INTRODUCTION

The broad introduction to the theme that is developed in this Doctoral thesis is set out in Chapter 1. However, it is considered appropriate to define some matters of a general character more closely in order to contribute to the formation of a rapid initial idea concerning the conception, orientation and content of this academic work.

Structurally the subject lies within the line of research of sustainable development, and in particular it interprets and proposes the application of the sustainability principles in the building construction sector. The objective is to bring forward operative criteria of this new paradigm for design and construction engineers working in industry, academia and government alike. As well as diffusing the concept in order to warn the wider public of the adverse impacts brought about by the construction sector.

The selection of the theme is justified by arguing that the construction and functioning of buildings are the causes of serious adverse impacts in today’s world. Consideration is not taken of the underlying reasons, as, for example, the case of pollution arising from cars and factories, although paradoxically the problems brought about by buildings can be solved more easily than the aforementioned vehicular contamination.

The focus and extent of the work are inscribed in the most frequently cited and well-known definition of sustainable development, contained within the report dating from 1987 by the World Commission on Environment and Development (WCED) to the General Assembly of the United Nations, the so called Brundtland Report. This report contains a profound conceptualization of sustainability,
establishing that human life could continue indefinitely on the planet if it were to sustain three fundamental dimensions: that people can progress (economic dimension), that cultures can develop (social dimension), but the effects of these activities must observe limits in order not to destroy the diversity and life systems (ecological dimension).

The foregoing reasoning explained in the cited text of sustainable development is...“ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs”. This philosophy of development has an ethical intergenerational content, in the sense of future generations having the right to at least the same quality of life as that enjoyed by today’s generations.

The detailed breakdown of this concept gave way to the proposals of action tending towards sustainable development, through the establishment of the obligations of the world's nations in the 21st Century, which were drawn together in the United Nations publication Agenda 21. This is the source document in which this thesis is based, from which its content is interpreted in order to propose the sustainability principles to be applied in the whole life cycle of buildings, which will be further explained in due course.

It is pertinent to comment that before the persistence of the debate concerning the concept of sustainable development, it is more easily understood and less controversial to use just one term. Once the difference is established with this dual expression, in the body of the thesis the noun sustainability and its adjective sustainable are used more frequently.

The anthropocentric essence of sustainability is not unknown in this case, however from the perspective of Construction Engineering the priority to be faced as soon as possible is the challenge represented by the antimony between economic development (which is the important component of the construction sector) and environmental deterioration (of which it is also responsible to a large
degree). That's why giving greater attention to the other species with which the planet is shared require different methodological treatments to those set out here.

In the Engineering field, a number of proposals and projects which seek to apply the concept of Sustainability are known (CIB W82, 1998; MIYATAKE, 1996; SUSTAINABLE SEATTLE, 1998; and others). These can be interpreted as a formula of technical progress that begins to contribute to the equity, to gain time and to provide information on the moderation in the use and handling of materials and resources. Reference is made to equity because with sustainable proposals of these works, finite and scarce resources tend to be shared, at least with the most immediate generations. Time is gained by lengthening the existence of the reserves of natural resources and the capacity of the landfills, while one learns to resolve the substitution in a meditated and rational form. For its part, the anticipated moderation in the use of natural resources would be, together with other types of measures, a consequence of the consciousness raising inculcated in the population at large.

To place in context, the response from the building construction sector to sustainability must include, at least, the rational use of resources and energy efficiency, the consideration of environmental impacts, the minimization of residues, and the creation of healthy and comfortable environments.

For the treatment of these broad proposals, this work sets out from a conceptual exposition which contributes to form an awakening over the meaning of sustainability and subsequently through the use of the technical procedures that are more well known to Engineers. An applicability approach to the principles of sustainability in construction is sought, which implies embracing an extensive thematic space. This has suggested the convenience of grouping the different stuffs obtained in the investigation stage in five articulated parts, with the objective of inductively approaching from the general theoretical field to the specific pragmatic field of building construction.
The first of these five parts, entitled **Theoretical and Conceptual Framework**, is the axis upon which the thesis is developed, since it is in this ambit that the orientation of the work, the objectives and the conceptual bases of sustainability are established.

Moving on to another part, it is of note that neither the breadth and intensity of the Brundtland Report, nor the details of Agenda 21 which extend to offering the estimation of budgets, offer any methodological guidelines in order to put the principles of sustainability into practise. Therefore it was resolved to investigate and put forward a space of information with a sustainable implication of an engineering responsibility, in order to understand firstly the confluence of the technical aspects and of sustainability, and as a consequence bring forward ideas, studies and technical solutions with the incorporation of the mentioned principles. To this bridge of communication between scientific and conceptual aspects of the much cited theme, what is explained in the second part, called **Techniques and Tools for Supporting Sustainability** and comprises the technical-environmental foundations of the principal items used in construction (Matter and Energy), as well as management methods and tools to help sustainability principles to be operative.

It is in these types of supports that the transition or approach to **Sustainable Construction** is based, set out in the third part, through the incorporation of the notion of sustainability in the planning, architectural and structural design, selection of materials, construction per se, building operation, demolition and reuse of building materials.

The fourth part, **Towards Sustainability Measuring** leads the initiatives for the qualitative and quantitative valuation of sustainability in real cases of the construction sector. Sustainability indicators are developed in a specific region (Northwest of Mexico), as well as the economic-environmental assessment of a type of detached residential building project set in the same region.
The generality of this wide panorama of themes that are addressed is summarised in the fifth part, which is called *Compendium of the Approach to Sustainability Principles for the Construction Sector*, precisely in order to make the allusion to the stock of information, references, conclusions, recommendations and commentaries which can be of use to further research work on the theme in question.

The core themes addressed in this thesis cover construction design and procedures, environmental management techniques and methods, regional development and the sustainability philosophy itself. In view of the breadth involved it is not considered that it warrants going into greater depth to demonstrate the interrelation between the said themes, the objectives set out and the essence of the thesis.

The theme of sustainability is an emerging and evolving concept. Therefore some of the information presented is neither definitive nor conclusive. Nevertheless it provides a conceptual and operative guide of sustainability, which coincides with the objectives of the content of this doctoral work, which are intended to be of a disseminating and awakening character. In contrast, the aforementioned breadth of the themes addressed, (ranging from the origin and unfinished semantic debate of sustainable development, the methods of support which still require research, to the putting in practice of sustainability principles) will enable the research and development of subsequent projects starting out from the results of the thesis.

It is also important to stress that this academic work has been written in Spanish, the way is spoken in Mexico, resulting from the author’s origins. Similarly it should be noted that some of the examples, proposals and ideas mentioned depend upon the experience, knowledge, idiosyncrasies and needs of the Latin American countries.
With respect to the format used, as previously mentioned the thesis is structured in various *parts*, according to the themes that are developed. These *parts* comprise *chapters*, which are in turn divided into sections and Finally, where necessary, subdivisions are made in order to include details that facilitate the corresponding documentation or explanation.

The Harvard bibliographical and information referencing system is used, with certain modifications for convenience. For example the last piece of information given refers to the place of publication, rather than placing this in the penultimate location, and the titles of books are not underlined, amongst other minor adaptations. Where the information source is the *Internet*, the exact date (year, month and day) of the consultation is stated and where it is provided, the updating reference is stated as well.

Finally, it is worth noting that in the conclusions of the Brundtland Report it was recognised that the path towards sustainability would not be easy and nor would it be devoid of obstacles. Rather hard decisions would have to be taken, requiring strong support in the political will of governments and in the consciousness-raising of different strata of the population. In the same way the elaboration of operative projects in the theme of sustainability is no straightforward task. That is they are not ready to be implemented in the same way as with other more conventional projects. This signifies therefore, that what has to be faced is a challenge of enormous dimensions.