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Energy Conserving Structures

Économie de l'Énergie dans les structures

Energieeinsparende Bauten

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This paper presents energy conservation in construction from the viewpoints of economy and energy consumption subject to uncertain oil supply and price fluctuation.

1. ECONOMICAL ANALYSIS

In general, an economical analysis for public works is supplementally carried out to know the effects of investment on projects in Japan. In the analysis, the Ratio of Cost-Benefit(B/C) is generally estimated by a method in which the investment and the profit during all periods of the project are based on the prices of standard year. However, it is supposed that the rising cost of energy has an effect on the price of all goods used in the construction process, and that said effect differs according to each good's degree of dependency on energy for its production. For example, A and B projects will be investigated. In A, the initial investment is larger than in B. Also, in A, the cost of running and maintenance are smaller than those of B, but other factors are the same for the two projects. Although the project is the same, the feasibility of the project differs according to the pattern of investments and energy goods. From Fig.1, it is clear that:

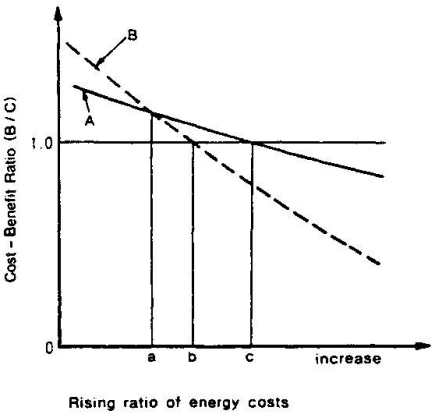

Fig.1 Comparison of the projects with different investments

1) Project A and B are feasible until the rising rate of energy costs at c and b, respectively.
2) Project B is better than A, until the rising of energy costs at a.
3) Project A is better than B, if the energy costs sharply escalate.

When the estimation with energy assumed to be spent on construction is carried out, it is better to estimate the recovering years of initial energy consumption(ne).

$$ne = \frac{Ce}{be - me} \qquad (1)$$

where, Ce:total consumed energy quantity. be:production or conservation of energy quantity. me:running energy consumption.
The Eq(1) shows clearly that in order to raise the efficiency of the project, (ne) has to be made small. For the sake of minimizing (ne), in the Eq (1), (Ce) and (me) should be made small, and (be) should be made larger. This process represents the energy conservation in construction.

2. ENERGY CONSUMPTION IN CONSTRUCTION

The flow of consumption in construction is shown in Fig.2. In the life cycle of a constructional project, the total energy consumption(Et) consists of:

$$Et = E1 + E2 + E3 - E4 \qquad (2)$$

where, E1:energy quantity consumed in construction. E2:energy quantity consumed in maintenance and service. E3: energy quantity in destruction. E4: energy quantity conserved by recycle of materials.

Now, we can only calculate E1 because data are very scarce about E2,E3 and E4. However, it is quite useful to estimate the conservation of energy for construction projects using only E1 within the limit of subsystem 2 in Fig.2.

For example, the energy consumption of construction of actual bridges was estimated using 52 bridges, and is shown in Fig.3. In Fig.3, the relation between energy consumption and span in bridge structure is shown by means of the liters of oil converted into energy consumption per bridge area in square meters. From other data, it is demonstrated that the concrete bridges and tanks use less energy in comparison to the steel and concrete ones. The following is clear:

1) There are considerable differences in energy consumption due to selection of structural system and material used, in the same construction project with the same profits.

2) It is very important to decide and check the method of conserving energy for the project, during the stage of planning and design, as well as doing an economical check of the project.

However, there is a serious problem in that energy conservation in Japan is not presently economically feasible.

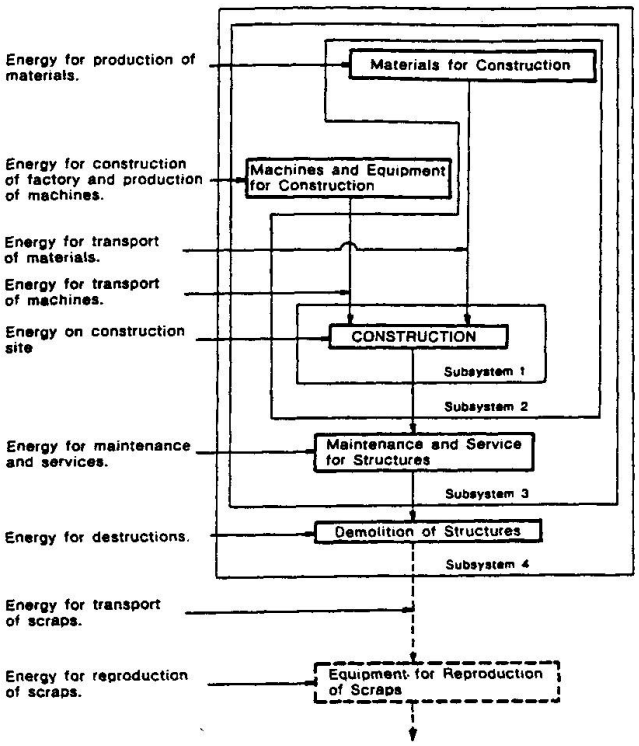

Fig.2 Flow chart of energy consumption in construction

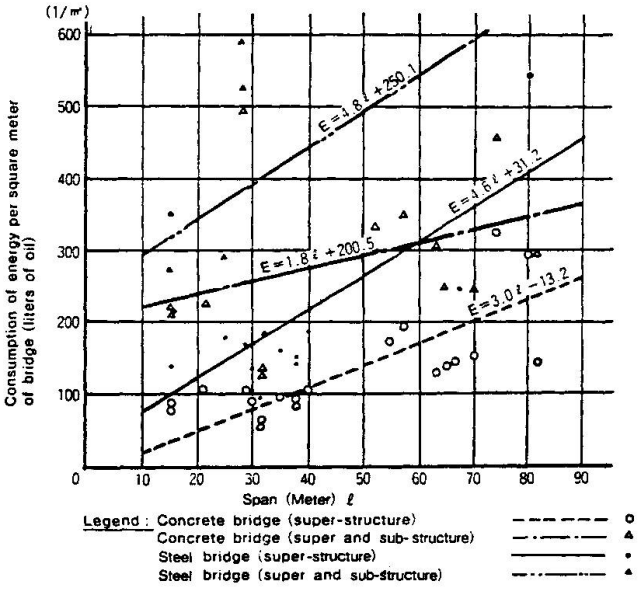

Fig.3 Relation between energy consumption and span in bridge structure.

3. CONCLUSIONS

There are many means of conserving energy in various branches of construction, thus it is important to collect data on the means of conserving energy. Constructional projects must be treated as a total system, and then greater energy conservation may be expected in the future.