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Elastic-plastic continua containing unstable elements obeying normality and convexity relations[1]

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Abstract

A one-, two-, or three-dimensional continuum is supposed to be composed of stable and unstable elements in the conventional structural sense or on the microscale. The initial and each of the subsequent yield surfaces for each element of a structure, or each point in a continuum, are taken as convex in a generalized or actual stress space. The increments or rates of generalized or actual plastic strain are taken as normal to the current yield surface. Initial and subsequent yield surfaces in load space for the entire body are seen to be convex and the vectors representing the corresponding permanent displacement increments or rates are normal to these surfaces, when the elastic response is unaltered by the deformation or remains linear. The character of the elastic and plastic response up to the point of overall instability is described. Conditions for stability and uniqueness of response are given.

Introduction

With few exceptions, the general theorems of elasticity and of plasticity have been developed for stable structures or continua composed of stable elements or materials [1] [2]. Geometric instability or buckling theorems have been written for the elastic range but little is known of a very general nature about inelastic instability.

Local instability does not necessarily cause overall collapse in a redundant structure, whether elastic or plastic. Path dependence in the plastic range makes analysis very difficult, however, and may obscure the essential features of the response to loading [3].

Corresponding difficulties arise when buckling or geometric change is of no consequence but regions of material strain-soften or exhibit a decrease of yield strength with temperature rise due to external or internal sources of heat. If the geometry changes of buckling do not have to be taken into account in the equations of equilibrium of the structure, as in the usual analysis of a pin-connected truss loaded at the panel points [4], the behavior of unstable elements of a structure can be treated in parallel with the behavior of unstable regions of material in a general continuum.

Unstable Structural Elements or Materials Obeying Normality and Convexity

Unstable behavior of the simple type is exhibited by the plastic buckling of a hinged-end column or the necking of a tensile specimen; the magnitude of the load decreases as the deformation increases. The generalization to more complex elastic-plastic elements or to materials is sketched in Fig. 1. The current yield surface in a generalized stress space S_i, or in an actual stress space σ_{ij} moves inward or shrinks, at the current yield point Y, as the plastic strain proceeds. For a very small increment of strain $\delta\varepsilon_{ij}$, the dot product $\delta\sigma_{ij}\delta\varepsilon_{ij}$ is negative instead of positive as for a stable material.

More subtle types of instability can occur which do not involve a shrinking yield surface. The combination of the Tresca yield criterion and the Mises flow rule provides such an example [5]. Such a possibility will be ruled out in this paper by supposing that the yield surface for each element is convex and that the plastic strain increment $\delta\varepsilon_{ij}^P$ associated with the infinitesimal stress increment $\delta\sigma_{ij}$ is in the direction of the outward pointing normal at the yield stress σ_{ij}^Y, Fig. 1. An otherwise stable material may be made unstable in a coupled thermo-mechanical system by the shrinking of the yield surface with a rise in temperature at the point or in the structural element [6].

The basis for a normality and convexity assumption for an unstable material or element will be discussed elsewhere [7]. All one-dimensional problems of trusses, beams, and frames with one component of generalized stress and associated generalized strain or strain rate automatically fall into this class. Limits on bar force or beam

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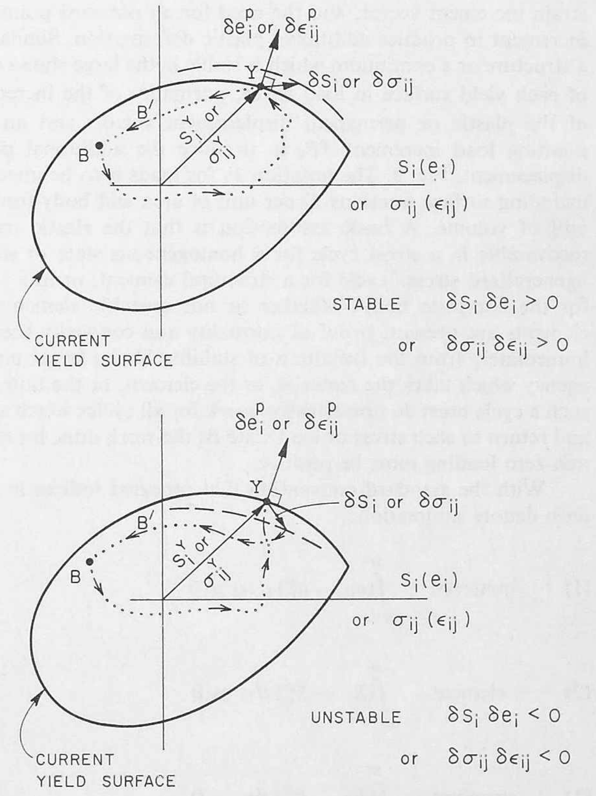

Fig. 1. Stability and instability

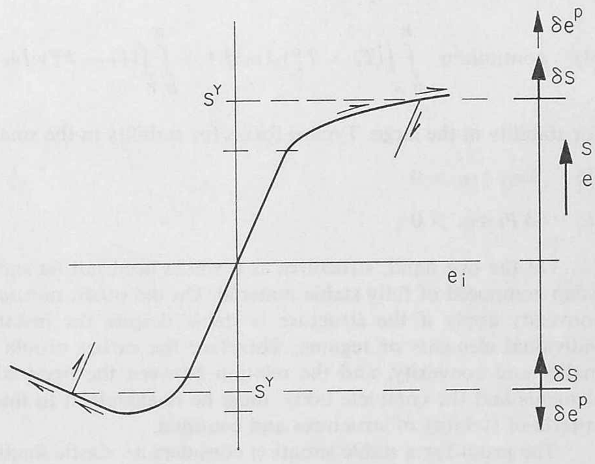

Fig. 2. One-dimensional example of normality and convexity (stable in tension, unstable in compression). Note that S^Y in tension and S^Y in compression are independent points on different yield surfaces

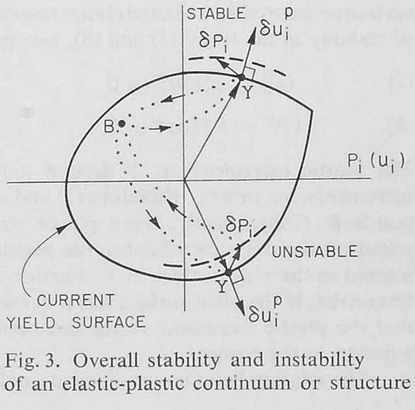

Fig. 3. Overall stability and instability of an elastic-plastic continuum or structure

moment provide the simplest form of convexity, Fig. 2, with normality of the total as well as the plastic strain assured by one-dimensionality. This class of structures has been discussed in Reference 4.

Yield Surfaces for Structures and Continua

An element or a material which is stable in the large exhibits convexity of each yield surface in stress space, normality of the plastic strain increment vector, and the need for an outward pointing stress increment to produce additional plastic deformation. Similarly [1] [8] a structure or a continuum which is stable in the large shows convexity of each yield surface in load space, normality of the increment δu_i^P of the plastic or permanent displacement vector, and an outward pointing load increment δP_i to produce the additional permanent displacement, Fig. 3. The notation P_i for loads is to be interpreted as including surface tractions T_i per unit of area and body forces F_i per unit of volume. A basic assumption is that the elastic response is recoverable in a stress cycle for a homogeneous state of stress, in a «generalized stress» cycle for a structural element, or in a load cycle for the complete body. Whether or not unstable elements or subelements are present, proof of normality and convexity then follows immediately from the definition of stability in the large: an external agency which takes the material, or the element, or the body through such a cycle must do non-negative work for all cycles which start from and return to each stress or load state B; the work done for any added non-zero loading must be positive.

With the standard convention that repeated indices in the same term denote summation:

(1) material $$\int_B^B (\sigma_{ij} - \sigma_{ij}^B)\, d\,\varepsilon_{ij} \geqslant 0$$

(2) element $$\int_B^B (S_i - S_i^B)\, de_i \geqslant 0$$

(3) structure $$\int_B^B (P_i - P_i^B)\, du_i \geqslant 0$$

(4) continuum $$\int_B^B \int_A (T_i - T_i^B)\, d\,u_i\, dA + \int_B^B \int_V (F_i - F_i^B)\, du_i\, d\,V \geqslant 0$$

for stability in the large. Typical forms for stability in the small are

(5) $$\delta\,\sigma_{ij}\,\delta\,\varepsilon_{ij} > 0$$

(6) $$\delta\,P_i\,\delta\,u_i > 0$$

On the one hand, structures as a whole need not be stable even when composed of fully stable material. On the other, normality and convexity apply if the structure is stable despite the instability of individual elements or regions. Therefore the earlier proofs of normality and convexity, and the relation between the material or the elements and the complete body, must be re-examined to find useful criteria of stability of structures and continua.

The proof for a stable situation considers an elastic loading path from any point B inside the current yield surface to a point Y on the surface, Figs. 1 and 3. Next, an increment of load is applied which causes plastic deformation. Finally, the load or stress point is returned to B along an elastic path. Plastic strains or permanent deformations are produced only during the excursion beyond the current yield surface because of the assumed elastic reversibility. Typical requirements of stability in the large, (1) and (3), become

(7) $$(\sigma_{ij}^Y - \sigma_{ij}^B)\,\delta\varepsilon_{ij}^P \geqslant 0$$

(8) $$(P_i^Y - P_i^B)\,\delta u_i^P \geqslant 0$$

The plastic increments at Y depend only upon the stress or load increments $\delta\sigma_{ij}$ or δP_i. Therefore (7) and (8) must hold for all interior points B. Consequently, when plastic strain coordinates are superposed on the stress coordinates, the plastic increment vector must be normal to the yield surface at Y. Furthermore, the yield surface must be convex. If the yield surface has a corner at Y, «normality» means that the plastic increment vector lies between the normals to points adjacent to the corner.

The relation between the elements and the complete body is given by the equation of virtual work. A typical form for a continuous displacement field is

(9) $$\int_B^B (P_i - P_i^B)\, d\,u_i = \int_B^{B'} \int_V (\sigma_{ij} - \sigma_{ij}^B)\, d\varepsilon_{ij}\, dV$$

where the B' indicates that the stress state need not return to σ_{ij}^B when the loading cycle is completed, unless the structure is statically determinate or no plastic deformation has occurred.

When the material is stable at each point of the volume V, the contribution to the volume integral on the right hand side of (9) is everywhere zero or positive. Therefore, the left hand side of (9) must be non-negative. Comparison with (3) shows that stability of material guarantees stability of the body. This is too really strong a result. It ignores geometric instability which was ruled out implicitly in (9) because, in the equation of virtual work, equilibrium is satisfied in fixed geometric configuration. Geometric instability lies beyond our interest here; it is material or element instability which is of concern, an instability whose physical cause may lie in geometric changes of the element or substructure but which does not alter the equations of equilibrium of the problem.

When an element of a structure or the material at a point of a body deforms plastically in an unstable manner, the stress path from the starting point B to the yield point Y of Fig. 1 cannot go beyond Y. Instead the path must turn inward as the plastic deformation proceeds and then go by an elastic path to B' as the load cycle is completed. Very small plastic deformations only need be considered, so that except in rather special circumstances which can be ignored here, plastic deformation will occur only in the neighborhood of Y on the stress path BYB'.

The assumption that the elastic response is recoverable permits a unique decomposition of the increment of strain $d\varepsilon_{ij}$ into an elastic and a plastic or permanent component

(10) $$d\,\varepsilon_{ij} = d\,\varepsilon_{ij}^e + d\,\varepsilon_{ij}^p$$

The right hand side of (9) may be written as

(11) $$\int_B^{B'} (\sigma_{ij} - \sigma_{ij}^B)\, d\,\varepsilon_{ij}^e + \int_B^{B'} (\sigma_{ij} - \sigma_{ij}^B)\, d\,\varepsilon_{ij}^p$$

per unit of volume. The integral over the elastic strain path is positive for all stable elastic behavior whether linear or non-linear. In a linear elastic material it represents the elastic strain energy of the stress field $\sigma_{ij}^{B'} - \sigma_{ij}^B$, not the difference in strain energy between B' and B which may be either positive or negative.

When the elastic response is fully recoverable, the integral over the plastic strain path is zero except in the immediate neighborhood of Y where a plastic strain increment $\delta\varepsilon_{ij}^p$ occurs accompanied by a stress increment $\delta\sigma_{ij}$. An approximate expression for the integral, which is very good when $\delta\varepsilon_{ij}^p$ is extremely small, is

(12) $$(\sigma_{ij}^Y - \sigma_{ij}^B)\,\delta\,\varepsilon_{ij}^p + \frac{1}{2}\,\delta\,\sigma_{ij}\,\delta\,\varepsilon_{ij}^p$$

The assumption of normality and convexity despite the material or element instability makes the first order term positive when B is inside the yield surface and non-negative when on the yield surface. Therefore, although the second order term is negative for unstable materials or elements, the first order contribution to the integrand of (9) is non-negative at each point of a continuum or for each element of a structure. Consequently the left hand side of (9) also must be non-negative to first order and positive when plastic deformation occurs for at least one starting point B *inside* the yield surface.

Comparison with (3) shows that if the structure is stable, all that has been achieved is a development which is consistent. An increment of load beyond yield is required for permanent deformation of a stable body. The left hand side of (9) must be positive. If elastic deformation is recoverable, normality and convexity in load space follow. The details of the computation procedure are irrelevant. What has been shown is that the assumption of normality and convexity for unstable materials and elements provides the picture in load space which one would expect.

The crucial test comes in the limiting case when the entire structure or body is unstable at P_i^Y. Once more the right hand side of (9) contains positive first order terms and some negative second order terms. The left hand side now also will have a negative second order term, $\frac{1}{2}\,\delta P_i\,\delta u_i^P$ (approx). However, when $\delta u_i^P \neq 0$, the first order term $(P_i^Y - P_i^B)\,\delta u_i^P$ is positive for all P_i^B within the yield surface. Therefore the yield surface in load space must be convex, and if it is smooth at Y the plastic increment vector δu_i^P must be normal to the surface there; if it is singular at Y, the plastic increment vector must be normal in the generalized sense.

An Alternative Derivation of Convexity

Convexity of the yield surface for a structure or continuum follows directly from the convexity of the elemental yield surfaces when the elastic response is linear. As shown by Hodge [9], the linear combination of two sets of loads on or inside the yield surface for the body gives a corresponding linear combination of the two states of stress, A and B.

$$P_i = \beta\,P_i^A + (1-\beta)\,P_i^B \qquad 0 \leqslant \beta \leqslant 1 \qquad \sigma_{ij} = \beta\,\sigma_{ij}^A + (1-\beta)\,\sigma_{ij}^B \tag{13}$$

Convexity of the elemental yield surfaces requires σ_{ij} to be at or below yield everywhere including states A and B (13). Therefore P_i is on or inside the yield surface for the body and so the yield surface is convex by definition.

Linearity is the essential ingredient of this proof. The more elaborate treatment of the earlier Sections is needed for non-linear elastic response which is recovered fully in a load cycle. However, it should be recognized that non-linear elastic response in real materials or structural elements is almost certain to change with plastic deformation [7]. An obvious exception is a statically determinate element for which (13) applies as does Hodge's proof of convexity.

Criteria of Overall Stability and Uniqueness

If overall geometric instability is ruled out, stability of material or element everywhere, $\delta\sigma_{ij}\delta\varepsilon_{ij} > 0$ or $\delta S_i \delta e_i > 0$, guarantees stability of the body. Therefore if all regions or elements which can become unstable when they enter the plastic range have not left the elastic range, the body is stable. If some or all of these regions do go plastic, the stabilizing influence of the rest of the body still may be sufficient to maintain overall stability. A quantitative assessment of this situation in terms of criteria of stability requires a more formal treatment.

The actual path of loading P_i^t and displacement u_i^t followed by a quasi-static time-independent system is stable if, [8], at each stage of loading

$$\delta P_i^t\,\delta u_i^t > 0 \tag{14}$$

and the reponse δu_i^t is unique. If the system is not to alter its configuration or path of deformation spontaneously, any external agency which is permitted to perturb the loading by δP_i^* must expend energy to cause the response to deviate by δu_i^* from u_i^t at fixed P_i^t, u_i^t or from $u_i^t + \delta u_i^t$ when P_i^t and u_i^t are changing. Stability as usually understood requires

$$\delta P_i^*\,\delta u_i^* > 0 \tag{15}$$

for *all* permissible load and corresponding displacement deviations δP_i^*, δu_i^*. Permissible means here that the boundary conditions on displacement are not altered and that equilibrium, compatibility, and the stress-strain relations are satisfied throughout. (15) includes (14) because the actual state is a permissible state.

In the absence of discontinuous displacements, and of the effect of geometry changes on the equations of equilibrium of the structure or continuum,

$$\delta P_i^*\,\delta u_i^* = \int_V \delta\sigma_{ij}^*\,\delta\varepsilon_{ij}^*\,dV \tag{16}$$

where again the asterisks denote permissible deviations from the actual state. Within these restrictions and the explicit assumption for each state of the material that $\delta\varepsilon_{ij}$ determines $\delta\sigma_{ij}$ or at least $\delta\sigma_{ij}\delta\varepsilon_{ij}$,

$$\int_V \delta\sigma_{ij}^*\,\delta\varepsilon_{ij}^*\,dV > 0 \quad \text{at} \quad \sigma_{ij}^t,\ \varepsilon_{ij}^t \tag{17}$$

for all sets of permissible deviations $\delta\varepsilon_{ij}^* \neq 0$ is both necessary and sufficient for overall stability at P_i^t, u_i^t.

It is difficult to take advantage of the weakness of the stability requirement (17) in elastic-plastic problems of any complexity. The complete path of loading must be followed step by step to establish the existing state. All permissible deviations then must be examined to determine whether or not the positive contributions of the stable regions to the integral are large enough to overbalance the negative contributions of the unstable domains. However, in principle, this can be done and it is quite feasible for simple problems of pin-connected trusses, bending, or torsion.

When the problems are more complicated, the incremental solutions $\delta\sigma_{ij}^*$, $\delta\varepsilon_{ij}^*$ at each existing state σ_{ij}^t, ε_{ij}^t cannot be found without tremendous effort. Instead, the $\delta\varepsilon_{ij}^*$ can be replaced by the more inclusive set of kinematically admissible strain increments $\delta\varepsilon_{ij}^k$ which are derivable from *any* set of displacement increments satisfying the boundary conditions on displacement. The corresponding stress increments $\delta\sigma_{ij}^k$ consistent with the stress-strain relations will not in general satisfy equilibrium without added body forces. However

$$\int_V \delta\sigma_{ij}^k\,\delta\varepsilon_{ij}^k\,dV > 0 \quad \text{at} \quad \sigma_{ij},\ \varepsilon_{ij}^t \tag{18}$$

for *all* $\delta\varepsilon_{ij}^k$ is a sufficient condition for stability because it includes (17). All sets of $\delta\varepsilon_{ij}^k$ must be examined so that (18) also may not be easy to use, unless the kinematics of the problem are especially simple, but this is a problem encountered in almost all stability calculations.

A sufficient condition can be written which does not require the path of loading to be followed and so ignores the existing state.

$$\int_V \delta\sigma_{ij}^m\,\delta\varepsilon_{ij}^k\,dV > 0 \qquad \text{for } all \ \ \delta\varepsilon_{ij}^k \tag{19}$$

where again $\delta\varepsilon_{ij}^k$ is kinematically admissible. The symbol $\delta\sigma_{ij}^m\,\delta\varepsilon_{ij}^k$ represents the algebraically least possible value of $\delta\sigma_{ij}^k\,\delta\varepsilon_{ij}^k$ at the point in the material for the chosen $\delta\varepsilon_{ij}^k$. It is the smallest positive or largest negative value which can be computed from $\delta\varepsilon_{ij}^k$ with any choice of σ_{ij}, ε_{ij}. Of course, a sufficient condition such as (19), which ignores the existing state, can be helpful only if the body is, in fact, stable at all loads. It has real advantages over (18) when only a small domain can become unstable, but is useless if every region becomes unstable in the plastic range.

The problem of uniqueness of solution, given the existing state and δP_i^t, is the same as the problem of stability of the path of displacement, u_i^t to $u_i^t + \delta u_i^t$. If two non-identical sets of continuous displacement increments δu_i^{tA} and δu_i^{tB} with strain increments $\delta\varepsilon_{ij}^{tA}$ and $\delta\varepsilon_{ij}^{tB}$ could accompany δP_i^t, in the sense that all equations and boundary conditions would be satisfied, the equation of virtual work for the difference between states A and B would give

$$0 = \int_V (\delta\sigma_{ij}^{tA} - \delta\sigma_{ij}^{tB})\,(\delta\varepsilon_{ij}^{tA} - \delta\varepsilon_{ij}^{tB})\,dV \tag{20}$$

For the path of deformation to be stable, it is necessary that the increment of force applied by the external agency $(\delta P_i^* - \delta P_i^t)$ does positive work on the change in displacement it produces $(\delta u_i^* - \delta u_i^t)$

$$(\delta P_i^* - \delta P_i^t)\,(\delta u_i^* - \delta u_i^t) = \int_V (\delta\sigma_{ij}^* - \delta\sigma_{ij}^t)\,(\delta\varepsilon_{ij}^* - \delta\varepsilon_{ij}^t)\,dV > 0 \tag{21}$$

for *all* permissible δu_i^* as defined previously; $\delta u_i^* \neq \delta u_i^t$. The criterion (21) of stability under changing u_i^t is quite different in principle from (17) for a given state P_i^t, u_i^t. Instability of path is a lack of uniqueness by definition; two or more solutions exist. Conversely, if (21) is satisfied (20) cannot be satisfied; stability of path requires the two states A and B to be identical. Also if two states A and B were to exist for the same δP_i^t, then (21) would be violated by either $\delta P_i^* = (1+\alpha)\,\delta P_i^t$ or $(1-\alpha)\,\delta P_i^t$ where $\alpha \ll 1$.

If full linearity were to hold in the small, $\delta\varepsilon_{ij}^* - \delta\varepsilon_{ij}^t$ would be just another permissible $\delta\varepsilon_{ij}^*$ and $\delta\sigma_{ij}^* - \delta\sigma_{ij}^t$ would be the corresponding $\delta\sigma_{ij}^*$; (21) would reduce to (17). However at most only a piecewise linearity in the small is found in the plastic range.

The bending of an axially loaded perfectly straight column of work-hardening material at the tangent modulus load [10] provides a good example of lack of uniqueness or of stability of path despite stability of the material of the column and the stability of the straight configuration at constant load. Although change in geometry is involved and is in fact central to the question of buckling, the example is a valid one because a pin-ended column treated as an element of a structure does not introduce significant geometry change into the equations of equilibrium of the structure. Clearly, then, stability at each P_i^t does not guarantee uniqueness or stability of path. Any lack of uniqueness in the response of an element or in the stress-strain relations can be reflected in possible lack of uniqueness of response of the entire body. Planes or corners in the yield surfaces which move with the stress point are especially troublesome in this respect when the material is unstable. However if the surfaces have continuously turning tangents and normality is obeyed, the stress increment $\delta\sigma_{ij}$ or δS_i is uniquely determined by a piecewise linear form in the strain increment $\delta\varepsilon_{ij}$ or δe_i with coefficients which depend upon the existing state when plastic deformation occurs. When geometric instability is ruled out, this piecewise linearity of stable or unstable material permits the writing of a sufficient condition for uniqueness or for the stability of all paths $\delta P_i, \delta u_i$ from P_i^t, u_i^t. The criterion is intermediate between (18) and (19), and follows from (21) in the same way as (18) follows from (16)

$$(22) \qquad \int_V \delta\sigma_{ij}^m \,\delta\varepsilon_{ij}^k \, dV > 0 \quad \text{at} \quad \sigma_{ij}^t, \quad \varepsilon_{ij}^t \quad \text{for } all \quad \delta\varepsilon_{ij}^k$$

where $\delta\varepsilon_{ij}^k$ represents a *difference* between any two kinematically admissible states. Otherwise the notation is the same as before and indicates that (18) is not a sufficient condition for this greater degree of stability; (19) is sufficient, but is much stronger than (22). If (18) is satisfied but (22) is not, the body is stable at the existing state but the *path* to a neighboring state needs not be stable.

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Architektur und menschliche Gemeinschaft

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Auch der *neunte Kongress der UIA* (Union Internationale des Architectes), der 1967 in Prag abgehalten wird, steht unter einem bestimmten Thema. Wir möchten kurz darüber orientieren und bitten, uns entsprechende Arbeiten zur Verfügung zu stellen oder uns das Interesse an den einzelnen Fragen zu bekunden. Der UIA gehören automatisch alle Mitglieder des S.I.A. und des BSA an. Wer gerne den internationalen Kontakt pflegen oder seine Probleme in den grösstmöglichen Diskussionsrahmen stellen möchte, wird zur Mithilfe in den Arbeitsgruppen gerne beigezogen.

Der Kongress von Prag 1967 behandelt das Thema «*Architektur und menschliche Gemeinschaft*» unter fünf Gesichtspunkten: Die Bevölkerungsstruktur, das historische Erbe und die moderne Welt, die Wohngemeinschaft, die Industrie und das Arbeitsklima, der Mensch und die Landschaft. Zwei allgemeine Fragen sollen unter jedem Gesichtspunkt beantwortet werden:

a) Wie veranschlagen Sie die Bedeutung der Architektur und der Planung sowie die Tätigkeit der Architekten in bezug auf die Bildung einer menschlichen Gemeinschaft (milieu humain) in der Theorie und in der Praxis? Worin besteht nach Ihrer Ansicht der Beitrag des Ingenieurs, des Soziologen, des Psychologen, des Hygienikers etc. bei der Erschaffung des menschlichen Lebenskreises?

b) Wie gross sollte Ihrer Ansicht nach der Grad der Festigkeit von Gebäuden, der Ausdehnung von geplanten Gebieten in der Zeit sein, wenn die sich ändernden Bedürfnisse des Menschen und ganzer Gesellschaften berücksichtigt werden?

Zu den einzelnen, oben erwähnten Gesichtspunkten stellten sich folgende Fragen, deren Beantwortung im internationalen Rahmen der UIA äusserst aufschlussreich zu werden verspricht:

Zur Bevölkerungsstruktur:

1. Gibt es in Ihrem Land Konzeptionen der zukünftigen Bevölkerungsentwicklung, der Neugründung von Städten, Agglomerationen, Industriezonen, Wohngebieten oder Erholungsräumen? Wie beurteilen Sie von diesem Gesichtspunkt aus die Bedeutung und die Entwicklung des Verkehrs? Welche Konzeption scheint Ihnen die beste?

2. Welches sind die angemessene städtische Ausdehnung und Struktur vor allem was die sonstige Entwicklung der grossen Städte in den speziellen Bedingungen Ihres Landes oder im allgemeinen betrifft? Wie wird die Zeitersparnis in der Struktur der Städte und ihrer Besiedlung berücksichtigt?

3. Welche Massnahmen scheinen Ihnen zur Bildung der wünschbaren Bevölkerungsstruktur und zur schwierigen Verwirklichung von städtebaulichen und planerischen Projekten im Bereiche der Gesamtwirtschaft und Richtsetzung unbedingt notwendig?

Zu historischem Erbe und moderner Welt:

4. Welche Funktion erfüllen die Monumente oder die historischen Stadtkerne im heutigen Leben Ihres Landes? Welche Auffassung haben Sie über ihr kommendes Schicksal?

5. Welche Methoden und welche Massnahmen werden in Ihrem Land für den Schutz historischer Monumente, Gesamtanlagen und Städte angewandt? In welchem Grade sind sie durchführbar? Welche Rolle spielen die Architekten beim Denkmalschutz?

Zur Wohngemeinschaft:

6. Welche Wohngemeinschaft und welche Wohnform scheint Ihnen den Bedürfnissen kommender Bewohner angemessen? Wie beurteilen Sie die künftige Entwicklung individueller und kollektiver Wohnformen? Wie können sie zur Bildung der Umwelt des zukünftigen Lebens beitragen?

7. Welche planerischen Massnahmen sind vom Standpunkt des individuellen, des familiären und sozialen Lebens aus gesehen wünschbar? Wie begreifen Sie die Organisation des sozialen Lebens: sollen die Wohngebiete zusammengefasst oder dezentralisiert werden, sollen Dienstleistungsbetriebe, Arbeitsstätten und Erholungsgebiete vom Wohnen getrennt werden?

Zu Industrie und Arbeitsklima:

8. Welche neuen Tendenzen erscheinen in Ihrem Land in bezug auf die Terrainwahl und die industrielle Bebauung, vor allem unter dem Gesichtspunkt der Notwendigkeit zur späteren Ausdehnung? Welchen Einfluss hat die Automation von Fabrikationsprozessen auf das Arbeitsklima?

9. Welche Faktoren bestimmen Ihrer Ansicht nach innerhalb und ausserhalb von industriellen Gebäulichkeiten das Entstehen eines befriedigenden Arbeitsklimas? Welche Rolle fällt dem Architekten dabei zu und wie gestaltet sich seine Zusammenarbeit mit den Technikern und andern Spezialisten?

Zu Mensch und Landschaft:

10. Welche Meinung bilden Sie sich über die Entwicklung und zukünftige Bedeutung der Landschaft im fortwährenden Zivilisationsprozess vor allem mit Bezug auf die Landesplanung?

11. Welche Wirkung haben die getroffenen Massnahmen in Ihrem Land zum Schutz und zur Erhaltung der Landschaft und des biologischen Gleichgewichts der Lebensgemeinschaften? Welche Massnahmen wären wünschbar? Welche Rolle fällt den Architekten, Planern und andern Spezialisten bei deren Durchführung zu?

Alle diese Gesichtspunkte und Fragen sollen im Vorfeld des UIA-Kongresses 1967 in Prag in jedem Land diskutiert und beantwortet werden. Ausser den hier zusammengestellten Punkten enthält der Fragebogen einen sehr ausführlichen Kommentar, der wesentlich zur Klärung und Erläuterung beiträgt (französisch). Wir bitten alle Architekten – und vor allem auch die Jungen unter ihnen – sowie alle andern Interessierten um ihre Mitarbeit.

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