SIXTH INTERNATIONAL MEETING ON TITANIUM

MARKETING OF TITANIUM

FOR

ARCHITECTURE APPLICATION

IN JAPAN

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CONTENTS

1. Brief history

Titanium was first used in Japan in 1973 as a building material for the small roof of ($50m^2$) a Japanese Shinto shrine located at the sea coast.
Subsequently after that, titanium was used for roofs and door plates of small buildings, including the citizen's constitution of Chigasaki City, roofs of Shinto shrines and their arch ways and because its use was on a very small scale and the number of projects was also small. architects' interest, at that time, was minimal.

However, since 1984 when titanium was used for the dome roof of the Electric Power Museum. a new modern building completed in the center of Tokyo. and owned by the Tokyo Electric Power Company. Inc. (TEPCO) , it has been attracting the attention of people engaged in architecture.

It was almost at the same time that the Application Development Committee and the Building Materials Group, a sub-committee of ADC, were organized that a decision to use titanium for the doom roof of the TEPCO Museum, was made.
This decision, however, was made solely by a progressive architect, Mr. Koichi Takahashi, and this was the first case where an architect decided to use titanium for part of a modern building.

After the ADC was organized, the committee looked for an activity to promote.
The Stainless Steel Association of Japan which had many successful results from their activities to develop new applications of stainless steel was consulted. Reference was made to the remarkable growth in demand for stainless steel in indoor piping and roofing applications, and we chose indoor piping application, putting roofing aside for the time being.

In fact. none of the group members expected that the application of titanium to roofs would be realized so soon, even before indoor piping application.

The result was completely contrary to our expectation. I suppose most of you still question the merit of using such expensive material as titanium in architecture. We shared the same feeling in Japan until recently. We did not realize that a change in the potential needs of a new age had evolved.

Using the case of the TEPCO Museum, we have begun to pay due attention to architecture applications and to approach architects who have been looking for new materials. There are high grade metallic materials such as copper, aluminum and stainless steel but architects have been looking for much higher grade materials to substitute the conventional ones which they have been using for many years.

According to our old common sense, titanium appears to be too expensive and too luxurious for architecture application. However, no higher grade metallic material other than titanium, which surpasses the conventional materials, could be found. So naturally architects have begun to show great interest in titanium.

However, no manufacturer or distributor had tried to approach architects recommending titanium as a building material. It was not easy for an architect who wanted to study about titanium, to find out who they should contact, and even if someone had been found, he could not be a good person to consult because generally speaking, most of the people engaged in the titanium business did not have sufficient knowledge about architecture.

Such being the situation, the architect who was interested in titanium was inconvenienced without knowing who he should consult and without the necessary data or information around him. Namely, the opportunity to inter-change the seeds of titanium and the potential needs of architects was non-existent. Thanks to the TEPCO Museum and Mr. Koichi Takahashi, the important and hidden channel was connected and a new titanium market for architecture application was born.

2. Shipment and uses of titanium for architecture application

As shown in Table 1, shipments of titanium for architectural application from 1973 through 1989 total close to 350 metric tons, about 90% of which was delivered in the last three years from 1987 to 1989. You will find not only an increase in the volume of titanium used but also an increase in the number of projects as well. Many people, such as progressive architects and rich properties owners, general contractors, and sub-contractors as well as distributors engaged in the architecture business are now showing more interest in titanium and consequently, enquiries are increasing. Judging from these facts and the current movement, it is presumed that a new market for titanium is beginning to grow in Japan although the current demand of about 100 metric tons per year is still small.

Fig. 1 shows the breakdown of the total shipments of titanium for architecture application from 1973 through 1989. About 67% is for roofing and about 20% is for curtain walls, both of which cover about 87% and the balance of about 13% is for miscellaneous uses such as monuments, towers, boards, gutters and sashes. Above all, most of the cases are for exterior components.

Fig. 2 shows shipments of different roofing materials in Japan in 1989. Total shipment is about 238 million square meters. The major share is covered by clay tiles (about 48%) and slate tiles (about 22%) and metal covers only 30%. Fig. 3 shows shipments of different metallic roofing materials which cover only about 30% of the total roofing materials. Coated steels cover a big majority of 89% and the balance of only 11% is shared by copper (7%), stainless steel (4%) and aluminum. Titanium is now trying to enter into this small area.

3. Characteristics of different roofing materials and their historical transitions

Thatchet	heat/noise insulation is good but inferior in fire proof
Tile	water/fire proofing is good but inferior in heavy weight and shock resistance
Metal	light weight, water proof, workability and formability are good and incombustible, but inferior in heat/noise insulation

Copper	since 1640
Coated steel	since 1955
Aluminium	since 1965
Stainless steel	since 1974
Titanium	since 1984 (TEPCO Museum)

4. Properties required for roofing materials and characteristics of titanium in comparison with other materials

Table 2 shows the properties required for roofing materials and the relative merits of different materials. Sales points of titanium are as follows:

4-1. Superiority over other materials in the area of corrosion resistance

4-2. Easy to transport and easy to lift up to high places because of its lightness

4-3. Thinner sheets could be used because of its durability

4-4. Considerably less deformation and less stress concentration at the junction because of its low coefficient of thermal expansion

4-5. Availability of many beautiful and assorted coloration by anodyzing

4-6. Economical on an overall cost basis if maintenance cost is considered

4-7. Good affinity, good compatibility and good harmony with natural environment because of its soft, warm, delicate, noble and chic surface appearance

4-8. Possibility of being maintenance-free

5. Important Marketing Target

5-1. Project or object

--large scale high grade luxurious memorial public building such as:

- religious building
- acquarium
- museum
- gymnasium
- prefectural government building
- city hall
- club house of golf course

5-2. Area

- water front (salt spray atmosphere)
- hot and highly humid area
- hot springs resort (hydrogen sulfide atmosphere)
- city center
- industrial area (air polluted atmosphere)

5-3. Customers

- big project planning department of governmental or public organization
- rich property owners
- young and new progressive architects
- general contractors and sub-contractors
- building component fabricators
- distributors

5-4. Timing and key point

- to get titanium specified in building components and additional budget allocated for titanium at the time of concept designing or basic designing

6. Some current issues regarding marketing of "titanium for architecture application --- penetration of right image of titanium ---

Until very recently, use of titanium in the building industry was virtually unknown. The metal's traditional image as an expensive and hard-to-work with material is a major obstacle to its acceptance as a reasonable alternate to other metals.

6-1. Cost competitiveness of titanium

With respect to its price, titanium materials do cost approximately ten times more than copper, aluminum and stainless steel if the unit cost per weight is compared. But a well researched design can reduce this price differential to less than two times that of these other metals when titanium is made into fabricated or finished components. For example. by making the best use of titanium's unique qualities, such as its lightness and high strength. you can reduce the difference in material costs by more than half if a thinner wall is specified. thereby making titanium a top-rated and yet highly competitive material.

Although the initial cost of the finished component is still expensive, it does not affect the total cost of the completed building in which the cost differential becomes almost negligible.
In assessing the overall costs, titanium's long-term low maintenance requirements and its proven durability present tremendous advantages even at its current price level.

In recent years, in order to meet increasing consumer demands for high quality luxurious materials and products, many architects have been actively seeking new metals and alloys to replace the conventional ones such as copper, aluminum and stainless steel. It has, therefore, become imperative that the image of titanium as an expensive and impractical metal be dispelled as soon as possible. This mistaken impression needs to be replaced with the correct view of titanium as a practical, economical, yet a high-quality building material, second to aluminum and stainless steel. Simultaneously, people involved in all aspects of the construction industry need to be familiarized with this accurate view of titanium, a view more in line with its true practical value.

6-2. Workability in metalworking and fabrication

Titanium is not as easy to work with as copper and aluminum. However, compared with stainless steel, it presents no significant problems with cutting, shearing, drawing, bending, forming, machining and other general working provided the characteristics of titanium, such as spring back, gauling and galvanic corrosion are taken into account.

(Welding)

As to welding operation, TIG and MIG welding must be conducted in Argon gas atmosphere, but seam and spot welding popularly used in roofing of stainless steel can be adopted as it is. In addition, titanium presents no risk in its corrosion resistance or the deterioration of the mechanical properties of the weld as is the case with stainless steel. Furthermore, titanium's weldability and low thermal expansion coefficient provide a distinct advantage in building application.

(Enlightenment of workers)

What is most necessary at the present time is a concerted effort to make up-to-date information about titanium known and available to general contractors, sub-contractors, and component fabricators. Namely, that it is not an especially difficult material to handle. That it is a relatively easy material to deal with once its properties have been properly understood and taken into account. To this end, the preparation of guide books and manuals outlining in a simple manner the precautions that must be kept in mind when handling titanium should be done immediately.

6-3. Development of application technique

One matter that awaits further attention is the development of more refined techniques for using titanium as a building material. Up to now a variety of techniques have been developed for adopting titanium for industrial use, but methods for using titanium in building material application have begun to be developed only recently.

Although it is necessary that these techniques, such as simple jointing other than welding, be further developed, it is equally vital that titanium's attractive appearance and decorative features be enhanced.
In addition to durability and economy, these features will naturally be required if titanium is to evolve into a truly high-quality building material at the beginning of the next century.

Titanium lags for behind stainless steel on this point. It is particularly important that techniques such as those required for surface finishing be further developed soon so that titanium may achieve a reputation as a high-quality metal, capable of meeting needs which conventional materials cannot.

Technical problems of titanium as a building material which should be investigated are as follow:

- technology to improve surface properties (uneven brightness)
- technology to improve flatness (in raw material as well as in finished roofs and panels for waveless surface)
- technology to improve the difference of color appearance between the lots of coil sheets.

- technology to develop uniform coloration in complicated profile components (including simple profile products)
- surface treating technology that provides fast snow releasing capability
- surface treating technology that does not show stains
- simple and easy cleaning technology if stained
- technology to form massive surface appearance in thin sheets
- technology to develop black, white, brown, amber and red colors

7. Future challenges

As I mentioned earlier, a remarkable progress in the practical application of titanium has been made in recent years. This progress can be directly attributed to on-going efforts of the members of the Japan Titanium Society. Further development of practical applications of titanium building materials will be the result of perseverance and cooperation of the member companies. This will allow us to take maximum advantage of the Japanese government's recent new policy to expand the domestic demand by spending 430 trillion yen for public investment in ten years. This big investment will provide many opportunities for new titanium applications in various development projects, especially in waterfront areas. It is also a very important matter in Japan to pay due attention to create a beautiful environment in promoting development projects in big cities, small towns and in rural areas as well, where titanium can play an important role as a new building material which can meet the needs of a new age.

In order to create a demand for titanium in large-scale megaoprojects, a campaign for the promotion of titanium must be inaugurated to promote the idea of titanium as a versatile and practical material for architectural design. The concept that titanium can be a new paradigm to the construction industry needs to be reinforced with reference to its obvious advantages. Themes such as, "Titanium for the Waterfront", or "Titanium: The Durable, High-quality Metal of the 21st Century" need to be publicized.

This should now be the focus of the titanium industry's efforts. We need to work diligently if this metal's potential as a building and construction material is to be realized. On the basis of our success so for we have good reason to believe that titanium has a bright future. However, continuous effort is needed to ensure that titanium becomes, in the coming century the metal most frequently used in building materials next to aluminum and stainless steel.

We are convinced that it is not unrealistic that at least 10% or several thousand metric tons of building materials normally made with copper, aluminum and stainless steel can be replaced with titanium in the beginning of the 21st century.

The idea of using titanium as a building material has not yet been adopted in the United States and in Europe, although this situation is expected to change in the future. The market situation outside Japan may be very different from that of Japan but I hope that you learned something from us which you can apply to your marketing activity, and hopefully, the application of titanium as a building material will grow on a world-wide basis.
Your kind comments or suggestions will be deeply appreciated.

Thank you for your kind attention.

	roof		curtain wall		others		total	
	no. of cases	MTS	no. of cases	MTS	no. of cases	MTS	no. of cases	MTS
1973~ 1980	5	2	—	—	9	10	14	12
1984	1	2	—	—	1	—	2	2
1985	6	4	4	1	8	1	18	6
1986	5	6	1	7	4	1	10	14
1987	11	140	4	11	13	2	28	153
1988	13	40	3	10	28	2	44	52
1989	20	35	5	36	23	33	48	104
total	61	229	17	65	86	49	164	343

Table 1 - Shipments of titanium for architecture application in Japan (1973 to 1989)

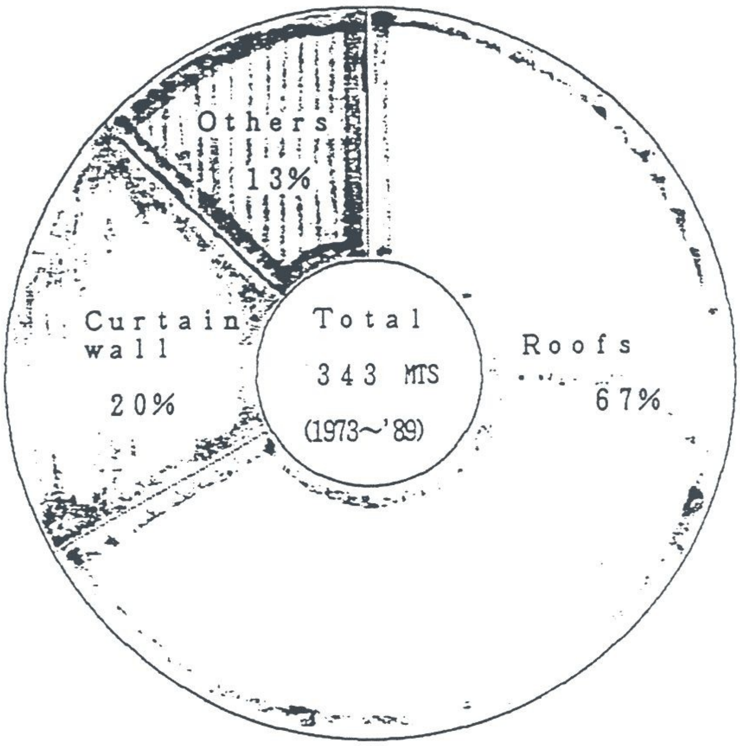

Fig. 1 - Shipments of titanium for architecture application in Japan

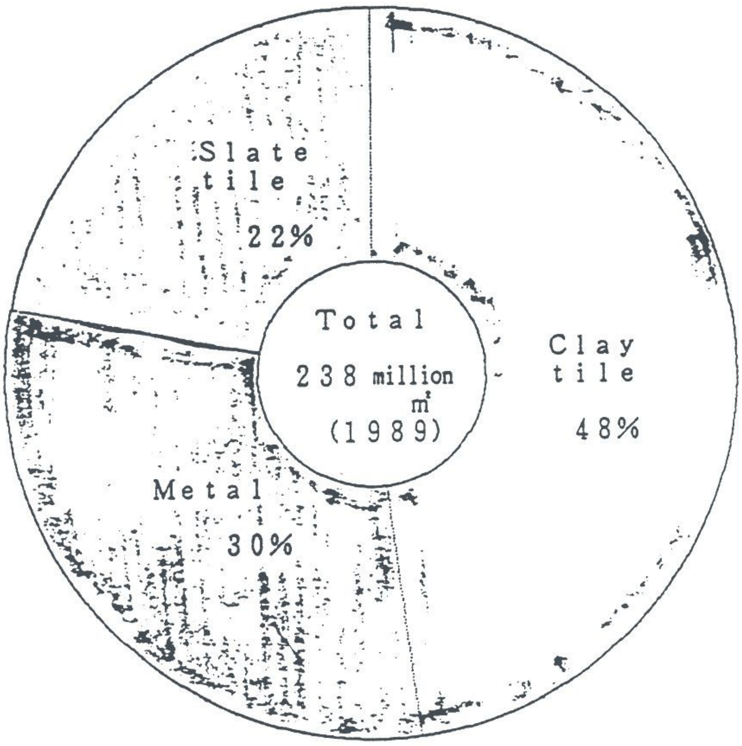

Fig. 2 – Shipments of differential roofing materials in Japan

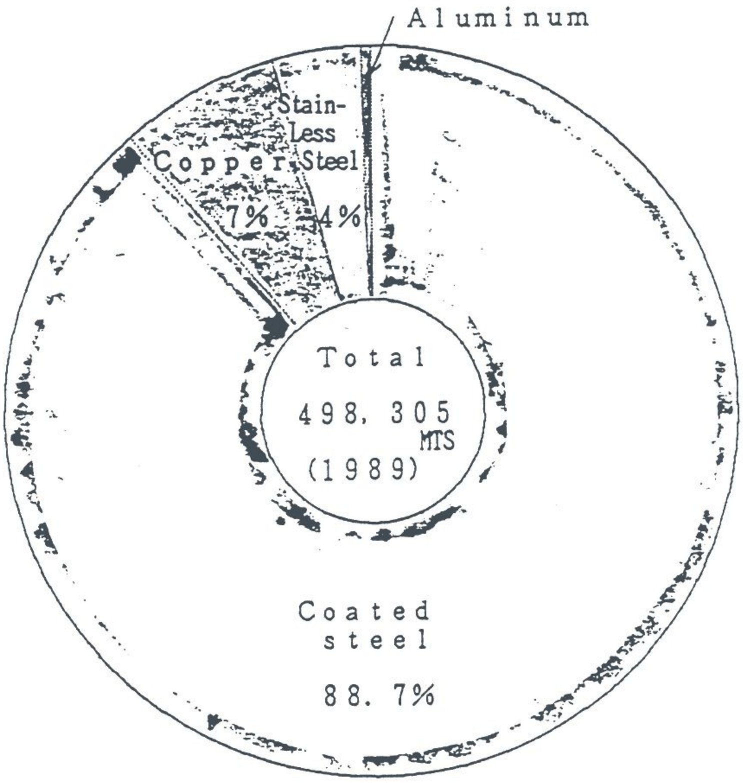

Fig. 3 - Breakdown of shipments of different roofing metals in Japan

Properties \ Material	Coated stainless steel	Precoated galvanized steel	Japanese roof tile	Colored asbestos slate	Copper	Titanium
Water-proof/water tightness	○	○	○	△	○	◎
Thunder proof	◎	◎	△	△	◎	◎
Wind proof	○	○	○	△	○	○
Earthquake proof	◎	○	△	△	○	◎
Heat insulation/antisweating	△	×	◎	○	×	△
Sound insulation	×	×	◎	○	×	×
Fire protection	◎	○	◎	○	○	◎
Dead weight	◎	◎	×	×	◎	◎
Strength	◎	○	△	△	○	◎
Corrosion resistance/weatherability	◎	△	◎	◎	◎	◎
Durability	◎	△	◎	◎	◎	◎
Machinability	○	◎	△	△	◎	○
Workability	○	◎	△	△	◎	○
Design	◎	◎	○	△	◎	◎
Economy	○	◎	△	◎	○	○

◎ Excellent ○ Good △ Fair × Poor

Table 2 – Properties required for roofs and comparison according to materials

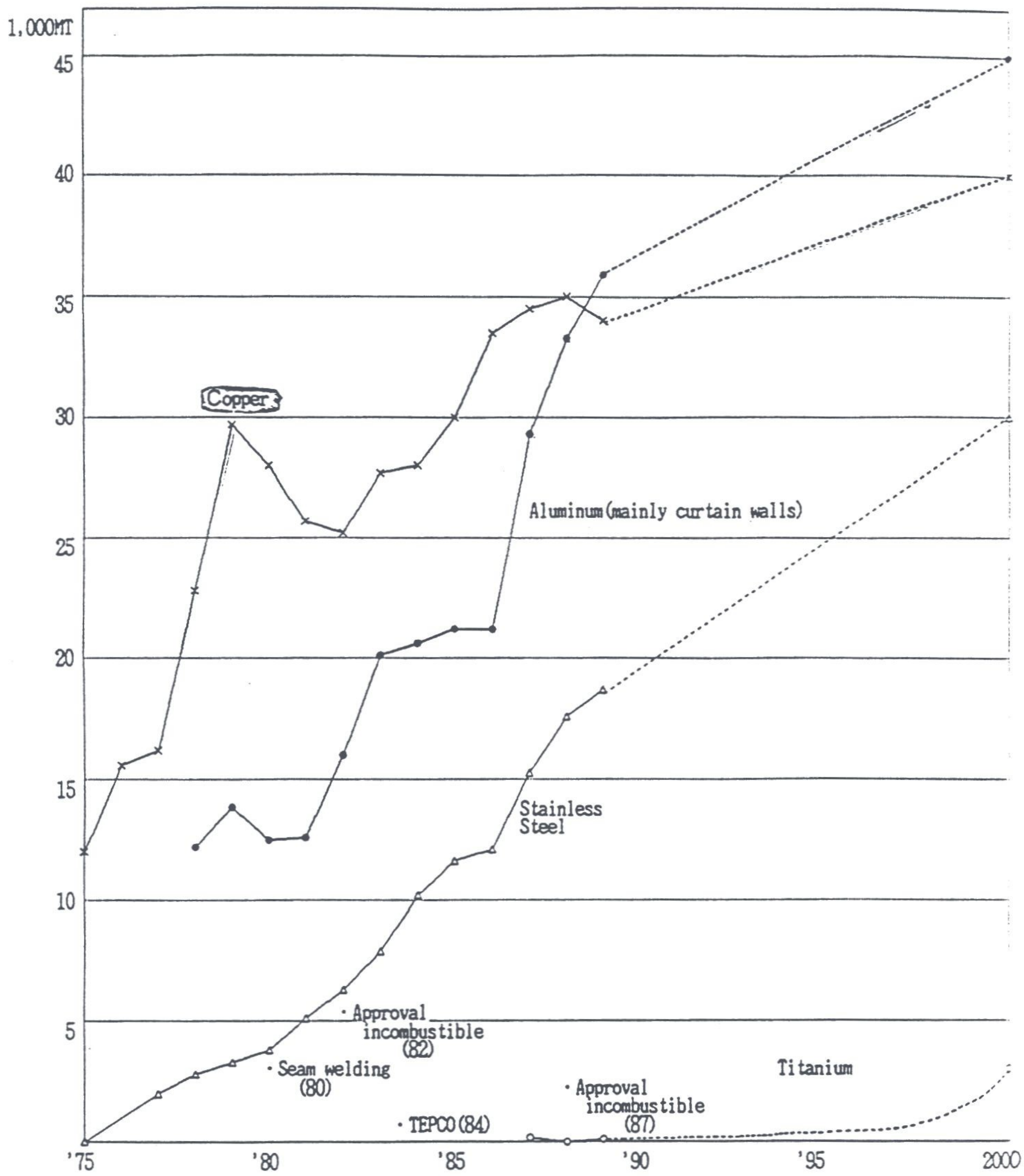

Fig. 4 - Demand of high grade roofing materials in Japan

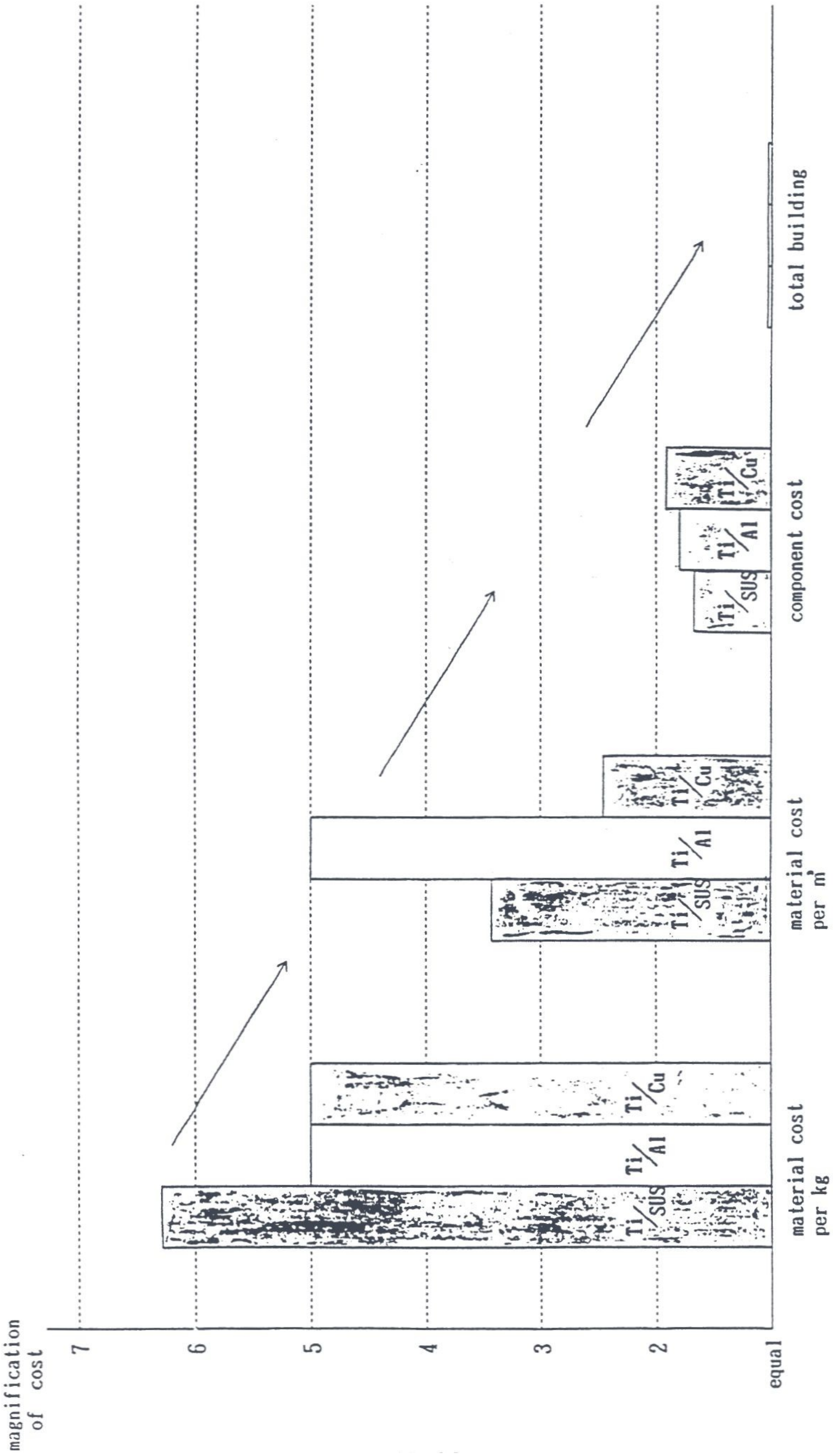

Fig. 5 – Cost differential, Ti to SUS, Ti to Al, Ti to Cu, in material cost per kg, material cost per m^3, Component cost and total building cost