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Design of a post disaster temporary shelter unit

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Abstract
The Istanbul metropolitan area, with its 12 million populations, is accepted to be under risk of one or more earthquakes which will cause more than 600,000 victims to become homeless. In the context of preparations in the pre-disaster period, the research project "MobARCH" is set, aiming to develop a post-disaster temporary shelter system to overcome the temporary "homelessness" situation. The paper is focusing on the design and application of a temporary shelter unit. In designing the temporary shelter unit, the main goals can be listed as follows; taking user requirements under extraordinary circumstances into consideration, temporary and multiple use of the unit, achieving minimum negative environmental impact in all stages. A design process is tailored for this special case. Although the design process has a "methodological" approach, it is allowing "creative leaps". The methodology of the design process is given together with its application on the temporary shelter unit design. The design process of the temporary shelter unit, comprises mainly three sub-processes; setting design objectives, developing design criteria and the "final" design, which are given in detail in the paper. As an output of the design process; the project of the unit and a prototype, which is manufactured, are also presented.

Keywords: *Design process, temporary shelter unit, post-disaster*

1. Introduction - Estimations on Future Istanbul Major Earthquake and the MobARCH Project

In the last century, several serious earthquakes struck the Anatolian peninsula, causing both significant material damage and severe casualties. The major earthquake disasters causing more than 20.000 collapsed residential buildings can be listed as follows; the 1939 Erzincan earthquake with 135.000 collapsed residential buildings, the 1942 Niksar earthquake with 32.000 collapsed residential buildings the 1943 Havza/Ladik earthquake with 40.000 collapsed residential buildings, the 1944 Bolu/Gerede earthquake with 50.000 collapsed residential buildings, the 1966 Varto earthquake with 20.000 collapsed residential buildings and the 1999 Marmara earthquake with 285.000 collapsed residential buildings (Ergunay, 1999). Thousands lost their life and thousands were left in the status of

temporary “homelessness”. In many cases, tents were the applied solution for emergency shelter demands. Temporary shelters could be erected after two months at the earliest. Different local and foreign temporary shelter systems have been used by earthquake victims for at least one year, before the construction of permanent housing was finalized (Ergunay, 1999).

The JICA report is prepared for estimations on future Istanbul major earthquakes. According to the JICA report, the Istanbul metropolitan area, with its population of 12 million, is accepted to be under risk of one or more earthquakes which will cause more than 600.000 victims to become homeless. One of the earthquake scenarios in the JICA report, is predicting that 52.000 temporary shelter units will be needed. Another value parametrically related to this calculation is the size of area required for these temporary settlements. The reserve area necessary for temporary settlements is estimated to be 516 hectares as a result of JICA report (JICA, 2002). The amount of heavy damaged dwellings and completed temporary shelters following the 1999 Marmara earthquake are leading to the conclusion that the demand for shelters will even exceed the JICA data. The need for temporary shelters is expected to be 70.000 as a result of these predictions (JICA, 2002).

In the context of preparations in the pre-disaster period, the research project “MobARCH” is set. MobARCH is a post disaster modular settlement planning and temporary shelter design project supported by the Istanbul Technical University Urban and Environmental Planning and Research Center, the Directorate of Urban Transformation and New Settlements of the Istanbul Metropolitan Municipality and The European Commission (Şener, et.al; 2003a). The project aims to perform a temporary settlement planning process and modular dwelling design in order to overcome the expected building shortage after a possible Istanbul earthquake and form a metropolitan scaled temporary housing storage in the pre-disaster period.

The main objectives of MobARCH can be listed as follows:

- to be prepared for a possible disaster in the pre-disaster period, from the temporary shelter related planning, design, production, storage, management point of view,
- planning and design of a prototype post disaster settlement unit according to urban planning pre-decisions,
- design of a post disaster temporary shelter unit,
- developing a generic road map for disaster management for Istanbul’s possible earthquake.

The MobARCH project consists of **“**disaster management”, “shelter design” and “urban planning” modules. One of the most important and complex modules of the MobARCH project is the design of a post disaster temporary shelter unit. The paper is focusing on the design and application of a temporary shelter unit. There are different approaches to design with advantages and disadvantages related to different cases (Jones, 1992). In this context the “starting point” is to develop an appropriate “road map” for the whole post-disaster temporary shelter unit design process.

2. Designing the Post-Disaster Temporary Shelter Unit

In designing the temporary shelter unit, the main goals can be listed as follows; taking user requirements under extraordinary circumstances into consideration, temporary and multiple use of the unit, achieving minimum negative environmental impact in all stages. Those goals were partly specified by the Istanbul Metropolitan Municipality and partly developed in the context of the MobARCH project (Şener, et.al; 2003a). In predicting the huge number of design requirements related to those goals and also considering the complexity of a search space with millions of alternative combinations of possible solutions fulfilling those requirements it was decided to use a methodological way in the design process. It was also decided to allow "creative leaps" in the "methodological" manner of the design process. The design process of the temporary shelter unit, comprises four main sub-processes: setting design objectives, developing design and evaluation criteria, evaluation of existing systems, "melting" of "fragmental" alternatives and "best" existing systems into the "final" design.

2.1 Setting Design Objectives

From the main goals related to the temporary shelter unit, design objectives are developed systematically. In setting design objectives, input data from three sources are used. An important source is the input data gathered from past experiences. Especially from the last major earthquake, that struck the Anatolian peninsula in 1999. Another source is research work on existing temporary shelter systems. Also user requirements in general are used in developing design objectives.

2.1.1 Experiences from the 1999 Marmara Earthquake

Focusing on the last heavy earthquake disaster in Turkey, the 1999 Marmara earthquake, many lessons related to temporary shelters, its interaction with the environment and "temporary shelter life" can be learned. After the 1999 Marmara earthquake disaster, temporary shelter settlements were established. According to observations and investigations, spatial performance criteria in those shelters were not fulfilled due to varying conditions (Şener, Şener, 2003). The users themselves have done significant modifications indoors and outdoors in order to compensate those imperfections. Those imperfections are caused by the facts that experiences from previous disasters have not been analyzed properly and neither user requirements nor environmental conditions have been taken into consideration during the planning, design and construction stages. Temporary shelters in the region have been put out to tender for contractors of the private sector by the Ministry of Construction. As the design, infrastructure planning and decisions on building materials and technologies have been done after the disaster, it took approximately eight months to finalize the construction of the first temporary shelter. Because of the defects, the disaster survivors have not used some of the temporary shelters which were constructed.

A detailed analyzing study was made at the temporary shelter settlements in Yeniköy - Kocaeli which was erected after the 1999 Marmara Earthquake (Şener, Şener, 2003). In the Yeniköy - Kocaeli temporary shelter settlement it was observed that 48% of the users have made modifications both indoors and outdoors of their shelter unit, 30% of the users have made modifications only outdoors, 3% of the users have made modifications only indoors. Only 19% of the users have not made any modifications to their shelter units. Indoor modifications are related to user requirements like space partitions and privacy needs (Figure 1). The outdoor modifications are related to user

requirements like; storage demands, needs of a porch at the entrance of the shelter unit, additional space needs and individualized recreational outdoor areas nearby (Figure 2).

Figure 1. *Examples of Indoor Modifications*

Figure 2. *Examples of Outdoor Modifications.*

Furthermore, problems related to building physics, like insufficiencies in thermal resistance, noise reduction and waterproofing were observed in the shelters. Also the insitu slab foundations of the shelters created “fields of concrete” after the shelter systems have been deconstructed, having an unacceptable impact on the environment. In analyzing Turkey’s post-disaster experiences, it is determined that some of the shelters were never been used or only been used after large user modifications. The reason of this situation can be summarized as lack of preparedness in terms of planning,design and management, resulting in poor quality of temporary shelters, erected under special conditions of the post disaster period.

2.1.2 Research Work on Existing Systems

As a result of an extended review of research work, literature and internet, 52 existing temporary shelter systems have been analyzed and evaluated,

(Şener, et.al; 2003a). Applied and used systems and only designed systems were included in the analyzing process. Those temporary shelter systems, were analyzed from the; materials used, production technology, construction technology, structural system, form and spatial organization points of view.

2.1.3 User Requirements

In developing design objectives also biological, physiological, cultural, psychological, spatial user requirements are taken into account. Those requirements are compiled from different sources (Rush, 1991), (Anon, 1968).

2.1.4 Design Objectives

Design objectives are gathered and organized from past experiences, research work on existing temporary shelter systems and from user requirements. The main objectives can be listed as follows:

- objectives related to technology, construction and materials,
- ecological objectives,
- objectives related to cost,
- objectives related to building physics,
- objectives related to spatial organization,
- sociological objectives,
- objectives related to aesthetics.

2.2 Design and Evaluation Criteria for Temporary Shelters

In the context of MobARCH's "preparedness strategy" one of the prior aims is to achieve a high level of safety performance in the urban environment of Istanbul, through; planning, design, production and storage of temporary shelter systems in the pre disaster period. A high level of urban quality and sustainability of the temporary shelter settlement itself is assured in setting design and evaluation criteria for an objective and systematic evaluation process in the analyzing, planning and design stages. In using design and evaluation criteria, the planning and design stages will have not only a arbitrary and institutional character, but also a rational, systematic and open decision making procedure will be ensured.

The production and storage of temporary shelter systems in the pre disaster period will be an enormous time saving act for the disaster management in the post disaster recovery stage. In using the design and evaluation criteria throughout the analyzing, planning and design stages will also ensure a rational usage of the limited resources in the post disaster period. This will make savings in cost, construction equipment, tools and workmanship possible. Through proper planning and design in the pre disaster period, also the hazardous impact of the temporary shelter settlement to the urban areas will be avoided and a certain level of sustainability achieved. Using results of the evaluation of existing temporary shelter systems in the planning and design of the temporary shelter system for Istanbul will also ensure higher overall performance of the system itself and a higher urban quality in general, parallel to disaster safety.

2.2.1 Methodology for Developing Design and Evaluation Criteria

The above listed vague objective statements are converted into measurable criteria to achieve a certain level of objective evaluation, (Şener et al, 2003b). At the first step 35 main design and evaluation criteria are generated from those objectives in analyzing past experiences, research work and user requirements (Table 1). At the second step 145 sub criteria are developed

from those main criteria for the design of post disaster temporary shelters and in creating neighborhood patterns.

Table 1. *Main Design and Evaluation Criteria.*

Technology, Construction and Materials	
criteria related to	material/system selection
	structural performance
	production
	storage
	transportation
	construction on site
	assembling / deconstruction
	withstanding movements
	service systems integration
	durability
	ease of cleaning
Ecology	
criteria related to	ecological impact in use
	building/ground interaction
	environmental impact
Cost	
criteria related to	cost
Building Physics	
criteria related to	indoor climatic comfort
	indoor air quality
	healthy environment
	thermal performance
	water tightness and moisture performance
	sound performance
	fire performance
	lighting performance
	air tightness of the external envelope
	tightness of joints
Spatial Organization	
criteria related to	users spatial requirements
	privacy requirements
	flexibility
	user behavior/room interaction
	disabled and elderly user requirements
Sociology	
criteria related to	sociological requirements
	visual communication
	psychological-sociological post disaster effects
	security
Aesthetics	
criteria related to	aesthetic requirements

2.2.2 Setting Limit Values and Developing Scales for Design and Evaluation Criteria

In order to evaluate design alternatives or existing systems the developed criteria are sorted in two different types. For the first type of criteria, "calculations" can be used as an evaluation technique. For the second type of criteria, "judgment" is needed for evaluation. For the first type of criteria, limit values are developed, from national and/or international standards, from national and/or international regulations and from the results of related research work. For the second type of criteria, evaluating scales ranging from 1 (poor) to 5 (excellent) are developed and specialists' knowledge and experience in related fields such as, urban planning, design and technology and disaster management is used for "judgment". For example the limit value for the criterion "thermal performance" is the U-value of the external envelope, given in the Turkish Standard "TS825". On the other hand for the criterion related to "psychological-sociological post disaster effects" an evaluating scale is needed. According to the limit values or evaluating scales, existing systems or design alternatives are evaluated, so that acceptable examples or solutions can be identified, (Şener, et.al; 2003a).

2.2.3 Setting Prior Design and Evaluation Criteria

As it is almost impossible for a system or a design alternative to fulfill all criteria at the same level, ranking of weighting of criteria is necessary. In the MobARCH project the relative importance of the criteria is ranked according to "specialist's judgment". Specialists' knowledge and experience in related fields such as, urban planning; design and technology and disaster management are used in ranking of design and evaluation criteria. A ranking scale is developed, ranging from 1 to 5, where values are interpreted from "less important" to "very important" for the judging process. The criteria are ranked in order of their preferential scores, according to the preferences of the specialists.

The relative importance of the 145 sub criteria is ranked according to urban planning, design and technology and disaster management specialist's judgment. The highest ranking sub criteria for the design and evaluation of post disaster temporary shelter and settlement pattern can be listed as follows:

- "space requirement related to basic actions"
- "interior climatic comfort"
- "acoustical and visual privacy"
- "visual comfort"
- "security"
- "hygienic environment"
- "air quality"
- "visual communication"
- "social relations"
- "accessibility for disabled and elderly users"
- "optimization in action-space interaction"
- "flexibility in space and form"
- "user's aesthetic preferences"
- "allowing individualism/personalization"
- "familiar images"
- "access to service systems"
- "energy efficiency in production and use"
- "avoiding environmental pollution of any kind"
- "no harmful emission related to materials"
- "using recyclable materials"
- "sustainability"
- "temporary interaction of unit and ground"
- "easy production and construction"
- "assembly in several steps"

2.3 Evaluation of Existing Systems with Developed Design and Evaluation Criteria

Resulting from an extended review of research work, literature and internet a set of 52 existing temporary shelter systems has been developed. Only systems with enough information on materials, construction and production technology, structural system, form and spatial organization were included in the set. All systems were evaluated according to the highest ranking sub criteria given above. It was necessary to use evaluating scales ranging from 1 (poor) to 5 (excellent) and "specialist's judgment" in the evaluation process, because of missing information on exact dimensional properties for some of the existing shelter systems. In evaluating all systems, three systems were assigned to be "best" examples. Although those three systems do have acceptable properties in general, each of them have imperfections according to the main objectives of the MobARCH project (Şener, et.al; 2003a).

2.4 Design Process of a Post Disaster Temporary Shelter Unit

The design process itself comprises again three sub-processes: Generating "fragmental" alternatives according to main objectives, evaluation of "fragmental" alternatives and "melting" of "fragmental" alternatives and "best" existing systems into a final design.

2.4.1 Generating "Fragmental" Alternatives according to Main Objectives

Abstracted post disaster temporary shelter unit alternatives are generated with only prior design criteria related to one main objective, like technology, building physics, cost, spatial organization etc. Those are alternatives taking only a fragment of the whole objective set into consideration. The outcomes of this design sub – sub process are solutions with "maximised" properties related to prior design criteria of one main objective.

Alternatives with "maximised" properties related to prior design criteria of one main objective are evaluated with the sub-criteria of the remaining main objectives.

The outcome of "materialised" design decisions for the post disaster temporary shelter unit, from the evaluation process can be summarised as follows:

- the basic material for the unit shall be *wood* in fulfilling design criteria such as "avoiding environmental pollution of any kind", "no harmful emission related to materials", "using recyclable materials" and "sustainability" etc.
- the unit shall be constructed of *prefabricated wood panels* in fulfilling design criteria such as "ease of manufacturing", "ease of construction" etc.
- the prefabricated wood panels shall be *100 kg in weight* at most and *3mx1m in dimensions* at most in fulfilling design criteria such as "ease of horizontal and vertical transportation (if necessary by muscle power)" etc.

- the unit's prefabricated wood panels shall have *"simple" connecting details* in fulfilling design criteria such as "ease of assembly (without needing specialized workmanship)"
- the *number of all components* shall be *limited* in fulfilling design criteria such as "ease of horizontal and vertical transportation" "ease of assembly" etc.
- the prefabricated wood panels shall be a *sandwich panel with a mineral wool thermal insulation* in fulfilling design criteria such as "interior climatic comfort" "energy efficiency in use and production", "avoiding environmental pollution of any kind" etc.
- the unit shall have "*prefabricated foundations"* in fulfilling design criteria such as "temporary interaction of unit and ground"
- the unit shall consist of *"two sub units separated & connected with a semi-open space"* in fulfilling design criteria such as "assembly in several steps", "familiar images" "flexibility in space and form" etc.
- the two sub units shall provide *"optimum space"* in fulfilling design criteria such as "space requirement related to basic actions", "acoustical and visual privacy" etc.
- the enclosure of the separating &connecting semi-open space of the unit shall give the opportunity to be "*constructed by the users themselves*" in fulfilling design criteria such as "user's aesthetic preferences", "allowing individualism/personalization", "familiar images", "social relations" etc.

2.4.2 "Melting" of "Fragmental" Alternatives and "Best" Existing Systems into the "Final" Design

The final step of the design process comprises both; a systematic methodological approach and "creative leaps" engaged with each other. The "materialized" design decisions for the post disaster temporary shelter unit listed above are taken together with the accumulated knowledge gained from the analyzing studies of the "best" existing shelter systems into consideration. Two parallel design sub processes are executed at the same time; namely the detailed design and the spatial organization & form design. Details are developed for each prefabricated wood panel and the assembly process separately in interaction with the unit's spatial organization & form as a whole. Using the results of the evaluation study of existing systems and considering the genuine conditions of Istanbul's environment, different design alternatives are developed. These design alternatives are also evaluated, using the sub-criteria in order to generate a post disaster temporary shelter and settlement pattern for the metropolitan Area of Istanbul according the request of the Istanbul Metropolitan Municipality, (Ergunay, 1999). The last stage of the design work comprises refinements to the unit in terms of spatial organization and form. As a result of the design and evaluation process a final post disaster temporary shelter unit and settlement pattern is developed and presented to the Istanbul Metropolitan Municipality for production of a prototype (Figure 3, Figure 4, Figure 5, Figure 6).

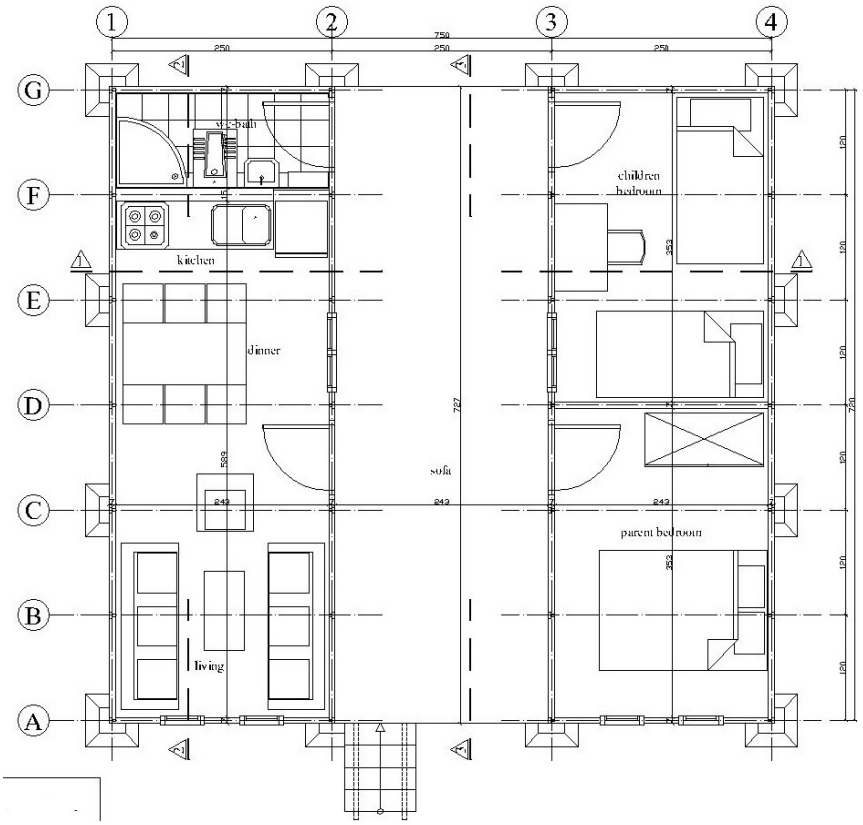

Figure 3. *Plan of the Temporary Shelter Unit.*

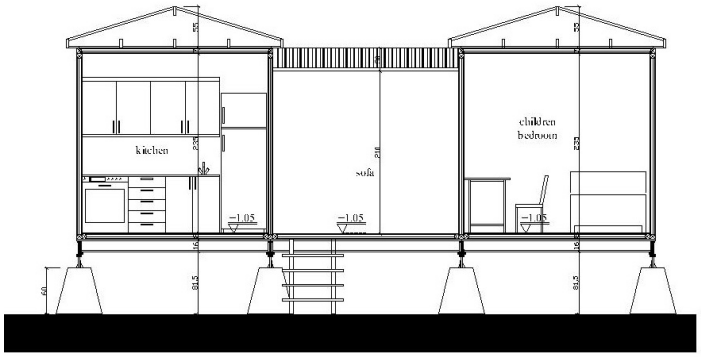

Figure 4. *Section of the Temporary Shelter Unit.*

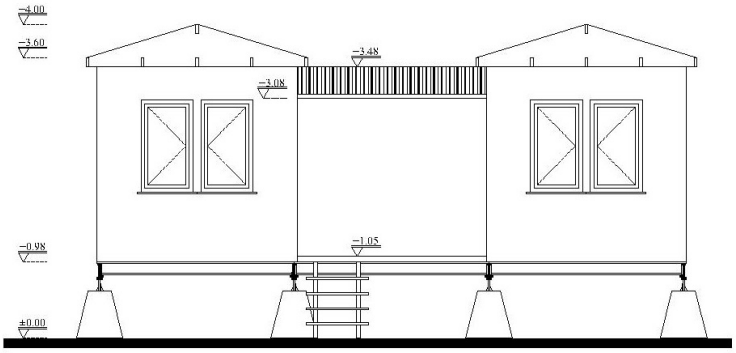

Figure 5. *Front Elevation of the Temporary Shelter Unit.*

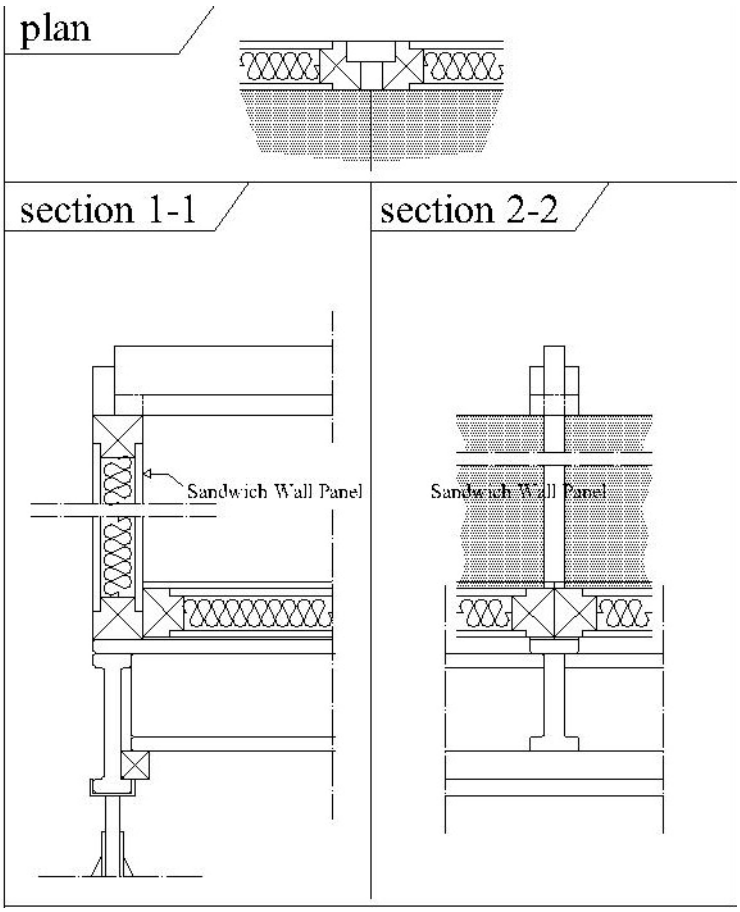

Figure 6. *Details of the Temporary Shelter Unit.*

3. Prototype of a Post Disaster Temporary Shelter Unit

A prototype of the post disaster temporary shelter unit is constructed by the Istanbul Metropolitan Municipalities Prefab Element and City Furniture Production Facility (Figure7). According to technological capability and possibilities of the production facility, some modifications were done to the prototype project, before manufacturing. The evaluation of the prototype is

providing feedback for the design process from the “constructability”, “storage possibility” and “durability” points of view.

Figure 7. *The Constructed Post Disaster Temporary Shelter Unit Prototype.*

4. Conclusion

The research project “MobARCH” comprises not only the design of a modular post disaster temporary shelter unit and the planning of a temporary settlement in order to overcome the expected building shortage after a possible Istanbul earthquake but also the forming of a metropolitan scaled temporary housing storage in the pre disaster period.

In the design process of the temporary shelter unit a methodological approach is used with “creative leaps” embedded into it. The design of the temporary shelter unit process has four main sub processes: setting design objectives, developing design and evaluation criteria, evaluation of existing systems, “melting” of “fragmental” alternatives and “best” existing systems into the “final” design. The first three of the sub processes do have a strong “methodological” character; where as the final sub-process combines intuitive design with the methodological design.

The “methodological” character of the design is playing a paramount role in overcoming the complexity related to the immense amount of alternative combinations of possible solutions fulfilling all objectives. The developed design criteria set aims to prevent the malfunctions and incompleteness in the performance of the temporary shelter units and gives the designers the opportunity to control themselves systematically. The “intuitive” character of the design promotes creativity in the process.

A post disaster temporary shelter unit is designed using the proposed design process. It is a unique attempt for Turkey in terms of disaster preparedness. The evaluation of the prototype is still ongoing, with the aim of mass production.

References

Ergunay, O.,(1999), “A Perspective of Disaster in Turkey: Issues and Prospects, Urban Settlements and Natural Disasters”, **Proceedings of UIA Region II Works**, Chamber of Architects of Turkey.

JICA, (2002), **The Study on A Disaster Prevention / Mitigation Basic Plan in Istanbul including Seismic Microzonation in the Republic of Turkey**, Final Report, Pasific Consultants International, OYO Corporation, Japan International Cooperation Agency (JICA), Istanbul Metropolitan Municipality (IMM).

Şener, S.M., Özçevik-Güngör, Ö., Şener, E., Altun, M.C., (2003a), **Post Disaster Temporary Shelter Settlement Pattern and Unit Development Project for Istanbul,** European Commission / Operations in Developing Countries, Directorate of Urban Transformation and New Settlements, The Metropolitan Municipality of Istanbul and I.T.U. Urban and Environmental Planning and Research Center, Project Report (in Turkish).

Jones, J.C., 1992, **Design Methods,** VanNostrand Reinhold. (Jones, 1992)

Şener, S.M., Şener, E., (2003), “Architectural Design Computing Studio Works on Prefabricated Post-Disaster Housing**”, 32nd International Symposium:Information-Communication-Knowledge-Engineering Education** *Today,* Werner Fischer & Federico Flückiger (eds.), 15-18, September 2003, Karlsruhe, pp. 331-334.

Rush, R.D., 1991, **The Building Systems Integration Handbook**, Butterworth-Heinemann.

Anon., (1968), **Guide to CI/SfB Classification**, The Architects' Journal-Information Sheet, August 1968.

Şener, S.M.,Altun, M.C.; Şener, E., Özçevik -Güngör, Ö., 2003, "Design Criteria Proposal for Post Disaster Temporary Shelter and Settlement Pattern", **Quality of Urban Life Policy Versus Practice**, Proceedings, N.Z. Gülersoy, N. Esin, A. Özsoy (eds.), I.T.U. Urban and Environmental Planning and Research Center, Istanbul, Turkey, p.p. 526-535.

Afet sonrası geçici konut ünitesi tasarımı

Yaklaşık 12 milyonluk nüfusu ile İstanbul Metropoliten alanı gelecek 30 yıl içinde, Richter ölçeğine gore en az 7 büyüklüğünde ve/veya daha büyük olmak üzere, bir veya birkaç deprem afeti tehdidi altında bulunmaktadır. Bu olasılık göz önünde bulundurularak, İstanbul Büyük Şehir Belediye Başkanlığı ile İstanbul Teknik Üniversitesi işbirliğinde "MobARCH" araştırma projesi geliştirilmiştir. "MobARCH" projesi, afet öncesi hazırlıklar kapsamında, "kentsel ölçekte bir afet sonrası geçici tip yerleşme ünitesinin planlanmsı ve tasarımı", bir "afet sonrası geçici konut ünitesinin tasarımı" ve "afet yönetimi amaçlı bir yol haritası geliştirilmesi" alt modüllerinden oluşmaktadır. Projenin önemli ve karmaşıklık düzeyi yüksek modüllerinden biri; afet sonrası geçici konut ünitesinin tasarımıdır. Afet sonrası geçici konut ünitesinin tasarımında, olağandışı şartlar altında kullanıcı gereksinimlerinin karşılanması, geçici ünitenin birden fazla kullanılabilirliği ve tüm süreçlerde ünitenin olumsuz çevresel etkilerinin minimize edilmesi temel hedefler olarak belirlenmiştir. Tasarım probleminin girdilerinin karmaşıklığı ve çözüm seçeneklerinin sayıca büyüklüğü ve çeşitliliği göz önünde tutularak, "yöntemli" bir tasarım yaklaşımının kullanılması kararlaştırılmıştır. Geliştirilen tasarım "yöntemi" ayrıca "sezgisel yaratıcılağa" da olanak verecek biçimde düzenlenmiştir. Tasarım yöntemi esas olarak üç temel alt süreçten oluşmaktadır: tasarım amaçları takımının belirlenmesi, tasarım ölçütlerinin tanımlanması ve "ana" tasarım süreci.

Tasarım amaçları takımının oluşturulmasında üç kaynaktan yararlanılmıştır. Bunlardan ilki; 1999 Marmara Depremi sonrası oluşturulan afet sonrası geçici konut alanlarında yapılan inceleme ve analiz çalışmalarından elde edilen bulgulardır. Ikinci kaynak; mevcut afet sonrası geçici konut sistemlerinin analizinden elde edilen sonuçlardır. Bu analiz çalışmasında 54 adet tasarlanmış ve uygulanmış ve sadece tasarlanmış ama uygulanmamış sistem ele alınmıştır. Amaçlar takımının derlenmesinde kullanılan üçüncü kaynak ise değişik çalışmalardan derlenen "kullanıcı gereksinimleri" dir.

Tasarım sürecinin ikince alt süreci tasarım ve değerlendirme ölçütlerinin geliştirilme aşamasıdır. Bu aşamada, muğlak ve ölçülmesi olanaksız olan amaçların, kesin ve ölçülebilir "ölçütler" e dönüştürülmesi gerçekleştirilmektedir. Tasarım ve değerlendirme ölçütleri ile karar verme eyleminin sistematikleştirmek, tasarımcı grubunun karar verme sürecini kolaylaştırmak, öznel yaklaşıma, nesnel bir boyut kazandırmak, seçenekler arasında rasyonel karar vermeyi kolaylaştırmak gibi hedeflere ulaşılmıştır. Geliştirilen ölçütlere "beşli" bir skala üzerinden değer verilerek, "çok çok

önemli" (1) ile "çok az önemli" (5) arasında ağırlık verilmiş ve bağıl önem sırasına göre sıralanmıştır. Ölçütlere ağırlık verme işlemi, kent planlama, tasarım ve teknoloji ve afet yönetimi konularında uzmanların birikimlerine dayanan "öznel" bir değerlendirme yöntemi ile sağlanmıştır. Geliştirilen ölçüt sistemi ile, mevcut 54 adet tasarlanmış ve uygulanmış ve sadece tasarlanmış ama uygulanmamış sistem değerlendirilmiştir. Değerlendirme sonucunda, mevcut sistemler arasından, olumlu özellikler taşıyan üç tane "en iyi" örnek belirlenmiştir.

"Ana" tasarım süreci, temel amaç takımına bağlı olarak, "parçasal" seçeneklerin geliştirilmesi ve "parçasal" seçeneklerin ve "mevcut en iyi örnekler" in bütünlenerek "nihai" tasarımın oluşturulması alt süreçlerinden oluşmaktadır. Parçasal" seçeneklerin geliştirilmesinde alt sürecinde her bir temel amaca bağlı olarak ortaya koyulan ölçütlerin öncelikli olarak ele alınmıştır. Böylece, belirli bir özelliği maksimize edilmiş seçenekler geliştirilmiş ve geriye kalan ölçütler ile tekrar değerlendirilmiştir. Bu süreç sonucunda somutlaşmaya yönelik "tasarım kararları" elde edilmiştir.

"Nihai" tasarım sürecinde, elde edilen "tasarım kararları" ve "mevcut en iyi örnekler" den yola çıkılarak, bir "afet sonrası geçici konut ünitesi" tasarlanmıştır. Burada "detay tasarımı" ve "bütünsel tasarım" süreçleri karşılıklı etkileşim halinde parallel olarak yürütülmüştür.

Çalışmanın sonucunda, tasarlanan "afet sonrası geçici konut ünitesi" ile bazı detay çizimleri ile bütünü anlatan, plan, kesit ve görünüş çizimleri verilmiş ve bu projeye bağlı olarak üretilen bir prototip tanıtılmıştır.