In summary and facing the possible solutions for a civil engineering firm:

a) DP department
b) end-users having access to microcomputers loosely connected
c) end-users using terminals of a central machine

we believe the latter to provide the best balance between the desired situation of giving the responsibility of the applications to the end-users, but at the same time being able to have centralized views over all the information and keeping it related, under control and without unnecessary redundancy.

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Modular Co-ordination and the Design Process
A Review of the Documentary Bases

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KEYWORDS

Component building, dimensional/modular co-ordination, tolerances.

ABSTRACT

The publication in 1984 of Report No. 68 of CIB, The Principles of Modular Co-ordination in Building, followed a detailed review of the original Condensed Principles (CIB W24/IMG 1967) and provides a consensus statement of the concept up-dated and expanded in the light of recent research and experience of implementation.

From time to time, it had been suggested that Modular Co-ordination lacked a coherent system of tolerances and an effective approach to the question of joints and junctions.

This paper outlines the background to the development of a general approach to building fit and tolerances within both CIB and ISO and also illustrates how a methodology for joints and junctions is defined within the existing agreed conventions linking theory and practice consistently.

The paper will also show how there now exists in terms of present documentation from CIB and ISO the necessary and sufficient basis for effective co-ordination of building dimensions at both the theoretical level and at the level of techniques of application.

Co-ordination Modulaire et Conception
Une Revue des Bases Documentaires

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MOTS-CLÉS

Construction par composants, co-ordination dimensionnelle/modulaire, tolérances.

RÉSUMÉ

La publication en 1984 du rapport No. 68 du CIB, Les Principes de la Co-ordination Modulaire dans le Bâtiment, à la suite d'une revue détaillée de la publication originale - Principes Condensés - représente une déclaration unanime sur le concept, mis au jour et élargi à la lumière des recherches récentes et de l'expérience de l'application.

On avait suggéré, de temps en temps, qu'un système cohérent de tolérances et une méthode effective pour aborder les problèmes des joints et des jonctions manquaient à la co-ordination modulaire.

Cette communication 1. trace les grandes lignes du développement d'une méthode générale pour aborder soit la mise en place en counstruction soit les tolérances, au sein du CIB et ISO et 2. montre comment une méthodologie pour joints et jonctions est definie dans le cadre des conventions existantes qui d'une manière cohérente lieent la théorie à la pratique.

La communication démontre aussi qu'il existe actuellement dans la documentation du CIB et ISO la base nécessaire et suffisante pour la co-ordination effective des deminsions de construction à la fois au niveau théorique et au niveau des techniques d'application.

"International harmonisation of building standards and modular co-ordination are necessary from the point of view of open markets of building components and the development of international trade in materials and components." In this quotation from the published proceedings of an ECE Seminar on Modern Building Technologies held in Warsaw during October 1985, Working Commission 24 of CIB, the International Modular Group (CIB W24/IMG) finds acknowledgement of many years of patient and consistent endeavour to provide the theoretical basis and practical methodologies for an open system of component building. At the same time, it has to be admitted that many remain not so much unconvinced of the effectiveness of the techniques of co-ordinated building dimensions as unpersuaded that there exists the "necessary and sufficient" body of standards and other documentation to provide a sound basis for achievement of a sensible level of international agreement on building dimensions and component sizing.

In 1984, CIB W24/IMG published Report No. 68 - The Principles of Dimensional Co-ordination in Building. This was not a revision of the so-called "Condensed Principles" (1967/1968) but rather a development and expansion of those principles in the light of some fifteen years experience of implementation and research. It was intended that the new document should "reflect the impact of practice on principle and act as a guide for further development". In this respect, CIB W24/IMG was mindful of the advice of D Khazanov, a founder member of the group, who said in his contribution to the 5th CIB Congress in 1971, "the stability of the principles adopted at the international level is of great significance and it seems that our task is not to revise the 'basic principles'.....but to develop, supplement and improve them without changing their essence".

Report No. 68, in drawing upon the contributions over a fifteen year period of such as the United Kingdom, France, the Netherlands, Switzerland, Germany, USSR and Japan as well as the publications of the International Organisation for Standardisation (ISO), provides a conspectus of the most up-to-date information on modular co-ordination. In outlining its objective, the report proposes;

> "a practical and coherent method for the co-ordination of position and dimension of elements, components and spaces in building design".

It further proceeds to outline the means of achievement which, in summary, comprise;

- application of the internationally agreed 100 mm module
- development of an agreed terminology
- exposition of the set of concepts which together constitute the principles of modular co-ordination, and
- agreement on a set of conventions to facilitate practical application.

In reviewing the progress of research and application for the purpose of this report, CIB W24/IMG drew specifically on work in the Netherlands, in particular that of Sticting Architekten Research, which proposed the use of modular co-ordination as, "a means of communication and as a tool to notate design decisions". Arising from this view, the priorities of POSITION and

DIMENSION, in that order, become a convention of the methodology of application. From France, through the publications of Association Construction et Composants (ACC), came a set of conventions which explored the use of two OPTIONS. The first of these associated a modular co-ordinating space and a modular containing space and the second associated a technical co-ordinating space and a modular containing space. In practice, this facilitated the accommodation of non-modular components sensibly in a fully dimensionally co-ordinated design through the identification and use of suitably sized adaptation spaces. The detailed documentation of the United Kingdom provided a simple approach to the sizing of components where assembly conditions at junctions demand an increment or decrement of dimension of a relevant modular co-ordinating space. In the area of tolerances and building fit, CIB Report No. 68 draws upon recent work within CIB and ISO which, in turn, built upon the early seminal work of such as Janicki (Poland), Ciribini and Maggi (Italy), Sefton Jenkins (U.K.) and Heinecke (Germany). In the text, a methodology is outlined which is in broad agreement with the terms of ISO/DIS 3443/3 - Tolerances for Building - Calculation of Joint Clearance and Prediction of Fit and provides a practicable approach to consensus in the matter of component work sizing.

Close co-operation between CIB W24/IMG and Sub-Committee 1 of ISO Technical Committee 59 (ISO/TC 59/SC 1) Building Construction has, over the years, ensured a consistency in terms of the interplay between research and standards development. Just as the original Condensed Principles (1967/1968) informed the development of ISO Standard 2848-1974, Modular Co-ordination - Principles and Rules, it is confidently expected that in similar manner, CIB Report No. 68 - The Principles of Modular Co-ordination in Building, 1984, will provide the basis for a detailed review of the output of ISO/TC 59/SC 1. Working Commission 24/IMG shares a common membership with ISO/TC 59/SC 1 and is indeed well represented on other relevant CIB Working Commissions such as W49 - Tolerances, W60 - Performance Concept in Building as well as the counterpart Sub-Committees within ISO, SC 4 - Limits and Fits in Building Construction and SC 3 - Functional/User Requirements and Performance in Building Construction. These inter-relationships have enabled the new CIB publication to call up, where appropriate, ISO documentation as the standard reference for such as;

Terminology

- ISO 1791-1973 - Modular Co-ordination, Vocabulary
- ISO 1803-1973 - Tolerances for Building, Vocabulary, and
- ISO 2444-1974 - Joints in Building, Vocabulary.

Similarly, in the case of;

Joints

- ISO 2445-1972 - Joints in Building, Fundamental Principles for Design, and
- ISO 3447-1975 - Joints in Building, General Checklist of Joint Functions.

And again in;

Tolerances

- ISO 4463-1979 - Measurement Methods for Building - Setting Out and Measurement - Permissible Measuring Deviations
- ISO 3443/1-1979 - Tolerances for Building - Part 1 : Basic Principles for Evaluation and Specification, and
- ISO 3443/2-1979 - Tolerances for Building - Part 2 : Statistical Basis for Predicting Fit Between Components having a Normal Distribution of Sizes.

In addition to the publications of ISO, CIB Report No. 68 makes reference to three important CIB Reports. These are;

- CIB Report No. 36 - Geometry of Joints (2nd Revised Edition)
- CIB Report No. 28 - A Checklist for Tolerances, and
- CIB Report No. 67 - Dimensional Tolerances, General Guidelines for Building Practice.

Geometry of joints provides a practical overview of this characteristic in facilitating correct component assembly. Crucial matters such as Field of Application, Key Joints, Order of Placing and Ease of Change and Repair are discussed in the context of an open system of catalogue components. The Checklist for Tolerances sets out a useful set of guidelines as to where and when to consider tolerance specification and observation in design, construction and manufacture. Report No. 67 - Dimensional Tolerances - is also directed to designers, builders and manufacturers and sets out to increase awareness among those groups of the relationship between functional requirements (tolerances) and practical realisation (inaccuracy). The point is well made that mere specification of tolerance without a defined procedure for effective control on site or in the works makes for difficulties when building with components.

Apart from the ISO Standards referred to in CIB Report No. 68, the current ISO catalogue lists some twenty four standards dealing, in the main, with modular co-ordination but also covering the related subjects of Tolerances, Joints and Performance. Among the more recent publications, the following could be seen as filling a number of long standing lacunae in the published literature of modular co-ordination;

- ISO 6511-1982 - Modular Co-ordination, Modular Floor Plane for Vertical Dimensions
- ISO 6512-1982 - Modular Co-ordination, Storey Heights and Room Heights
- ISO 6513-1982 - Modular Co-ordination, Series of Preferred Multi-Modular Sizes for Horizontal Dimensions
- ISO 6514-1982 - Modular Co-ordination, Sub-Modular Increments.

Taken together with the ISO Technical Reports published in 1984;

- No. 8389 - Building Construction - Modular Co-ordination - System of Preferred Numbers Defining Multi-Modular Sizes, and
- No. 8390 - Building Construction - Modular Co-ordination - Application of Horizontal Multi-Modules

this documentation provides a comprehensive and coherent compendium of modular co-ordination in the nineteen eighties. Allowing for the fact that publication was spread over a period of ten years with a large number of disparate inputs, an impressive consistency informs the whole which does effectively provide the necessary and sufficient basis for the international harmonisation of building and component dimensions.

Within CIB W24/IMG, work is currently in hand which will see published a practice handbook or manual which will demonstrate the application of the principles outlined in CIB Report No. 68 and the ISO Standards. It is planned to illustrate the manual with a number of case studies of different national approaches. Modular co-ordination as expressed in a set of rules may be applied with a varying degree of rigour depending upon the particular circumstances. Examined against a formalised design methodology or plan of work, its capacity to "fit" the design demands of a process, which for convenience can be described in stages, is clearly evident. In Figure 1 is shown a schematic representation of such a situation indicating how effectively the references can be matched to the information demand of specific work stages moving from broad generalisations of outline proposals through scheme design, detail design and production information. In circumstances where procurement demands an alternative model of organisational form linking design and production more closely, clearly the technique of modular co-ordination is both comprehensive enough and flexible enough for adaptation. The co-ordination of design dimensions sets a groundwork for the assessment of performance compatibility. Based as it is on CIB/ISO documentation, which represents a broad consensus, it constitutes a positive result of a committed effort to harmonise the standards and codes upon which an international trade in components and materials may be developed.

CIB W24/IMG is currently embarked upon a work programme which, in addition to the practice manual previously mentioned, includes studies of;

- The Technology of Junctions, and
- Modular Co-ordination and the Design Process - Computer Applications.

The appropriateness of the techniques of modular co-ordination to a computer aided design process and to computer aided manufacture have been demonstrated in working documentation of CIB W24/IMG. The potential to develop a coherent and consistent component/materials data base in dimensional terms and the facility to assess existing product ranges against agreed conventions for practical application is a challenging but feasible objective for contemporary building technology.

Among the objectives and scope of the Group is mentioned that of providing "informed guidance for the development of standards and building industry policy internationally". In developing pre-standardisation material and through participation in the working groups of the International Organisation for Standardisation, CIB W24/IMG has discharged that responsibility and will continue to do so by reviewing and up-dating published material and by expanding its research endeavour.

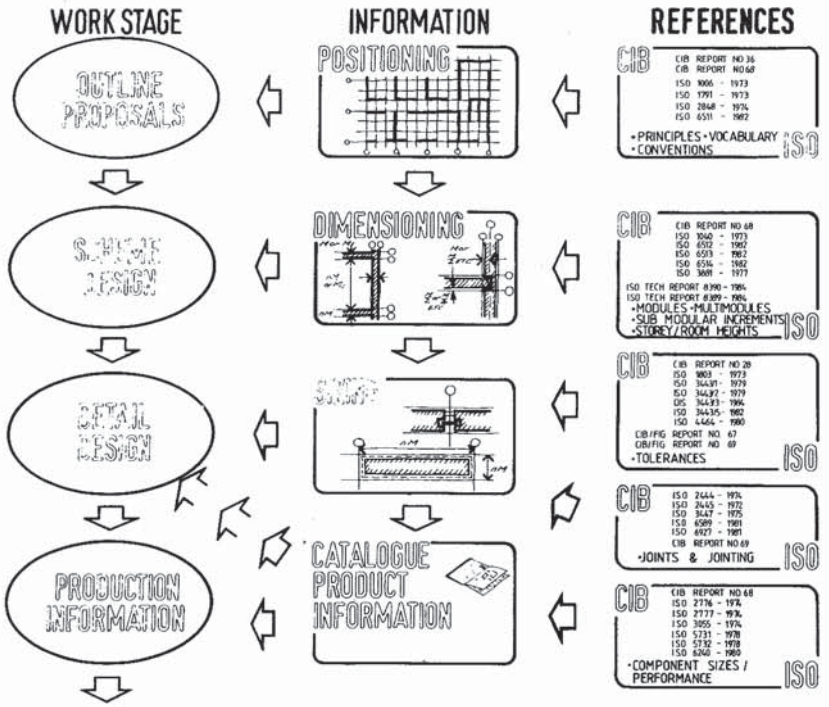

FIG. 1 CIB/ISO REFERENCES AND THE DESIGN PROCESS