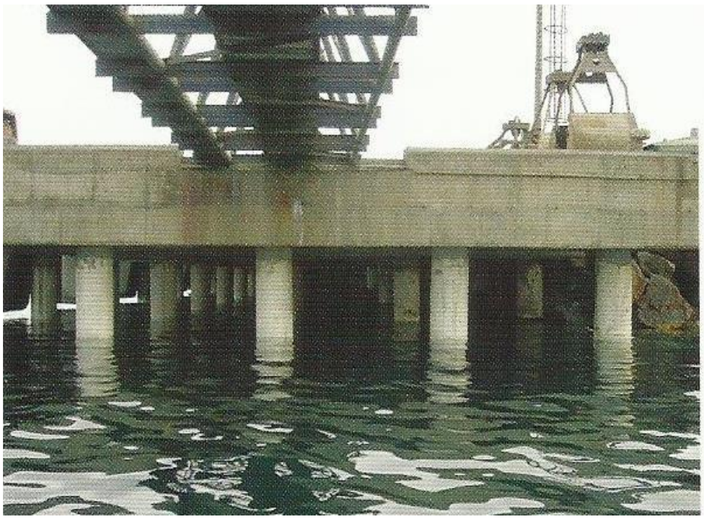
REPAIRS ON MARINE STRUCTURES

In industries based on maritime transport, marine structures (pier, port, etc.), which form the lifeblood of the enterprise, are susceptible to the constant mechanical and chemical effects of the salty and often extremely corrosive water of the sea and the damages caused by sea creatures, as well as the wearing effects of the heavy operating conditions they are in. extremely clear.

Many marine structures, for which no precautions are taken against corrosion during the design phase and which are not supported by any protective measures during construction and use, gradually lose their designed features and, more importantly, their strength over time, depending on the environmental conditions. These structures, which remain in use for a certain period of time without maintenance, gradually wear out and become inoperable due to various external factors over time. Extremely corroded structures create extremely serious dangers in terms of use, and if they are damaged for any reason, their maintenance can be done if possible, and if it is not possible, their renewal causes very high costs and loss of time.

Marine structures that have not been adequately protected, have suffered wear and tear at the end of normal use, damaged as a result of accident, or have to withstand static and dynamic loads different from the original design values, also need maintenance, repair and static reinforcement processes in order to remove these problems.

The most important points to be considered in the protection, maintenance, repair and strengthening operations to be carried out are the existing deterioration, corrosion, damage, etc. of the operations to be carried out. Considering the reasons first, the works to be done should include measures and contributions that will ensure the effective and economic use of the structures throughout their useful life. The effectiveness of the solutions must be weighed against the initial investment costs of the repairs to be made against the features and benefits gained from these repairs over the useful life of the structure.

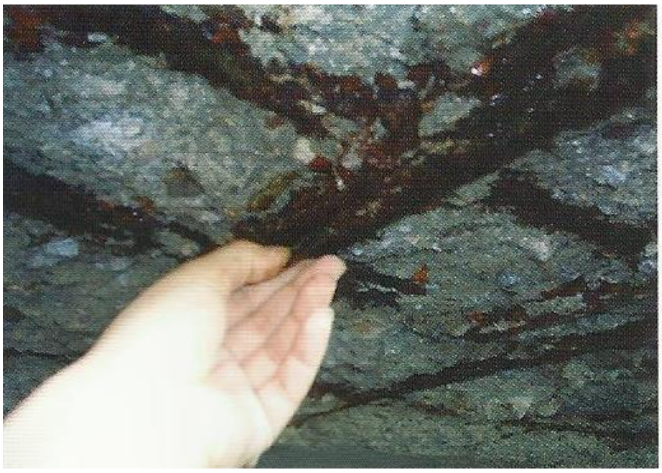


Corrosion in Steel Structures:

Steel elements used in marine structures are susceptible to the corrosive effects of the sea and its surrounding environment. Due to the turbulence and high volatility (aeration-aeration) caused by the activity of sea water, corrosion occurs at high speed and rate, especially in the tidal and fluttering areas of the water. While the initial wall thickness of a steel pier of 11mm without corrosion protection after 8 years of use in the warm climate bay area had the highest average corrosion rate of approximately 90% in the flutter regions, this rate was observed as 5% in the above sea areas and 30% under the sea. Again, under the conditions of our country, corrosions of more than 50 mm in the flutter areas and approximately 6 mm in the underwater areas have been observed intensively in the concrete filled piles with Ø508 mm spiral wound seams and 10 mm wall thickness of a 25-year-old pier built in the Izmit Korfez. As can be seen from the examples above, corrosion occurring in the flutter areas destroys the unprotected steel walls in a short time, quickly melts the concrete filler inside the pipe, and as a result, destroys the entire strength of the marine structure. The amount of corrosion seen in the flutter areas is 10-20 times higher than that in the atmospheric environment, and 1.5-3 times more intense than the underwater areas. These rates and times are obtained for normal seawater environment and warm-temperate climates, and they cause destruction in much shorter times for seawater environments that contain heavy industrial wastes (sulphate, nitrate, chlorine, etc.).

Corrosion in Reinforced Concrete Structures:

Reinforced concrete structures, which are used extensively in marine structures, have found various uses, from concrete piles to reinforced concrete decks. The damaging effects of adverse environmental conditions on reinforced concrete structures have been known for a long time. Reinforced concrete structures that show high deterioration under these effects and require intensive maintenance and repair are frequently encountered.In order to eliminate the errors caused by these reasons, it is necessary to understand the causes of the errors well. Chlorine attacks are the main cause of corrosion in reinforced concrete structures in the sea

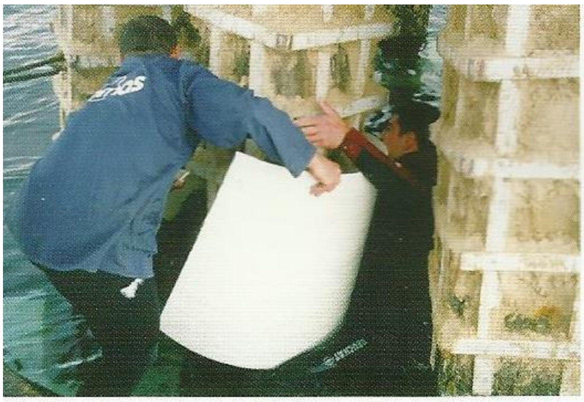


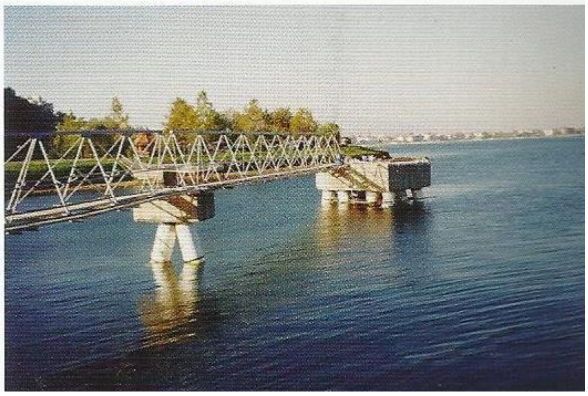
REPAIRS ON MARINE STRUCTURES

Protection of Port Piers Against Corrosion

As it mentioned before, the most corroded regions are flutter regions, submerged regions, and regions in the atmosphere, respectively. For corrosion, the areas approximately 1 meter below and above sea level are of primary importance.

Izo-KTS® process system, a special sheathing system, is applied to all piles in marine structures, if any, after repair and reinforcement to be made, in order to protect against the intense corrosive effects of the environment. In this system, the repair work starts with the surface cleaning of the area to be repaired with roughing, sandblasting or pressurized water spraying. In the Izo-KTS® pile renewal and protection system, rigid PVC case are mounted around steel or reinforced concrete piles with a special locking mechanism and filled with underwater epoxy or special cement-based filling mortar, as needed. If desired, it is also possible to make a cathodic protection so that it remains in this case.





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■	1978	TCCD - Söğütlü Çeşme Station,İstanbul 190 Tons Cracked Beam Repair (Wiht Epoxy Injection)
■	1985	Turkish Aırforces Command - yenişehir Aırcraft Facılıtıes Repaır Constructıon
■	1989	Dericeler Sitesi - İzmir Clearıng Pool Statıc Repaır
■	1991	Kınalı – Sakarya Hıghway 4 Km Concrete Pıpe Statıc Repaır
■	**1992**	**The Mınıstry Of Defense** **Erzincan 3rd Army Mılıtary Damaged Barracks** **By Earthquake (Statıc Repaır)**
■	**1992**	**The Mınıstry Of Defense** **Erzincan 3rd Army Mılıtary Damaged Socıal Facılıty** **By Earthquake (Statıc Repaır)**
■	**1992-93**	**The Mınıstry Of Defense** **Erzincan 3rd Army Mılıtary Damaged Housing** **By Earthquake (Statıc Repaır)**
■	**1994**	The Mınıstry Of Defense Turkısh Armed Forces - Ankara Mıcro Pıle, Water Proofıng And Repaır
■	**1994**	**Presıdency Florya Socıety** **420 Unit Reınforced Concrete Pıer Repaır**
■	**1995**	**Tugsas – Samsun** **650 Mt Port, 416 Unit Reınforced Concrete Pıer Repaır**
■	**1995**	**Petkım – Aliağa - İzmit** **480 Mt Port, 376 Unit Reınforced Concrete Pıer Repaır**
■	**1996**	**Shell,Turkey – Yarımca** **240 Mt Port, 80 Unit Reınforced Concrete Pıer Repaır**
■	**1996**	**Petkım – Yarımca - İzmit** **180 Mt Port, 212 Unit Reınforced Concrete Pıer Repaır**
■	1996	Zeytinburnu Pomp Center - Istanbul Column + Beam Repaır Wıth İzo-Pst System
■	**1997**	Karadeniz Bakır Operatıons Samsun Nıtrogen Pıer K.B.İ Pump Department Repaır
■	**1997**	Yapı Kredı Bank - Bayramoğlu Static And Concrete Reınforcement

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■	1997	Ankara Navy Operations Centre Buıldıng Repaırıng Statıc And Concrete Reınforcement
■	**1997**	**Tügsas - Gemlik** **23 Unit Reınforced Concrete Pıer Of Port**
■	1998	İstanbul Hilton Hotel Isolatıon Of Car Park And Repaır
■	**1999**	**M.S.B. Ankara Cıvıl And Buıldıng** **Anıtkabir Aslanlıyol Foundatıon Statıc And Concrete Reınforcement**
■	**1999**	**Petkım – Yarımca - Izmıt** **Repaır Of Damaged 92 Unit Reınforced Concrete Pıer By Earthquack And Port**
■	1999	Aksa - Yalova Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System
■	1999	Türk Kablo - İzmit Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System
■	1999	Akal Tekstil Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System
■	1999	Kordsa - İzmit Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System
■	1999	Dusa İzmit Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System
■	1999	Phillips - İzmit Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System
■	1999	Akkim Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System
■	1999	Parksa Hilton - İstanbul Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System
■	1999	Pamir Gıda - İstanbul Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System
■	1999	Tuzla Elektronik Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System
■	1999	Dz.K.K Yıldız H.A.İ.T Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System

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- **2000** — **M.S.B. Ankara Cıvıl And Buıldıng**
  Anıtkabir Aslanlıyol Foundatıon Statıc Repair And Concrete Reınforcement

- 2000 — İlim Yayma Vakfı
  Statıc And Concrete Reınforcement

- **2001** — **Borusan Logistics - Gemlik Pier**
  Repair of Corrosion Damage in Reinforcements at the Pier

- **2001** — **Topkapi Palace Treasury Department**
  Strengthening of the Masonry Building with the Izo-Pst System

- 2002 — Eğerli Iron and Steel Factories Inc., Kdz-Ereğli
  Repair of the Sinter Stack Concrete
  and Determination of Protection Methods

- 2003 — Ministry of National Defense, Ist. Construction Real Estate and
  NATO Information Department
  Repair and Strengthening of Orhaniye Administrative and Shift Personnel Buildings

- 2004 — Mersin HiltonSA Hotel
  Static Reinforcement with the Izo-Pst System

- 2004 — Hacılar Mosque
  Static Reinforcement with the Izo-Pst System

- **2004** — **Adile Sultan Palace**
  Strengthening of the Masonry Building with the Izo-Pst System

- **2005** — **Tüpraş Körfez Petroleum Chemıstry And Refınery Dırectorate**
  Repaır Of Scaffoldıng Pıles Wıth İzo-Pst System

- 2005 — Şişecam Soda Industry Inc., Mersin Plant, Caustic Soda Unit
  Repaır Of Damaged Rc Structure And Statıc
  Reınforcement Wıth Izo-Pst System

- **2006** — **Akçansa Çanakkale Cement Factory,Marıne Structures - Çanakkale**
  Steel Pıle And Rc Port Repaır, Cathodıc Protectıon

- 2006 — İzhan Busıness Center - İzmir
  Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System

- 2007 — Mercury Hotel– İzmir
  Repaır Of Damaged Rc Structure And Statıc Reınforcement Wıth Izo-Pst System

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■	**2010**	**Akçansa Ambarlı Facilities, Çanakkale** **Akçansa Ambarlı Port Reınforcement**
■	**2011**	**Asım Kibar Mansion, Istanbul** **Heritage Building Reinforcement and Soil Improvement**
■	2014	Vista Tourism Inc., Istanbul Strengthening of the Structural System According to the Project of the Reinforced Concrete Structure
■	**2014**	**Dilek Sanabcı Mansıon** **Reınforcement And Soıl Improvement**
■	2023	Kahramanmaraş Modasan Textile Factory Static Reinforcement with the Izo-Pst System

- ■ **REINFORCED CONCRETE STRUCTURES**
- ■ **ERZINCAN: THE BEGINNING OF STRENGTHENING & ANITKABIR**
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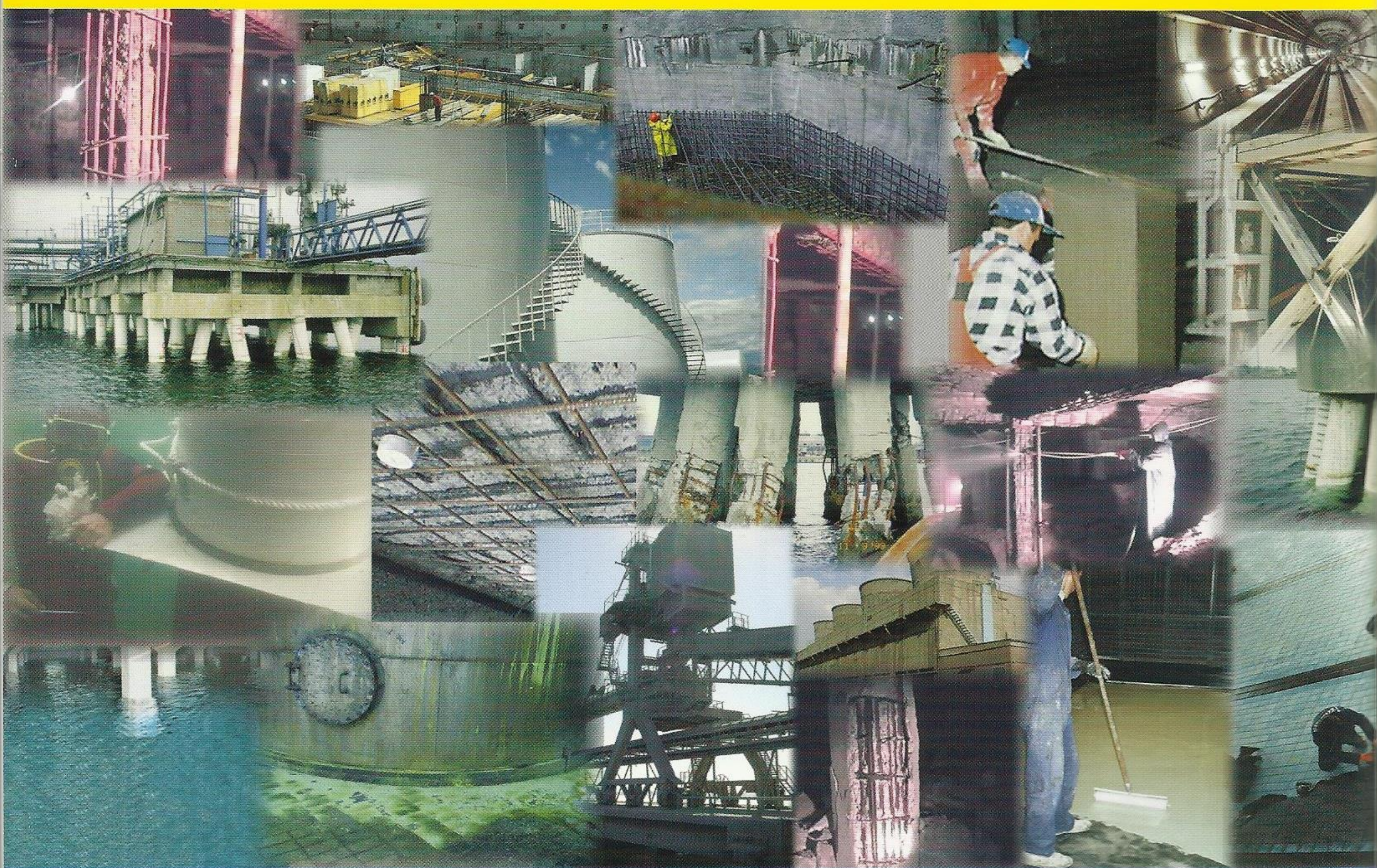

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