

**REPORT 7**

**SUSTAINABLE CONSTRUCTION  
IN JAPAN  
A PERSPECTIVE TO THE YEAR 2010**

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**NATIONAL REPORT**

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## **1. INTRODUCTION - INITIATIVES ON SUSTAINABLE CONSTRUCTION IN JAPAN**

In early 1990s, the issues relating to construction and the environment got great concern only by limited number of people in Japan like academics, research minded practitioners and government officers.

However, in late 1990s, construction and the environment is the critical issue for most of the construction people in Japan. The word sustainability is frequently used in articles and papers in magazines and journals relating to construction.

Public sectors are now taking various measures to constrain environmental impacts by construction. Public sectors are now integrating these independent and fragmented measures in order to realize more holistic and comprehensive approach. Various non governmental organizations (NGO) were established to encourage or to initiate measures.

This national report summarizes various research and practical initiatives related to sustainable construction since early 1990.

## **2. INITIATIVES BY THE MINISTRY OF CONSTRUCTION (MOC)**

### **2.1 The framework of governmental policy**

In November 1993, the Environment Basic Act was enacted in Japan. The act gives comprehensive legal basis for environmental policies and measures implemented by the governmental bodies. All acts, regulations and codes are requested to harmonize with this law. The Environment Basic Act declares three basic principles. These are:

- Enjoying and preserving the benefit of the environment
- Developing sustainable society by reducing environmental impact
- Promoting international collaboration toward conservation of global environment

Based on the Environment Basic Act, the Environment Basic Strategic Plan was established by the Cabinet in December 1994. It gives the basic strategies for integrating policies by the government in the coming decade. These are:

- Cyclic utilization; Realizing socioeconomic system with less environmental impact by cyclic utilization.
- Harmonization with nature; Harmonized coexistence with living creature by conservation and restoration of ecologies environment

- Participation; Participation of all organization to the activities toward 'cyclic utilization' and 'harmonization with nature' under equaled role sharing
- International frameworks; Promotion of international collaboration

Prior to the Environment Basic Strategic Plan by the Cabinet, the Ministry of Construction (MOC) established the Environmental Policy Plan in January 1994. In the plan, there are two significant recommendations. The Plan declares that the environment issues are not the additional requirements to the facilities constructed by MOC, but the basic demand that all facilities should meet in their basic nature. The Plan involves recommendation that construction industry should establish the action plan voluntarily.

Up-to-date information in terms of MOC policies is available from Web site (<http://www.moc.go.jp>)

## **2.2 A voluntary action plan by construction industry consortium**

Pushed by the recommendation, ten industrial associations in construction industry established a consortium called as Environmental Action Board. The participant bodies of the Board involve the association of contractors, building consultants, house producers and so on. In 1996, the Board declared the Vision of Construction Industries' Environmental Action. The vision puts its basis on the idea of sustainable construction.

## **2.3 MOC Eco city projects**

So-called Eco-city project was started by Building Research Institute (BRI) in 1991. BRI is the governmental agency in Ministry of Construction (MOC). This is the five years' large size research project where university researchers and practitioners in construction industry were invited.

As a part of the Eco-city project, LCA program was developed as a tool to aid environmental conscious building design. This is a software for PC. The designers are able to get the life cycle energy consumption and carbon dioxide emission by entering parameters. It is easy for designers to compare energy consumption and carbon dioxide emission among possible alternatives.

In the process developing the software, required data was collected by MOC. To get the figures of embodied energy and carbon dioxide emission per unit quantity of building materials and components, the questionnaire survey was implemented to the fabricators of building materials and components. In the questionnaire, all resource materials and energy input were filled in. MOC also did analysis of I-O (Input - Output) tables. The figures obtained in questionnaire survey and I-O table analysis was compared. Then BRI table of embodied energy and carbon dioxide emission was constructed as one of the sub-package of LCA program.

In order to get operational energy and carbon dioxide emission, one year monitoring surveys were implemented in ten Japanese cities. The quantity of energy and resource used by one dwelling was modeled by correlated parameters.

The LCA program is now being distributed to the practitioners in building industry.

## **2.4 Recycle Plan 21 Initiative by MOC**

The Ministry of Construction (MOC) is the body to implement public works. Thus, it is a 'strong' and influential client. MOC organized regional board composed of local office of MOC, local councils and association of firms in construction industry. The regional body is a promoting body to realize the following purpose:

- Minimizing the quantity of construction by-products by design measures
- Maximizing the recycling by intensive exchange of information among parties involved in construction work
- Promoting appropriate disposing wastes in terms of which reuse is difficult
- Encouraging R&D

These initiatives are called as Recycle Plan 21. The long term goal of this initiative is realization of almost 100% reduction of disposed waste, except particular wastes which have difficulty in reusing. Its short term goal is 50% reduction of disposed construction waste. Thus, it needs 10% reduction in production of construction by-products plus upgrading recycling ratio of construction by-products from 42% to 80%.

The initiative is generating considerable effect to reducing construction waste in public works. However, it is not certain whether the effect could reach the level defined as the figures above

## **2.5 Green governmental buildings initiative**

The public building department of MOC initiated green governmental buildings initiative in 1996. The initiative aims to construct and renovate governmental buildings with less environmental impacts. By 1998, the initiative made draft guideline together with environmental impact assessment method (check-sheet). The guideline involves the following recommendations:

- Less contextual impacts to surrounding area by constraining change of original geographical features, increasing planted area and preventing pollution.
- Less energy and resource use by intensive insulation, utilization of renewable energy and natural light, introduction of ventilation cooling, application of efficient equipment, utilization of rain water and by systematic operation of building equipment for balancing of energy use.
- Better longevity by improving adaptability, utilization of more durable building materials and components.
- Utilization of 'eco-material' like materials with less environmental impacts, recycled materials and byproducts.
- Appropriate reuse and disposal

The guidelines will be applied to all newly constructed and refurbished governmental buildings.

The Ministry of Education implemented 'Eco-school project' in 1995. Many local authorities made and/or are making design guidelines on environmental conscious building.

## 2.6 Strategic policy programming after COP3

COP3 held in Kyoto in December 1997 decided to demand to industrial countries to reduce greenhouse gas emission by 2010. Japan promised to reduced 6% than the quantity level in 1990.

After COP3, Japanese government established task force to make the comprehensive policy program in terms of measures taken by governmental bodies for reducing green house gas emission.

Comparing with EU countries and north American countries, Japanese industrial sectors already realized fossil energy efficient industry. More energy efficient facilities are disseminated. Japanese manufacturers are supplying more energy efficient products. The statistical figures indicate that the quantity of green house gas emission from manufacturing sectors has been almost stable since 1990.

The fact suggests irrationality of the indicator based on quantity level in 1990. However, Japanese government feels strong responsibility to prevent global warming. Japanese government is now making serious effort to reduce green house gas emission. The target is transportation sector and non-industrial sector, because the green house emissions from these sectors are considerably increasing since 1990.

Thus, reducing green house gas from building operation is now becoming the critical issue. Under the comprehensive policy program, MOC is now making policy plan. MOC established the Advisory Committee composed of experts from academic bodies, industry and consumers. MOC requested the Advisory Committee to submit the recommendation report by May 1998. The report is expected to contribute to establish policy plan. The policy plan is expected to integrate already implementing measures exemplified in Table 1.

- 
- Upgrading comprehensive insulation level
    - Revision of Energy Saving Guideline for housing (Minister's ordinance)
    - Revision of technical requirements for Government Housing Loan Corporation's loan
  - Registration of qualified insulation technicians
  - Encouragement of 'Environment symbiosis' urban regeneration projects by subsidy
  - Facilitation of 'Eco-care' Building pilot project by supplying low interest loan.
  - Encouragement of replacement by more energy saving building services by providing benefit in tax payment.
- 

**Table 1. The example of present measures by MOC for greenhouse gas emission.**

### **3. INITIATIVES BY ARCHITECTURAL INSTITUTE OF JAPAN (AIJ)**

#### **3.1 Global Environment Research Committee**

Architectural Institute of Japan (AIJ) is a unique body; It is an academic body. It has about 40 thousands' members. The members are academics and practitioners including architects, engineers and construction managers. Up to date information is available from Web site (<http://www.aij.or.jp/>).

AIJ initiated global environmental special research program in 1990. Following the special research program, AIJ established the Global Environmental Committee. Under the committee there are more than ten research groups. Each group is composed of researchers and practitioners. The research committee is organizing workshops and symposium in every three months. The Committee already published reports and proceedings (AIJ, 1997, see Appendix 1).

By the initiative of the Global Environment Committee, AIJ will organize symposium on 'sustainable construction' at the annual conference in September 1998.

Under global environmental research committee, AIJ established sustainable building research sub-committee in September 1997 chaired by Prof. Murakami at the Univ. of Tokyo. The mission of the sub-committee is to establish criteria and indicators for sustainable building from Japanese perspective. The final report of the sub-committee would be published by the end of 1998 (The author is the secretary of the sub-committee).

#### **3.2 Building Agenda 21 by AIJ**

Architectural Institute of Japan (AIJ) announced Building Agenda 21 to the public in October 1995. The agenda represents general understanding among Japanese academics in terms of sustainable construction. The agenda is based on the principle of AGENDA21 in UN Global Environmental Summit in 1992 and on Japanese Environmental Basic Act in 1993. The Agenda declares:

A life cycle of building has profound interrelationship with global environment. The effort of environmental conscious measures would make great contribution to preserving and redeveloping of global environment. The member of AIJ must notice the responsibility for global environment and need to participate in decision making process more positively. 'Sustainable construction' is the significant theme that AIJ must put first priority. Thus, AIJ proposes seven principles for future research activities.

Seven key principles involved in the agenda are :

- Establishment of the methodology to evaluate life cycle impact of building to the environment, as well as creation of measures to constrain impact by using the methodology.
- Producing code of practice of planning together with reconsideration of present life style from the aspect of energy consumption.
- Prolonging the life of buildings in order to prevent rapid resource consumption.
- Reducing energy and water consumption in building operation and setting up measures to use reproductive resources.
- Planning for sustainable land utilization and for preventing pollution to water, air and land
- Creating measures for healthy environment
- Promoting technology transfer and information exchange for international cooperation.

In July 1997, Building Agenda 21 was revised as 'Action Plan for the Global Environment' (Appendix 2).

### **3.3 AIJ President's appeal in December 1997**

The president of AIJ announced the appeal to the public for constraining carbon dioxide emission on 2 December 1997. It declares that 30% of reduction of carbon dioxide emission for newly constructed buildings is feasible if they meet to the conditions that AIJ offered, while 15% reduction is possible from existing buildings if they are properly refurbished based on the AIJ guidelines. These measures could contribute to the reduction of carbon dioxide emission up to 5% in national scale. The appeal also insists on the necessity of longevity of buildings; it proposes the three times' extension of building life than present situation (Appendix 3).

## **4. INITIATIVES BY PROFESSIONAL AND INDUSTRIAL BODY**

### **4.1 Code of practices and guidelines**

Industrial Associations established permanent organization on sustainable construction. For instance, BCS established Global Environment Committee.

Codes of practice or design guidelines are being made. Japan Institute of Architects (JIA) published the guideline of 'sustainable design'. The Building Contractors Society (BCS) published guidebook of environmental conscious design. Building Department of MOC is now developing design guideline for environmental conscious public building.

## **4.2 Reduction of consumption of tropical wood plywood forms for cast-in-site concrete**

In 1992, Building Contractors Society (BCS) announced officially to the public that member firms of BCS would realize 35% reduction of consuming tropical wood plywood forms for cast-in-concrete within coming five years.

Though the author does not have any data on actual figure of reduction, it is certain member firms of BCS made an effort to realize the figure by applying following measures; Using plywood made from renewable wood such as pine and cedar, applying durable plywood forms such as paint coated plywood forms, using metal forms, using precast concrete and so on.

The problem is that only member firms of BCS seems to make intensive effort for the last five years. BCS is composed of about 90 largest contractors. In another word, other smaller contractors did not join the effort so positively. (There are almost a half millions' construction firms in Japan!)

## **4.3 ISO 14000s and environmental management**

The number of environmentally conscious firms would be increased rapidly by the introduction of ISO 14000, because the Japanese clients of construction are now enthusiastic to introduce environmental management system (EMS). Institute of Building Energy Conservation (IBEC), nonprofit subsidiary body of MOC, established EMS research consortium. The consortium is composed of governmental officers, university researchers, practitioners from the industry. The consortium is now editing several documents to support activities to establish environmental management system in the firms relating to construction industry. (The author is the chair of task group of the EMS consortium.) The EMS consortium published following manuals, tool-kits in order to encourage and assist construction firms to introduce EMS.

- ◇ Manual of establishing EMS
- ◇ Manual of environment impact assessment
- ◇ Checklist of environment performance
- ◇ Environment database
- ◇ Domestic environment code database

Several large contractors and prefabricated house producers are now preparing to establish environmental system and to take ISO 14000s approvals. Already 12 firms relating to construction got ISO(JISQ) 14001 approval.

## **4.4 GBC 98**

Two Japanese teams, IBEC and Building Contractors Society (BCS), are participating Green Building Challenge (GBC98). IBEC is also the counterpart body of IEA-Annex group.

## **5. KEY ISSUES IN JAPAN**

### **5.1 Review of environmental impacts by construction industry**

The researchers in construction industry are now making an effort to review environmental impacts by construction industry. These efforts are done by personal basis or by single organization or by collaboration of various organizations through industrial associations of contractors, suppliers and fabricators relating to construction industry. The following are results of the review.

#### **5.1.1 Global Warming**

Total CARBON DIOXIDE emission in Japan increased 7.2% among 1990 and 1994. Construction works in sites only occupy 1.3% in total national CARBON DIOXIDE emission. However, production of construction materials has contribution of 12.8%, transportation related to construction has 3.4%, operation of buildings has 16.5%. As a total, Japanese construction activities have over 34% share in national CARBON DIOXIDE emission (Sakai 1992).

#### **5.1.2 Energy use in summer time**

Japan belongs to Asian monsoon region. Thus, air-conditioning in summer time requires more intensive load in energy use than heating in winter time, in most of the country. In another word, most of Japanese architects and engineers put much concern on cooling system in summer time in building design.

#### **5.1.3 Depletion of Tropical Forests.**

Plywood made by tropical timbers has been used as forms for cast-in-site concrete in Japan for long years. Only 3.4% of consumption of tropical woods is exported. However, erecting facilities for exportation give incentives for unplanned and uncontrolled consumption in tropical country. 33% of exported tropical timbers are consumed in Japan. 10% of Japanese domestic consumption of tropical woods is used in construction industry (Osaka Building Contractors Association, 1992).

#### **5.1.4 Ozone Depletion**

Halons from fire safety devices and CFCs from insulation materials have potential for ozone depletion. Recycling of these materials from dismantled buildings is now being promoted in Japan. At present stage, Japanese construction industry has 5.5% share of total national emission of Halons and CFCs gas.

### 5.1.5 Acid Rain

Researchers in Japanese construction industry understand that construction industry has little potential for acid rain, because NO<sub>x</sub> and SO<sub>x</sub> emission from construction machinery has small share in the whole national emission.

### 5.1.6 Construction wastes

In 1990, 76 million-ton amounts of construction wastes were produced in Japan. It is about 21% of total industrial waste in Japan. Compared with other industrial sectors, this is the largest share. Only 42% were recycled. The government statistics suggest that 127 million-ton amounts of construction waste would be produced. Upgrading the recycling ratio is the critical issue in Japan.

## 5.2 Capacity of space

The habitable land area in Japan is 126 thousands' km<sup>2</sup> among total land area of 379 thousands' km<sup>2</sup>. It is comparative with UK; Japan has about 120 million's population that is almost double of UK. The national gross population density in Japan is 329 persons per km<sup>2</sup> while 236 persons per km<sup>2</sup> in UK. The population density in habitable area in Japan is 988 persons per km<sup>2</sup> while 245 persons in UK. The figures of demographic and geographical condition suggest how intensive the density of economic activities in Japan is. Consequently, the limitation of capacity of space is a critical issue for environmental matters in Japan.

For instance, the high density of energy consumption in urban area cause the phenomena called as 'heat island'. This is local concentration of heat atmosphere by heat transmission, energy consumption by building and transportation in urban area. Urban climate modeling is 'hot' topic among researchers. In this context, the constrain of energy use is not only global environmental issue but also local issues in Japan.

The limitation of capacity of space also causes the lack of waste disposal space. The reuse of waste is becoming the sensitive issues in Japan not only by the reason of resource saving but also of space saving.

## 5.3 Short life buildings

In the past three or four decades, Japan repeated the short term repetition of 'new build and demolition'. It was proved that RC structural office buildings have around 40 years' life in medium, while steel structural has around 30 years in Japan (Yashiro, 1990). Eventually the author presented at the first CIB W82 symposium that quite a certain amount of construction waste would be produced in coming future, if Japan should keep repetition of short cycle of demolition and new build activities (Yashiro, 1992)

The short life tendency was generated by the recovery of war disaster and by the rapid economical growth. The tendency made affection on the nature of Japanese construction industry. There was a sign that some parties in the industry promote demolition of usable building to get their job opportunity. Considering that Japanese construction volume (i.e., over one million dwelling units newly build per year), short life buildings in Japan have global impacts in natural resource conservation.

Governmental agencies, public bodies, industry associations and academic institutions announce the achievement of 'long life building' policies and programs. All the 'future building' R&D projects promoted by various kinds of organizations involve the paradigm of 'long life'.

#### **5.4 Global supply chain**

Construction materials and energies applied in construction activities are involved in the global network of supply chain. Various resources and raw materials for construction are imported. The vast volume of construction in Japan made great influence on environment in the other countries.

99% of aluminum ingots used in Japan are imported from Australia, USA, Indonesia and etc. It is understood that usage of aluminum by Japanese construction industry generates energy consumption in these countries.

## **6. ANSWER TO FIVE MAIN QUESTIONS AND FIVE SUB-QUESTIONS**

### **6.1 What kind of buildings will be built in 2010? And how could we adapt existing buildings?**

Though it is not certain how comprehensive the idea of sustainable construction would be disseminated among Japanese construction industry by 2010, it is quite certain that considerable numbers of building built in 2010 would be designed based on the following paradigm.

- Long life design which assures effective whole life cycle management
- Separation of decision making level such as open building by realizing interchangeability of subsystems ( which is expected to assure reuse of materials)
- Low embodied energy and carbon dioxide emission
- Low energy use and carbon dioxide emission in operating building
- Involving a sort of autonomous mechanism
- Low environmental impacts on surrounding area
- non-toxic indoor air quality

The most important issue in Japan is providing measures to prolonging the life of existing buildings. In another word, establishment of modernization method of existing buildings constructed after 1970s is the critical issue in Japan.

## **6.2 How should we design and construct them?**

It is certain that more intensive negotiation and discussion would be required among construction team (architects, engineers, contractors, fabricators and so on) in each project to find the most appropriate way toward sustainable construction. Moreover, in total process of projects, constructing agreement among interested parties ( not only stakeholders) would increase its importance than now. The construction process would be more complicated. In this circumstances, not only automated way is effective, but also excellent human skill would be effective. The most innovative construction would be the most appropriate combination of automation and excellent human skill.

## **6.3 What kind of materials, services and components will be used there?**

Following materials would be the preferable materials:

- Low embodied energy and carbon dioxide materials
- Renewable materials
- Materials with less environmental impacts

In this context, timbers and wooden materials would have popularity than now. There is an encouraging fact; Japanese forests would be recovering its sustainable cycle in late 1990, whose sustainable cycle was destroyed during the time of world war II. However, there is also discouraging fact. Domestic timbers are more expensive than imported timbers from North America. There are economic constrains to establish sustainable supply-demand chain in specific region.

## **6.4 What kind of skills and standards would be requested?**

Apparently sustainable construction requires different skills and ways of thinking to construction people. For example, recycling of construction waste requires skills to dismantle building elements into basic elements.

Environmental performance indicators proposed in ISO 14000s would be the basis for new standard. Methodology of LCA disputed under the framework of ISO 14000s would be also the basis as well.

So called boundary problem would be the critical issues in terms of quantifying the environmental impacts, because construction industry has the nature of assembling product from the other industries. Some agreement is needed in the definition of boundary (Yashiro, 1997).

## **6.5 What kind of cities and settlements would we have then?**

Low density building complex and districts together with preserved nature would be the paradigm in city planning in 2010.

## **7. GOOD PRACTICES**

There is not agreement on the definition of sustainable construction yet, because Japanese 'construction people' including practitioners and academics prefer 'concept follows practice' attitude than 'practice follows concept'. Thus, prior to establishing the definition, many pilot attempts are being implemented concurrently. It is expected that feed back from experiences of daily practices and pilot attempts would establish precise definition of sustainable construction in future.

### **7.1 'Environment symbiosis' building**

Japanese traditional culture involves the paradigm of harmonization with nature. It is acceptable for Japanese people to define human as only one of the players in the environment.

Based on these cultural basis, the word of 'environment symbiosis' building is more frequently used than sustainable building, environmental conscious buildings and green buildings in Japan.

### **7.2 Good practice projects**

The pilot projects and experimental projects of are being done concurrently by various institutions.

NEXT 21 projects in Osaka city is the most integrated and innovative example of sustainable design, where open building idea assures harmonization of independent measures (Utida, 1995).

TEPCO (Tokyo Electric Power Corporation) is now monitoring their experimental 'autonomous' buildings.

Housing and Urban Development Corporation (HUDC) and local councils are now constructing environment' friendly' estates in nationwide.

Remarkable example is Fukasawa Housing Complex in Setagaya-ku Tokyo. It is typical example of environment symbiosis building. It was designed by architect Kazuo Iwamura. He involves feasible environmental friendly measures in the council housing project where budget is extremely tight.

Moreover, specific type of passive solar house called as OM solar house is being rapidly disseminated among timber detached houses. Around ten thousand's OM solar house was constructed in Japan.

These projects are worth to visit. It is uncertain whether the impacts of these good practice projects are strong enough to encourage future clients and construction professionals to try similar projects. In addition, some people in construction industry have misunderstanding that these pilot projects are expensive projects.

## **8. BARRIERS AGAINST SUSTAINABLE CONSTRUCTION**

The disputes among researchers and practitioners in various opportunities made by concurrently undergoing initiatives identify barriers against comprehensive approach:

- Understanding on responsibility of construction sector to the global environment is not matured in the whole construction industry.
- In almost all firms in Japanese construction industry, environmental impacts by the activities of the firm had not been reviewed precisely until recently, partly because they are less conscious about environmental issues, and partly because the methodology of precise review of environmental impacts has not been established.
- There is not clear agreement on role sharing and responsibility allocation among members of construction team in the projects (including clients).
- Tight contract budget makes construction firms hesitation to apply environment-friendly measures
- The pressure by the clients had not been strong until recently.
- Exchange of information and ideas within construction team and with other industrial sectors has not been adequate, because there has not been the platform of exchanging information.
- Necessary information were not available for most of construction firms.
- Environment-friendly materials are not available at reasonable price in the market.

The following recommendations are proposed as the measures to overcome the above mentioned barriers, through the disputes and discussions among researchers and practitioners in Japan.

- Dissemination of knowledge (especially to executive board members) about the significance of responsibility of construction firm to the global environment
- Developing and disseminating the methodology of reviewing environmental impacts of the construction firm
- Promoting education and training of employees and operatives
- Establishing agreement in terms of role sharing and responsibility allocation among members of 'construction team' in the projects (including clients) in order to keep necessary budget for sustainable construction
- Setting up information network to introduce good practice to other department of the firm or other firms in the industry

- Constructing common comprehensive data base to provide necessary information such as; LCA data, cost data, delivery data and so on.
- Encouraging construction materials industry to provide environment-friendly materials
- Awarding good practice and good client
- Introduction of environment management system
- Establishing the professions of 'construction environment consultant'

## **9. CONCLUDING COMMENTS - WHAT IS INCENTIVE FOR SUSTAINABLE CONSTRUCTION?**

Possibly, in a long term, investment to the environment would generate the benefit to the construction firm and whole construction industry. This is the logic that several books published in USA do emphasize. However, there still exist misunderstanding in Japan that measures toward sustainable construction requires additional cost. In short term, this misunderstanding would meet the reality than the opposite understanding. Japanese government is providing or will provide economic incentives such as tax reduction, low interest financing and subsidies. However, there is a limitation in the effect (, partly because Japanese policies do not involve ideas of bringing up new environment business). The author is obliged to have the doubt that economic motivation would be the most significant incentive to disseminate sustainable construction in Japan.

Explicit demand in terms of sustainable construction issues by the client gives construction firms marketing motivation. Thus, the demand by clients can be the different incentive. This is one of the reasons why Japanese large contractors are enthusiastic for sustainable construction issues, because their long term good clients are environmental conscious firms. Contrarily prefabricated house producers have less motivation. Most of their clients put much priority on value for money rather than environmental issues. Consequently, these firms are less passionate to implement measures toward sustainable construction.

Different with European culture, there exists other incentive in Japan; Japanese construction firms put much significance on the reputation or credibility of the firm in the society. Thus, reputation can be the other incentive toward sustainable construction for firms in construction industry. If Japan would be successful in making social system to upgrade reputation of firms doing good practice of sustainable construction, comprehensive movement in the whole construction industry toward sustainable construction would be generated.

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## **11. APPENDIX 1 : THE LIST OF PAPERS INVOLVED IN AIJ PROCEEDINGS 'ARCHITECTURE AND URBAN PLANNING MEASURES TO MITIGATE CLIMATE CHANGE' SUBMITTED TO UNFCCC-COP3 KYOTO, DEC. 1997**

### **I. Life Cycle Assessment**

- 1 Development of Guideline for Life Cycle Assessment of Buildings Subcommittee on Life Cycle Assessment Guidelines, Research Committee on Global Environment of AIJ.
- 2 A Study to Evaluate Environmental Impacts and Costs throughout a Building's Life Cycle Masaaki Sato.
- 3 System Boundary Definition for Evaluation of Embodied Carbon Dioxide Emission by Construction. Tomonari Yashiro.
- 4 Example of Estimating CO<sub>2</sub> Emissions from the Wooden Structure Building. Kazuharu Takemoto, Kanji Sakai.
- 5 Carbon Storage for Timber Structure - Service Life and Recycling. Takanori Arima.
- 6 Why Trees Should Be Cut for Global Environment? Mario Tonosaki.
- 7 Buildings and Building Service Systems for Global Environment Age Laboratory for Global Environment and Building/Building Service System Advanced Research Center for Science and Engineering, Waseda University.
- 8 Evaluation of Global Environment Load with LCCO<sub>2</sub> for Urban Cities. Laboratory for Global Environment and Building/Building Service System Advanced Research Center for Science and Engineering, Waseda University.

### **II. Ecological Architecture and Building Service**

- 9 Earthport Tokyo Gas Kohoku New Town Building. Energy Saving Office Building Using Natural Energy & Cogeneration-Fumio Nohara. Osamu Shibata.
- 10 Energy Conservation in the TEPCO R&D Center. Power Engineering R&D Center, Tokyo Electric Power Company.
- 11 Effect of Natural Ventilation System at Ecological Architecture. Moriyama Laboratory, Research Center for Urban Safety and Security, Kobe University.
- 12 Ecological Architecture in the City of Kobe. Kobe City Council.

- 13 The New Kobe City hall Building as Ecological Architecture. Kobe City Council.
- 14 Utilization of Rainwater for Public Buildings in Kobe City Kobe City.
- 15 The Utilization of Solar Energy for Public Buildings in Kobe Kobe City.
- 16 Ecological Architecture as Products of the Workshop-Ohgo-community-welfare-center with children Kobe City.
- 17 Ecology in Harmony with Economy-Rokko toll office, Rokko workshop, Yanagidani toll office. Toshihiko Omori.
- 18 Seeking Environment-Conscious Architecture Part I A Look into Architecture from a Thermodynamic Point of View. Shukuya Laboratory of Building Environment, Musashi Institute of Technology.
- 19 Seeking Environment-Conscious Architecture- Part 2 Solar Control. Shukuya Laboratory of Building Environment, Musashi Institute of Technology.
- 20 The Effect of Shading Devices. Hirotsugu Yamada.
- 21 High Efficiency Air-Conditioning System for Computer Room. Hirofumi Hayama, Manabu Kishita, Akira Takakusagi.
- 22 Evaluation of Halon Replacement Agents for Application to Telecommunications Equipment. Takayuki Abe, foshiyuki Murata, Akihiko Kujuro.
- 23 An Environment-friendly Air Conditioner for Telecommunications Equipment Rooms. Shisci Waragai, Tsuneo Uekusa, Kazuo Chiba.

### **III. Urban Energy System**

- 24 The Reduction of CO<sub>2</sub> Emission by Promoting the Spread of District Heating and Cooling in all over Japan . Satoru Sadohara, Katsunori Nagano, Masao Miura, Kimiya Murakami, Masakazu Moriyama, Yoshiyuki Shimoda, Tadahisa Katayama, Ilirotoshi Yoda, Hiroki Kitayama.
- 25 Energy saving by transportation networks of urban waste heat and heat source water. Yoshiyuki Shimoda and Minoru Mizuno.
- 26 Energy Saving by means of Effective Usage of heat Pump. Toshihiko Tanaka, Toshio Ojima.
- 27 The Study about the District heating and Cooling Plan by Unused Energy Moriyama Laboratory, Research Center for Urban Safety and Security, Kobe University.
- 28 Transition of CO<sub>2</sub> Emissions from the Housing all over Japan and its Reduction. Shuichi Miura.

- 29 Actual Situation and Transition of Carbon Dioxide Emission in Tohoku Area. Shuichi Miura.

#### **IV. Urban Climate**

- 30 CFD Analysis of Warming Mechanism of Urban Climate. Working Group on Modeling for Urban Climate, Subcommittee on Dynamics for Urban Environment.
- 31 Global Warming and Urban Climate in Okayama City. Atsumasa Yoshida.
- 32 Characteristics of Urban Thermal Environment Using Thermal Image. Shuhei Yamamoto.
- 33 Climate Analysis for Urban Planning in Kobe. Moriyama I Laboratory, Research Center for Urban Safety and Security, Kobe University.
- 34 An Ecological Development with a Predictive Tool of Urban Climate. Yasunobu Ashie.

#### **V. Urban and Regional Planning**

- 35 Proposal for the Vertical City as Ultra Super high-rise Building for Improvement of the City Environment. Shizuo Harada, Masayoshi Iizuka.
- 36 Proposition of Formulae for Energy Conscious Urban Planning. Research Group of Urban Structure and Energy.
- 37 Landscape Conservation in the Intermediate Zone between Urban and Rural Land Use. Kiyoko Kanki.
- 38 Configurational Scheme of Zero Emission System for Kampo Medicine Factory. Yasuyuki Asakura, Kazuhiro Takamatu.
- 39 Global Environment from the Sea. Kenji Hotta Riichi Kobayashi.

## **12. APPENDIX 2: ACTION PLAN FOR THE GLOBAL ENVIRONMENT**

The Architectural Institute of Japan - July 1997.

### **1. Architecture and the Global Environment**

Attention has focused recently on worldwide deterioration of the environment, including problems such as global warming, depletion of the ozone layer, and waste pollution. Architecture has always been a fundamental factor in the human living environment and it strongly reflects regional history and culture. Since ancient times, mankind has striven to create comfortable and safe surroundings in which to live. However, as our living spheres on the earth have expanded and economies have become dynamic, we gradually realized that everyday acts which from a narrow perspective were thought to improve our living conditions have actually been aggravating environmental quality on a global scale. It is time to review the interactive relationship between architecture and the global environment from the perspective of Earth as the dwelling place for mankind.

### **2. Our Measures**

Since 1990, the Architectural Institute of Japan has conducted a special research program to study preservation of the global environment because we recognized that both architects and their patrons were partly responsible for ecological deterioration. In 1995, we established the Global Environmental Committee and initiated broader, in-depth research in the fields of science, technology, and art. Based on the outcomes, we summarized priority issues to be addressed by the Institute and developed our action policy for each effort presented herein, with the attendant goal to actively advance its implementation in order to realize sustainable living spheres while conserving the global environment.

### **3. Deployment of our Action Plan**

The Institute conducts fundamental research for the specific issues under the policy, and promotes activities for timely disbursement of the research benefits to society. We must examine the progress of such activities when necessary; periodically incorporate the findings into the policy of the Institute as a whole; and transfer the Action Plan to subsequent generations.

## 4. Member Awareness and Action

We encourage our members to be aware that their professional knowledge can contribute toward relieving environmental problems, and to make the utmost effort to resolve the issues in each field while vigorously participating in relevant activities.

### The Action Policy

#### 1) Lifestyle

As the current global environmental issues have arisen as a result of the entire chronicle of human endeavors, we must reevaluate the roles and significance of economics and ethics in a broader sense, while also pursuing the traditional architectural discipline that has emphasized studies of human living environs related to architecture itself. We take initiatives in establishing an entirely new architectural paradigm, and in proposing and promoting alternative lifestyles suitable to the era of global environmental awareness, without being confined to the concepts of architectural production and consumption alone.

#### 2) Analysis and Assessment of the Environmental Load

Toward the goal of proposing means to curtail environmental load, we undertake comprehensive research and development to establish databases and methodologies for load assessment, exemplified by the CARBON DIOXIDE issue that is said to be the major contributor to global warming, in the field of architectural life cycle; namely, the series of architectural stages from planning, design, and construction, practical use, and modification, to eventual dismantlement and removal.

#### 3) Use of Resources

Architectural production has traditionally been responsible for the mass consumption of our natural resources; toward the goal of curtailing depletion of our resources, we examine and propose ways to enhance architectural longevity and durability; appropriate use of architectural resources reflecting regional characteristics; methods to reduce resource consumption and promote recycling; and development of materials to reduce architectural waste and improve structural planning and construction design.

#### 4) Use of Energy

The quantity of energy and water consumed in the process of architectural construction and operation has been a profound load factor to the global environment. We conduct further research toward reducing the amount of these wasted resources, and improving utilization efficiency and recyclability. We also work to discover and implement innovative design techniques such as the use of natural energy to foster our symbiotic coexistence with the natural environment.

#### 5) Use of Land

On reflection that our previous development activities in pursuit of economic efficiency often resulted in devastation of our ecosystems, we strive to provide prime living environments for all people through the better use of land and superior

design techniques while also embracing ecological conservation. Furthermore, we promote new research and design activities to create buildings and cities that are hospitable, pleasant, and safe from disaster.

6) Health

Based on our experience that inadequacies in pre-development assessment of environmental impact have led to the change and degradation of our environs, we endeavor to undertake research on the desirable status and methodologies for environmental conservation in relation to human living conditions. In addition, in order to protect our health and the earth's ecology from contamination and deterioration, we propose and disseminate architectural measures, regional planning, and design techniques that enable us to alleviate damage caused by water, air, and soil contamination.

7) International Cooperation

As global environmental issues exactly involve the entire human endeavors on global scale, worldwide collaboration is essential. Through the exchange of information with other nations and organizations, we encourage reciprocal utilization of all experiences and achievements and promote further international cooperation toward our goal.

### **13. APPENDIX 3 : AIJ PRESIDENT'S STATEMENT ON THE MEASURES TO THE GLOBAL WARMING**

The research by AIJ members indicates that carbon dioxide emission by building activities including manufacturing and transporting building components and operating buildings occupy about 40% of national total emission in Japan. It means that building activities in Japan reaches almost 1% of global total emission. In addition, the emission by building activities in Japan is apparently increasing. The constrain of carbon dioxide emission by Japanese building activity is quite significant from global aspect.

AIJ established the Global Environment research committee in 1990. The committee implemented and encouraged various research activities in order to identify the correlation between building and the global environment. The achievements of these researches are published as reports for public attention.

AIJ held the symposium titled as 'AIJ action plan and the global environment' at the annual conference in September 1997. The it organizes eight hours continuous brain storming titles as 'The responsibility and role of building people for the global environment' in October 1997.

At the opportunity of COP3 conference in Kyoto, AIJ decided to initiate following actions to encourage reduction of carbon dioxide emission from buildings.

1. AIJ has the following understanding in terms of reduction of carbon dioxide emission.

A. 30% reduction of life cycle carbon dioxide emission (LCCO<sub>2</sub>) is feasible for newly build buildings if the recommended measures by AIJ members are installed into design/construction/operation program. It is quite significant to the recommended measures should be the comprehensive paradigm to all activities relating to construction.

Simulation by AIJ members shows that 5 % reduction of carbon dioxide emission from all building activities would be realized only if 30% reduction from all new constructed buildings and 15% reduction from all refurbished buildings are realized for coming ten years.

The other research by AIJ members proves that 30% reduction of whole life cycle carbon dioxide emission from newly constructed office buildings is technologically feasible. Though certain methodology for reduction is not established in terms of other usage of buildings, 30% reduction appears to be feasible by integrating socio-economical measures.

B. For reduction of carbon dioxide emission, three times of extension of building life is definitely required. The extension is feasible.

The field survey implemented by AIJ member shows that medium of RC structural office building is 38 years and steel structural is 29 years. The medium of the life of wooden structural houses is 40 years. The figure in USA is around 100 years. Eventually, carbon dioxide emissions for constructing building occupy about 40% of whole life cycle carbon dioxide emission.

The extension the life up to the level in European and North American country gives great effect for reduction of carbon dioxide emission.

The technological requirements to realize the extension of building life are; structural safety for maximum scaled earthquake possibly occurred in every 100 years and durability of structural materials against acid rain. Moreover, the paradigm change is required in socio economical system and custom such as; the strategy of construction investment, the regulation of possession and utilization of building asset, maturity of second hand building market and adaptability of building. Theoretically it is not so difficult.

2. AIJ starts following action in order to propose basic measures for reduction of carbon dioxide emission within one year.

3. AIJ will establish interdisciplinary task force to make the proposal.