ENGINEERING COMPANY OF CENTRAL AMERICA
Civil, Structural and Multidisciplinary Engineering and Supervision

NEWSLETTER

Special Issue: Hospitals

GENERAL INTRODUCTION

Hospitals[1] are important within the health care system for several reasons. First, they account for a substantial proportion of the health care budget: close to 50 per cent in most of Western Europe and up to 70 per cent or more in other countries. Second, their position at the apex of the health care system means that the policies they adopt, which determine access to specialist services, have a major impact on overall health care. Third, the specialists who work in hospitals provide professional leadership. Finally, technological and pharmaceutical developments, as well as more attention to evidence-based health care, mean that the services that hospitals provide can potentially contribute significantly to population health. If hospitals are ineffectively organized, however, their potentially positive impact on health will be reduced or even be negative.

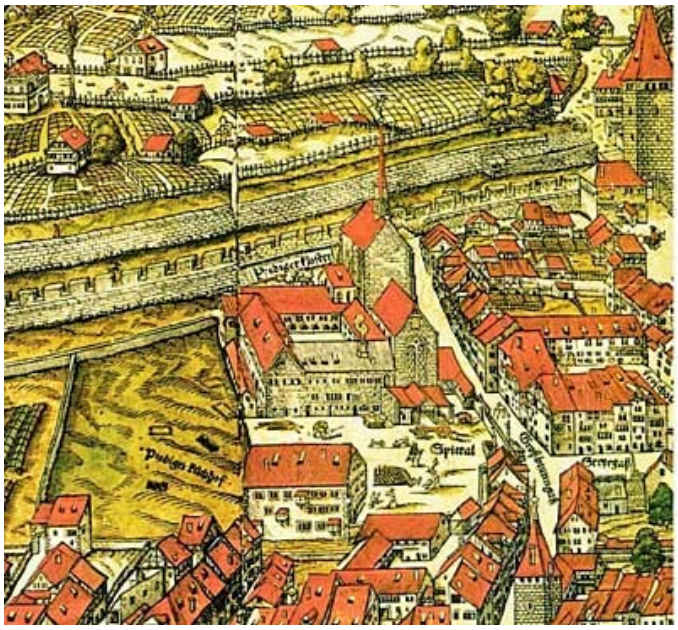

Fig. 1 Illustration of the Zurich Hospital (w. Prediger Church) on a city map by Josef Murer of 1576. Built in 1204, this facility originally served as clerical accommodation for travellers, as well as for alien citizens who impoverished due to disease. As from 1300, it served as a nursing institution. It was transformed into a hospital in the 16th century and, after turning into to an University Clinic in1833, it was relocated in 1842. (Source: Spitalarchiv Kanton Zürich, Switzerland.)

HISTORY

Hospitals in China were built as early as the 10th century B.C.; subsequently with the spread of Buddhism many hospitals were built by 845 A.D.

In ancient India, hospitals for men and animals were established during the reign of Maurya and Gupta Kings. Under the Emperor Asoka (260 B.C.), there were schools with attached hospitals. A few religious and charitable endowments in South India established schools with attached hospitals. Such hospitals were known as "Veera Solan". In South India an edict dated 1097 of Veera Chola Maharaj refers to a sixteen bedded hospital for students of the school attached to the temple at Tirumakundal in Chingleput District.

In the Greco-Roman civilization "Asklepieia," - the health resorts named after Asklepius - existed where patients were admitted and treated for their illnesses. Under the patronage of Caliph Harun- Al -Rashid (763 - 809) and later his son Al Mamun (786 - 833), the first hospital in Baghdad flourished.

In Europe in the 16th century, certain religious orders were exclusively connected with nursing. Among these, the Augustinian Sisters of Hotel Dieu of Paris stand supreme in their service to the sick and the infirm. The first organized hospital was built in Paris in the year 660 A.D. and named "Hotel Dieu of Paris". The first schools of medicine were started in Montpellier in 1220 and in Paris in 1270. In London, St.Bartholomew's Hospital was built in 1123 and St.Thomas Hospital in 1215.

Today's modern hospitals can be classified according to the type of supporting organization (public, non-profit, private), their main field of practice (medical speciality) or research focus, or their number of beds. A brief overview of the world-wide hospital statistics is given in the next section.

[1] The word hospital derives from the Latin word *hospes*, and *hospitum*, whereas the former meaning guest or person having the right of receiving hospitality. In ancient Rome, *hospitum* was referred to a pact of private or official nature where an individual was given the right to be received and maintained at state expenses. Hospitality amongst individuals included the compromise of mutual protection and defence of interests. In the US, a common technical term referring also to hospitals is "**health care facilities**".

SITUATION WORLD-WIDE

The number of hospital beds, relative to the population world-wide is given in table 1. Evidently, the number of hospital beds per 10'000 inhabitants varies considerably on a regional level. Considerable differences are also found for national health care systems where situations may differ considerably not only between single nations, geographical areas, but especially between urban and rural regions. It would be far beyond the scope of the present overview to present a general overview of the world-wide health care construction market, for which differences between countries and regions will be illustrated with a few examples, namely China, United States, Switzerland and, specifically, El Salvador.

	Population (millions)	Hospital beds per 10'000 inhabitants	Total hospital beds (thousands)
WORLD	**6.445,634**	**28,4**	**18.327,99**
SOUTH EAST ASIA	1.656,529	17,0	2.816,099
WEST PACIFIC REGION	1.743,954	34,0	5.929,444
EASTERN MEDITERANEAN REGION	538,001	13,0	699,401
AFRICA	738,086	9,0	664,277
EUROPE	882,731	67,0	5.914,298
AMERICAS	**886,333**	**26,0**	**2.304,466**
North America	330,546	33,0	1.090,587
Latin America & Caribbean	555,852	19,0	1.056,119
CENTRAL AMERICA	40,000	9	3,600
Belize	0,270	13	0,035
Costa Rica	4,327	14	0,606
El Salvador	6,881	7	0,482
Guatemala	12,599	5	0,630
Honduras	7,205	10	0,721
Nicaragua	5,487	9	0,494
Panama	3,232	18	0,582

Table 1. Population **and hospital beds per region, with special consideration of Central America, where the number of hospital beds per each 10'000 inhabitants is below the equivalent of the American continent, Latin America and the world-wide average. Although widely used in international statistics, the number of hospital beds is becoming less meaningful criteria when comparing health care systems in different regions.**
SOURCE: WHO World Statistics 2005.

For example, China today has 18,396 hospitals with 2.4 beds per thousand people. With 1.3 billion people accounting for 22% of world's population, China only has about 2% of world's total medical resources and 80% of all existing hospitals need to be rebuilt. China built an average of 270 hospitals every year during 1950 and 2000 and 519 hospitals each year from 2000 to 2004.

As SARS directly caused an economic loss of 37 billion US dollars to China, which is partially attributed to the poor and outdated design and planning of most existing healthcare facilities, the Chinese government appropriated millions of dollars to upgrade its healthcare infrastructure. Such new infrastructure projects will include more centers for disease control, more hospitals for infectious disease, women, children, and mental health, and more emergency life-saving units with the existing general and specialized hospitals. As a result, China's fast growing hospital construction market should benefit design and engineering firms on a word-wide basis.

The construction market for health care facilities in the United states is estimated at 17 billion US dollars annually, an amount, which roughly doubles the equivalent amount spent in China (65 billion RMB or 8 billion US dollars). In the US, per capita spending in both health care and health care facility construction, tops on a world-wide level. However, serious concern arises at present, whether the present health care system in the US is sustainable on a mid-term basis.

A similar problem arises in Switzerland, which accounts for a staggering 8 hospitals per hundred thousand people. In this country, relative health care spending ranks second highest in the world: 11.5% of the GNP per year – only second to the US (15% of GNP) and, when taking into account the Swiss GNP per capita, the highest per capita spending in health care in the world.

Latin America has an estimated number of 16'500 hospitals and averages 1,9 beds per 1000 inhabitants, compared to 3.4 in the US. Large differences are also found in this region: Central America for example, accounts only for 0.9 beds per thousand people – in El Salvador, with an average 0.7 beds per 1000 people in 2005, the coverage is even less.

In view of the present lack of hospitals, the Salvadorian government has decided, with the help of the BID and other financing institutions, to increase the number of hospitals in the next years. In 2006, for example, the Social Security Institute of El Salvador (ISSS) plans to build a total of seven (8) hospitals, with an estimated investment of over 70 million US dollars, whereas the Ministry of Public Health is taking charge of 7 hospitals of the National Network – this effort in proportion would correspond to roughly twice the relative effort presently made in China.

DESIGN & CONSTRUCTION OF HEALTH CARE FACILITIES

The planning, design and construction of health care facilities in general, not only needs the cooperation of various disciplines, but may considerably according to the culture and applicable Norms and Standards in each geographical region.

State-of-the-art developments in architecture, medicine and medical technology, as well as the sociological and economical developments. The role of the patient, functional aspects, services of critical areas the position of the health care facility as an institution financed by public and/or private sources, as well as the ongoing developments in technology, medicine and the environment – and their consequent interactions - are factors to be specially considered during health care facility planning, design and construction.

EC-EXPERIENCE

Our Company's record in participating in the design of national healthcare facilities starts in 2001, in the aftermath of the earthquakes of January 13th and February 13th[2] occurred in El Salvador that year. EC participated in a variety of damage assessment and structural evaluation projects for the National Hospital Network. A more detailed documentation of the works performed for the 15 principal units are documented in Table 2.

During the past 5 years, EC's participation in national healthcare facility design & construction projects has constantly increased, both in terms of project volumes and in the number of services involved. Based on its historical core experience, initial activities from EC focused mainly structural engineering and geotechnical studies. EC´s excellent performance in these initial projects, together with gained experience with both national and international hospital design norms and standards have gradually expanded its involvement to a more general participation in health care facility projects, which today covers the fields of consulting, design and supervision of practically all design and construction aspects.

Only recently, EC has been appointed with the overall supervision of the complete design and construction works of the "Hospital Psiquiátrico" from the Salvadorian Social Security Institute (ISSS). This 120-bed hospital includes three divisions for psychiatry treatment, surgery recovery and diabetes treatment (see Fig. 2). The facility's 3-story building is to be completely remodeled and expanded. EC's scope of works within this project comprises the supervision of the design and the construction of this turn-key project.

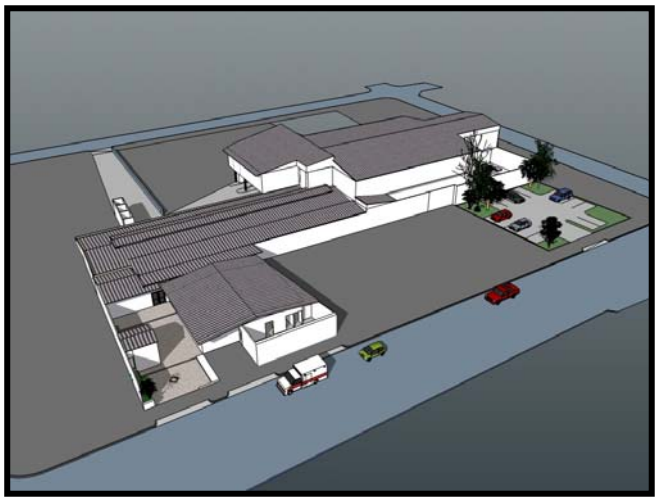

Fig. 2: 3D-Presentation of the new "Hospital Psiquiátrico" from the Salvadorian Social Security Institute (ISSS). EC has recently been appointed as general supervisor for the design and construction of this 120 bed facility, including complete design revision and approval, QA/QC for design and construction works, supervision of contingency plans all erection works and medical equipment installation.

Table 2: Reference Projects from EC in the Health Care Facility Construction Market

Hospital Name & Location (all in El Salvador)	Constr. Area (m^2)	Health Care Facility Description			EC Scope of Works												
					On-site assessment				Geotechnical, Civil and Structural evaluation:			Evaluation of Vital Supply Lines[3]			Design		
		Number of beds	Number of specialties	Other	Physical damage for structures	Physical damage of vital Supply Lines	Soil studies and geophysical studies	Destructive and Non-destructive testing.	Evaluation of Seismic Resistance and Liquefaction Potential	Determination of repair works for structures	Determination of repair works for Vital Supply Lines	Evaluation of risks in architectural elements	Risk evaluation for Vital Supply Lines	Risks for equipment.	Detail engineering (structures, repair and reinforcement)	Detail list for non-structural vulnerability.	Budgets, Specs, Reference Terms
Hospital San Juan de Dios, San Miguel	37'122	400	18	ICU*	X	X	X	X	X	X	X	X	X	X	X	X	X
Hospital de Maternidad, San Salvador	17'792	300	7	ICU	X	X	X		X	X	X				X	X	X
National Laboratory Dr. Max Bloch, San Salvador	8'236	Medicine certification and reference diagnostics for other laboratories			X	X	X		X	X	X	X	X		X	X	X
National Medicine Storage Center, San Salvador	18'200	National Center for Distribution of Medicine. & Vaccine Production			X	X	X	X	X	X	X	X	X		X	X	X
ISSS Sonsonate Hospital, Sonsonate	6'181	70	*N/A*	ICU	X		X		X						X		X
ISSS Hospital of Santa Ana	10'300	135	*N/A*	ICU	X				X						X		X
SSS Specialty Hospital, S. Salvador	16'250	274	*N/A*	ICU	X		X	X							X		X
ISSS Healthcare Units (total 10)	Urban and rural ambulant health care units (for 3-5000 patients)				X				X								X

[2] See of example www.usaid.com for a detailed documentation of the resulting damages

[3] Vital supply lines (VLs) include water, electrical energy, data & voice communication, gases, vapor, waste, etc.

SAMPLE PROJECT: HOSPITAL SAN JUAN DE DIOS

Fig. 3: Hospital de San Juan de Dios, located in San Miguel, El Salvador. This health care facility is amomgst largest of its kind in Central America. It consists of four buildings of six levels each, and a series of 1-2 level buildings. Total constructed area is 37'126 square meters. Left: Front view. Right: Top wiew w. indications of the main areas.

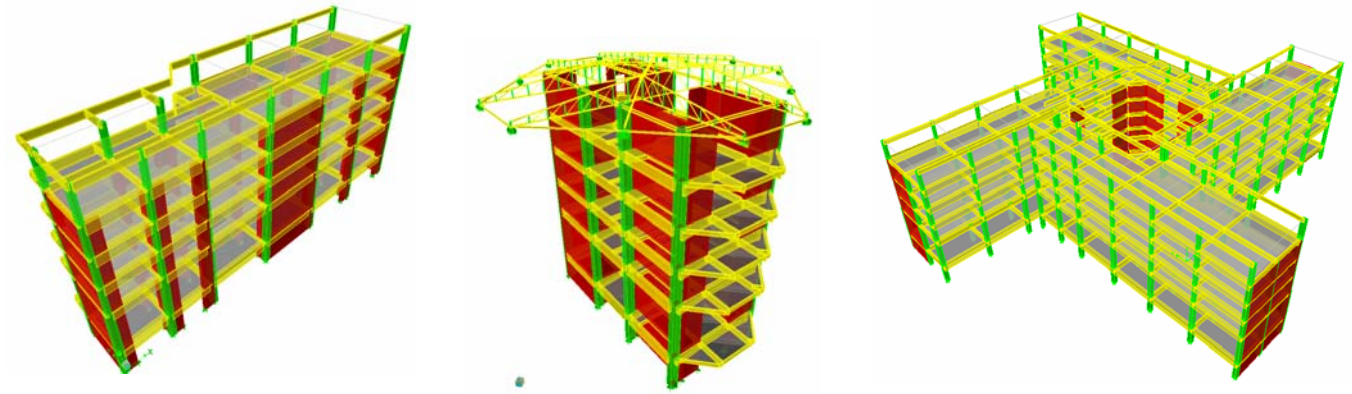

Fig. 4: Different repair scenarios for the San Juan de Dios Hospital (see above) proposed by EC, based on a complete structural assessment. The results of this assessment showed that, earthquake resistance of the buildings had been reduced to 28% of the value required by the applicable norms. Calculated building displacement values exceed 3-4 times the maximum allowed values.For the case of the central tower, 100% of the girders were found to be damaged. EC proposed different repair scenarios, including costs. Left and Middle: Proposed repair scenario where each building (left) and the central tower (middle) is reinforced individually through the massive implementation of reinforced concrete shear walls (marked in red). Right: Schematic illustration of an alternative approach, showing that when the structures of the individual buildings and the central tower with special elements, fewer additional shear walls are needed.

Fig. 5: As part of its scope of works, EC performed a complete diagnosis of the actual state of the vital lines of the San Juan de Dios Hospital, including ducts for medical and industrial gases, electricity, telecommunications, vacuum, potable water, industrial water, air conditioning, steam and other. Works also included recommendations for improvement, design of specific support structures and cost budgets.

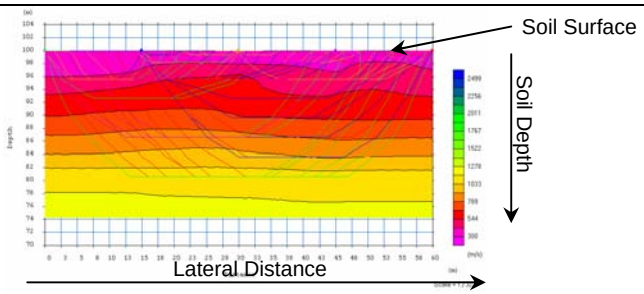

Fig. 6: Geophysical soil investigations were performed by EC in this project as well, using own state-of-the-art equipment and technology. Above: Typical result of seismic refraction measurements, taken over a lateral distance of 60 meters and reaching to a soil depth of 26 meters. The different measured wave propagation velocities for the different soil layers are marked with colours. Velocities range from 300 m/s in the surface vicinity (loose soil) to 1000 m/s (well-compacted soil).