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CHOOSING RESISTANT MATERIAL AND BUILDING SYSTEMS FOR HOSPITALS IN AREAS OF HIGH EARTHQUAKE RISK

SUMMARY

Cosidering the great number of settlements in earhquake zones on earth, architects and civil engineering have to coordinate and carry out detailed studies in order to solve the problem of earthquake, starting from macro scale and further examining on the micro scale of a single building.

Today, the population growth, industrialization and technical developments are inevitable parts of life and therefore the problems of migration, urbanization, openning new areas for settlements have to be solved in detailed geological studies. During the process of planning "the ways to find the best material" should be considered. The type, the place and location of the construction should be determined by a coordinated organization. An optimum and rational building type should be applied, and all these should be taught during the vocational training.

The buildings for which regional characteristics have been regarded, the best materials have been used and the most advenced building techniques have been designed can be considered "lucky" just like their owners, because they can resist earthquake, the worst of all disasters.

Keeping these in mind, we will study and compare the traditional system, regional materials and building systems, such as wood building with prefabricated steel-frame constructions.

Considering this given information, we can talk about a rural hospital project, which has to be built resistant enough against a catastrope. It is accepted that there are fully equipped; high-technology hospital buildings strong enough in cities; but it is also a truth that small regions are the places where there are more deaths, more injures and damage. Uncontralled buildings, without any project, inefficient usage of material, labouship and detail are the causes of given results.For these reasons, hospital buildings should be built single-floored from easily made regional materials, which can be enlarged due to the needs. Pin-jointed, compact plan analysis with a court, which makes it possible to develop horizontally to both sides, can be applied.

The building-system, properties of material, dimensions should be considered realistically adaptable to the conditions of the region and country. Apart from these the selected systems should be open to different programmes and to solutions. Modular plan of panel systems, flexible designs, industrialization, suitable building techniques for hospitals on earthquake zones will be examined and examplified. Also the earthquake resistance depending on different materials will be studied.

Our goals are taking the possible structural measures and deciding on the right materials, static systems functional planning of hospital buildings.

Keywords: earthquake-resistant hospitals, earthquake zone, building systems

ÖZET

Yerkürenin yadsınamayacak kadar ağırlıklı yerleşme düzeni, deprem bölgelerinde bulunmaktadır. Bu nedenle, deprem sorunlarını öncelikle bir yerleşme sorunu olarak makro ölçekten başlayarak, tek yapı bazında mikro ölçeğe kadar indirgeyerek detaylı olarak düşünmek, problemleri çözmek; mimar ve mühendislerin işbirliğiyle oluşturulacak yoğun ve çok yönlü çalışmalar gerektirmektedir.

Nüfusun hızla arttığı; sanayileşmenin, iletişimin, teknolojik gelişmenin kaçınılmaz olduğu çağımızda göç, kentleşme, yeni yerleşim bölgeleri ve paralelindeki endüstri bölgelerinin gereksinimi, sağlık yapılarının yer seçimi saptanırken , zemin verileri üzerinde hassas jeolojik araştırmalarla başlayan çalışmalar ilk sağlıklı adımı oluşturmalıdır. Depreme dayanıklı yapı tasarımı ve üretimi amaçlı bir planlama sürecinde; yapının türü, yapı yeri, konumu, malzeme ve yapım sistemi seçimi ile koordine edilerek gerçekleştirilecek organizasyonda, çağdaş üretim yöntemleriyle, kaliteli ve rasyonel bir yapım sözkonusudur.Bu bilinç ise, meslek eğitimi süresince verilmelidir.

Yöresel özellikler, yöresel malzemelerden, en ileri geliştirilmiş yapım tekniklerine kadar, detaylar ve birleşim noktalarının her türlü ve özellikle yataydaki dış etkenlere de davranışları önceden düşünülerek hesaplamış ve tasarlanmış olmalıdır. Bu amaçla çalişmada, geleneksel sistemden, ahşap, kagir gibi yöresel malzeme ve yapım sistemlerinden, olumlu ve olumsuz yönleri ile ile günümüze kadar yapılan uygulamaları ve gelişmeleri ile betonarme, prefabrike ve çelik sistemlere kadar kapsamlı bir inceleme ve karşılaştırma yapılacaktır. Bir yapının yeterli derecede yerine getirilmesi gereken eylemlerin, deprem ile ilişkilerini ayrıntılı olarak incelenerek belirlenen kriterler olan; tasarım, ekonomi, taşıyıcılık ve fonksiyonel kullanım ile uzun ömürlülük değerlendirilmelidir. Bunlara göre alınacak yapısal önlemler, statik sistemi, işlevsellik, malzeme seçimi kararları doğru verilmelidir. Deneyim, bilgi iletişimi, araştırma, somut örnekler yoğun çalışmalar ve teknoloji olanakları ise gerekli araçlar olmalıdır.

Deprem bölgelerinde sağlık yapıları üretiminde, depreme dayanıklı olması gereken veya bir doğal afet sonrası gerekli bölgeye acil olarak yapılaştırılması gereken, kırsal alan hastana projesi modelinden söz edilebilir.Yapım olanakları kısıtlı küçük yerleşimler, deprem felaketini ciddi bir boyutta yaşarlar.Dolayısıyla sağlık yapıları yoğun bir ihtiyaca hizmet verecektir.Çoğu zaman son depremlerde olduğu gibi mal ve can kaybıyla, hastanaler de yok olmuşlardır. Bu nedenle kolay uygulanabilen, mobil hastaneler belirli yapım sistemleri ve malzemelerle üretilebilmeli, ihtiyaca göre belirli akslarda kolaylıkla büyüyebilmeli, gerekirse taşınabilir olmalıdır.Koşullara göre belirlenecek sistemler, bölgesel olanaklar prefabrike ve karma sistem uygulamalarını yönlendirir.Tip alternatif projeler, lineer planlama, iki yönde ve düşeyde büyümelere olanak sağlayacak ; kompakt, mafsallı,ve avlulu tip plan çözümleri uygulanabilir.Hastane yapim sistemi ve malzeme özellikleri, modüler gerçekçi bir yaklaşima olanak sağlamalidir. Seçilen sistem değişik programlara uygunluk gösterebilmeli , açık endüstrileşme ve çok mafsallı üretime esnek çözümlere olanak sağlamalıdır.

Anahtar kelimeler: Depreme dayanıklı hastaneler, Deprem Bölgeleri, Yapım sistemleri

INTRODUCTION

Due to its sysmic location Turkey is on an active earthquake zone. Man gets on with his lodging need in his hause and the need of satisfying his other necessities is the source of all production systems. Our environment consists of natural and artifical parts, two of which we form the latter.

The man's search for somewhere to live had started with the beginning of the history and todayreached to a certain point with his abilities, intellect and technology. The future is open to endless opportunities. Under there circumstances reaching the rights is good whereas faults, sometimes with his life. In other words the price for compensation on building is quite high.

Our research topic is constructional properties of houses and handling with the conscious of hearthquake.

We should evalute the harm on Earth in a realistic way. Particularly there is an unconscious population growth in under-developed and developing countries. In addition, the whole mankind faces some problems caused by migration, industralization, communication and deviated construction. Related with all these, the quality of adequateliving places increases, where as the tendencies change. The experiences we have had in places without any precautions against naturak disasters shoulh be a good reason for us to use all facilities of today's technology, production technigues and material.

1. EARTHQUAKE- BUILDING- MATERIAL- EXPERT

Our country is situated on one of the most active tectonic dikes; the effect region is wide. It is the architect's and engineer's duty to take the necessary precautions when 80% of Turkey's population is living on a risky field. All studies about earthquakes should be made gradually at micro and macro scales. Development programs and regional plans have to be detailed towards a single detailed building scale. Firstly, we need the work on regional properties, then on ground properties and lastly on underground and ground layers, when we are searching the relation between earthquakes and construction.

Ground periods vary according to the ground types. It is an unavoidable fact in Turkey to investigate the ground before building something on it. The building periods are related with tigids, height, width and length. For this reason both factors should be taken into consideration to avoid resonance. The shock waves, which are formed during the earthquake, causes some changes on the ground layer when they are moving towards the surface. Ground types have an effect on these changes.(1)

The main point of building design and qualified building production is examining. The strength of building is closely related to the selection of material and bearing system; and the detailing design are defined by some standards, directories and norms.

The most important principles of earthquake resistant building design can be defined as suitable architecture, selection of bearing system and efficient resistance and flexible.(2) Walls, not bearing anywhere, useless gaps, smooth floors with upper dimension may cause important dangers.

Before discussing what to do after a natural disaster, a wide notification- net should be settled about the precautions. This net should include professional education, applicants, examiners and users.

2. PLANNING DECISIONS

Protective measures begin with the selection and direction of ground. The region, ground examine, winds, water effects, underground water level, type of ground, the thickness of layers should be effective on building - types and planning. The location of the buildings, compared with the surrounding buildings and roads, the design and height of them, planning and shaping of them should be designed appropriately for the characteristics of earthquake zones.

Instead of high buildings with simple geometrical shapes, buildings with parts separated by pin-joint and earthquake joint should be built. The decorative elements and suspended features would have some draw-backs in case of earthquakes. While designing earthquake resistant buildings, earthquake measures from the planning decisions where as the location of buildings with each other in case of an earthquake, main exit relations between places have to be taken into consideration in vertical and horizontal circulation.

Especially when designing buildings like schools, hospitals or hotels where a lot of people use, engineers should assist on the selection of structure and design.

Looking at the experiences the world has had up to now, we can say that. There aren't many safe buildings. In high-populated cities, the need for higher buildings increases everyday, so does the risk of being effected from the earthquakes. Not projecting a building from the point of earthquake resistance causes a low standard in buildings, and this proofs that we are still not conscious enough on earthquake resistant buildings.

Earthquakes cause the loss of man-life and buildings. The life of living things, particularly of man, is known; but the most important historical knowledge and datum is the abstract heritage and for this reason the protection of historical buildings together with their surroundings is very important. Çamlıbel (3) made a system research on the improvement of the protection of historical- places in Istanbul. Throughout the history, the base settlements due to the changes on the ground, increased the risk of damage for the buildings in case of an earthquake. He stated that on some occasions where security is inefficient, application of strengthening to the bearing systems, would have an undesirable effect on historical and esthetic view of the building. At this point, the resistance of the basement should be investigated against the effects of an earthquake.

For the investigation, the maximum acceleration, period, frequency, amplitude and velocity; which are the characteristics of a possible earthquake, should be clarified. He added that after these researches, building systems which decrease the effect of earthquake by absorbing the energy (like in nuclear power centers) can be built.

Later, in 1932-1933, an American Professor M.A.Biot found the "Spectral Analysis" method, which is the calculation of maximum acceleration related to the periodic of buildings.(4)

3. THE PARTS & PRINCIPLES OF EARTHQUAKE RESISTANT DESINGS

In this study, the main facts which are effective on earthquakes are searched one by one. On the point of decisions; the architects and engineers have the primary importance.

A good organization should be held by the planning suitable for the regulations, selection of the right bearing systems. Then in the building process the selection of appropriate and high-quality material, careful effort should be applied. In this system, coordination between calculation material and production should be found throughout investigating the behavior of each element against earthquakes. Maximum detailed work should be applied on these special occasions; because researches held out at earthquake zones showed that the unavoidable end is a result of wrong topographical and geological applications, bearing system faults, selection of wrong material due to the economical conditions or lack of necessary knowledge.

Considering all these facts when we accepts that we have all the contemporary facilities related to equipment and machinery; the main point will be "expert" man-power. The importance of education can not be denied. Efficient professionally-educated experts should design and control the buildings.

4. THE METHOD FOLLOWED RELATED TO THE BASIC PRINCIPLES

Checking each project from the point of regulations, examining whether they are designed correctly, or not is the main principle which will be carried on by the experts working on the control mechanism. According to the regulations, the aim is having strong buildings which won't collapse and which have a certain resistance in a "too severe" earthquake, and this will be supplied by the unification of design, structure, building materials and construction. Selection of regular bearing system is related with architectural design. The first condition for an earthquake resistant building is to organize the bearing systems simple and continuous both in plan and in vertical direction.(5) Large empty spaces and sudden section changes should be avoided; also vertical bearing elements have to be continuous. Too much cutting power is formed on short columns due to bearing or unbearing element like a wall. Collapsing is unavoidable for these buildings, because those cuttings act as a dynamite.

5. SELECTION OF BUILDING MATERIAL & ELEMENTS

Wood is a heavy and high-resistant material. It shows resistance with the fibres in all directions, that's why it is a regional and practical material.

Wood is one of the first materials which man used to build a shelter. Blocked system and higher building techniques were seen later. In addition, deformation and stretching curve of wood and decomposition of fibres is different from other materials and because of this wood does not collapse like metal or concrete.(6) Materials like stone, brick or concrete shows different strength against high pressure, they can not face the pulling stress and collapse.

On the other hand, since wood and metal work well against pulling stress, they give better solutions usage of concrete with iron has more advantages when compared with wood and steel. Flexible tools should be used instead of crisp ones. (7) Stone, which is both a traditional and also an esthetical material wood lead to bad results, if it is used in a wrong way; especially alluvium stones are not recommended as they are slippery. Block and cut-stones carried out the history up to today with their special joint details, lead joinings and better mashing principles. The unembankment arcs and vaults are the best examples which carried the stone work for ages.

Adobe and comment block, which are burnt clay materials, are also traditional construction elements. They are not only economical and easily produced, but also easily applicable. On the other hand, adobe has a low resistance and stability against pressure, that's why the adobe used in earthquake zone should have higher pressure resistance. This kind of adobe can be gained by adding some stable material like cement, lime, bitumen emulsion or hay; and by applying static pressure on adobe mortar during the shuttering stage.(8)

Concrete blocks and bricks have different pressure resistance according to certain norms and standards. If the material is going to be used in an earthquake zone, after choosing the appropriate standard type, wall construction techniques and mashing rules should be applied consciously. Connection of corners, and mostly high connection quality of the mortar which will be used in meshing should have high binding strength.

Concrete is a component of reinforced concrete building. It is a material which has a preparation phase, which is easy to carry and use and which gives efficient results with careful usage. Alternatives have been found against concrete. Steel fibred concrete should have higher cutting resistance when compared with ordinary concrete. For this reason it seems beneficial to use it in cutting or twisting.(9)

An earthquake resistant building should be flexible and high resistant. The best material having these qualities is steel, but also reinforced concrete constructions are accepted to have similar qualities as steel. Both concrete and reinforced steel should not be below a certain quality. This is very important especially in column dimension defects. The column should resist equally against all effects of earthquake. Effects of short column behavior should be avoided.

The general belief that steel buildings are reliable was questioned seriously after the earthquake in Northridge California, USA in 1994, because serious damages have been found in column beam joints of more than one hundred steel frame worked buildings.

6. BUILDING SYSTEM AND EARTHQUAKE RESISTANCE

Block construction should be designed more limited than carcasses ones. A simple building strategy should be applied to the earthquake zones.

Although wooden buildings are damaged during an earthquake, they rarely cause deaths, but the construction and particularly joint application is difficult. Since they are light and flexible constructions, they face the effect of earthquake easily. In the earthquake in Adapazarı - Turkey, 1967 most of the 86 people who died were living in reinforced concrete constructions, because majority of the buildings in this region are wooden carcasse and death rate in lower. Surviving rate in a wooden construction is higher than buildings made of stone, soil or adobe. While people living under thick soil roof have the risk of drowning, the others living in wooden buildings are safer.

The damage in wooden buildings are always related to the unproper joints or lose of quality. The wooden construction's not being tied to the stone walls and feet properly causes collapsing. The fires in the wooden-buildings which occur after the earthquakes cause deaths (Gediz-Turkey, 1970) (Kanto-Japan, 1923)

Wooden buildings are divided into two as lathing and baywork. The resistance of lathing-building which has inner and outer vertical half-battens either left empty, or filled, is less than the baywork ones which are filled with stone, brick and adobe. (10)

The adobe constructions shouldn't have more than one floor in earthquake zones. The Construction should be made a square one with a strong base. Maximum attention should be paid on wall meshing principles; soil roofs should be avoided and the construction should be formed by a slight wooden application.

The earthquakes in Kocaeli-Turkey, 1999 - Bolu, Düzce Turkey, 1999 Erzincan -Turkey, 1992 and Dinar - Turkey, 1995 were really frightening. 50000 buildings in Kocaeli, 5883 buildings in Bolu- Düzce,(11), 70 buildings in Erzincan and 200 in Dinar collapsed which proofs the poor-quality of reinforced concrete constructions.

The advantages of reinforced concrete should be supported by the best calculations. The height of earthquake load's construction and the distribution of vertical bearings on each floor are very important. The control of pulling -effects and cut -pressure which is formed on width cross - section against a reduced horizontal load is another side of design; on the other hand control levels are not included in the experiment.

The main factors which effect flexible attitude of the construction are ties, the level of cut - power and length of anchorage in the vertical reinforcement. Flexible attitude takes place with the use of energy which is formed during the creep strain before the fraction of the reinforcement. Related to these, consolidation of reinforcements like column and beam is probably the main principle of earthquake resistant concrete reinforcement construction.(12)

The problems in moment carrying, steel -frame - worked column and beam connections should be improved immediately in the necessary way.

In prefabricated buildings, a certain standard is being improved. The shape changes take place mostly during the production stage since they are produced in factories under some circumstances. The most important part of design - basis is related to assemblage, where cutting - friction factor is very important.(13)

The joints of bearing - system elements should be detailed appropriate to the earthquake power.

7. FLEXIBLE HEALTH BUILDING'S FOR CATASTROPHIC ZONES:

It is unavoidable to face an unexpected disaster on an earthquake zone. I believe in the necessity of single-floored health buildings particulary in less crowded, small settings. This kind of smaller health units, which are built with a pre-construction method, can handle with any need not only before the earthquake, but also after it.

The basic principle of building a hospital which can afford the increasing need on a catastrophic region is building a fast, easy and functional one. Using flexible material which can afford the changing facts should be included in thr state policy. The lack of health buildings in villages, districts and small towns can be removed by leaving necessary budget and applying an accelerated work. Industrilazed building system and ready-made elements, appropriate for this fast construction can be applied by changing the planning and selection of material.(14)

The best materials are to be chosen according to the regional conditions and the resistability of authentic elements. The connections, joint details are very important related to the resistance against earthquake.

Building Prefabricated Concrete Constructionn Resistant for an Earthquake. (15)

a) Buildings where all load of earthquake is carried by frameworks which transfer the moments, have flexible systems.

b) The flexibility level is high in buildings where all earthquake load is carried by fixed based, upper-joint, single-floored frameworks.

c) Bearing system ratio is lower in buildings where all earthquake load is carried by prefabricated walls.

d) Prefabricated frameworks which transfere the moment can be used in buildings with tie-beamed or cast elements that have a changable ratio.

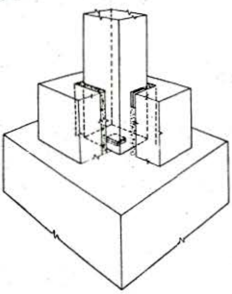
There are some rules to be followed in first and second earthquake zones where combined bearing systems are used: (16)

1. Single entrasol can be built in prefabricated buildings with encastered and upper-beamed frame-works and whose bearing system attitude ratio is defined according to "b" and "c", but the flexibility level of there buildings should be designed considering main bearing system and encastere in case of an earhtquake.

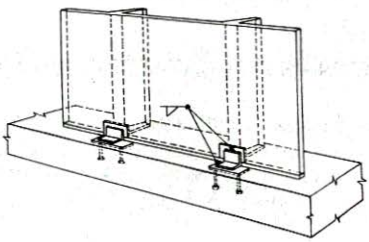
2. It is advised to use tie frameworks in prefabricated and steel multi-floored buildings in order to maintain bearing all the earthquake load with diogonal steel guards.

The figures below, show that various classifications can be made according to the type of joined elements: (17)

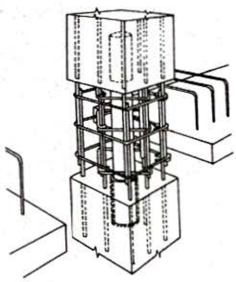
a) Base-column joint.



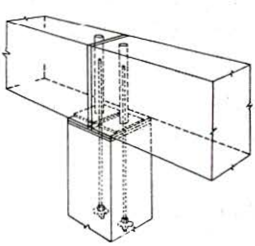
b) Base -wall joint.



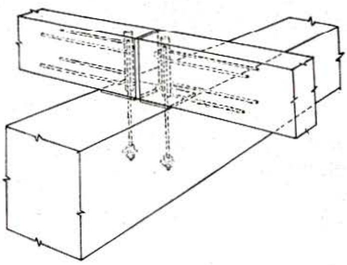
c) Column-column joint.



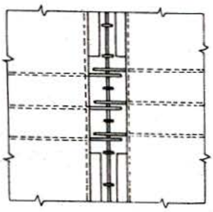
d)Column-beam joint.



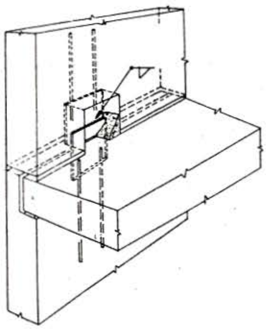
e) Beam-beam joint.



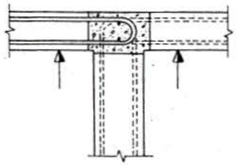
f) Beam-slab joint.



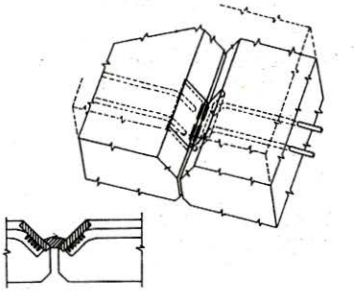
g) Wall-wall joint.



h) Wall-slab joint.



i) Slab-slab joint.



The government should support the prefabrication in health buildings. New investments should be advised in 5-year-development-plans. Particularly improved industrialized models should be used in health buildings on earthquake regions. The authentic materials which can be used as fillers in building's walls will decrease the cost.

There is an increasing need for earthquake resistant health buildings, built with high technology and prefabrication. The quality of production, elements and concrete in prefabrication is very important in building earthquake resistant hospitals.

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