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**Seminar I****Health and Safety in Construction**

Prévention des accidents dans la construction

Arbeitssicherheit im Bauwesen

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**SUMMARY**

„Health and Safety“ has proven to be a far greater problem in construction than in any other industry. Accident statistics give some information only, and is merely used for insurance calculations. Unsafe situations occur far more often than we can discover from reported accidents and incidents. Frequency ratios from different countries are not comparable and often unreliable. Risk analysis could be a tool for health and safety management.

**RESUME**

Le thème „Santé et sécurité“ est un problème bien plus important dans la construction que dans les autres branches de l'industrie. Les statistiques d'accidents ne donnent que certaines informations utilisées essentiellement dans des calculs d'assurance. Des situations dangereuses se produisent bien plus souvent qu'il n'est possible de le découvrir à partir de rapports d'accidents et d'incidents. Les fréquences et les valeurs statistiques ne peuvent pas être comparées d'un pays à l'autre et sont souvent sujettes à caution. L'analyse du risque pourrait être un outil intéressant pour la gestion de la santé et la sécurité.

**ZUSAMMENFASSUNG**

Das Thema „Gesundheit und Sicherheit“ ist ein grösseres Problem im Bauwesen als in anderen Industriezweigen. Unfallstatistiken geben nur gewisse Informationen, welche vor allem für Versicherungszwecke gedacht sind. Gefährliche Situationen sind viel häufiger, als es die in den Statistiken erfassten Unfälle und andere Einwirkungen auf die Gesundheit aufzeigen. Die berichteten Häufigkeiten aus verschiedenen Ländern sind nicht vergleichbar und sind oft nicht zuverlässig. Risikoanalysen könnten ein Werkzeug für das Management der Arbeitssicherheit sein.



## HEALTH AND SAFETY IN THE CONSTRUCTION INDUSTRY

### 1. INTRODUCTION

#### 1.1 Tokyo, 1982

In August - September 1982 a workshop was held in Tokyo, organised by the Japanese Group of IABSE and by Working Commission IV "Construction Management", dealing with the subject "Health and Safety in Construction". During a Colloquium and a Symposium, experts of Asia, America and Europe listened, discussed and told about the developments in and the state of art of this subject.

We think it will be good to start this contribution to the introductory report of the coming IABSE-Congress, Vancouver 1984, with the final conclusions of our Japanese workshop:

1. In the Construction Industry we have a big problem in the field of Health and Safety
2. The number of accidents in the Construction Industry is relatively far more higher than in all other industries
3. Accidents come from unsafe situations; the unsafe situations occur much more often than we can read from our accidentratios
4. Accident-ratios and Health-ratios should be related to each other; an equal definition of these ratios in different countries would give a possibility to compare.
5. Looking to these ratio-figures is one thing: far more important is to find a feedback to prevention of accidents.
6. Safety-risk-analysis gives us a tool of management to more safe working conditions
7. Safety-planning and -programming is a necessity for each construction company and for each constructionsite.
8. Safety-measures should start at the sources of possible unsafe actions and circumstances.
9. Safety and Health should be subject for more research and developping programs.
10. Safety is the responsibility of all partners in the construction process.

#### 1.2 Vancouver, 1984

Part of the IABSE-Congress 1984 will be a Symposium dealing with Health and Safety. During this symposium we want to have new contributions to this problem-field and we hope to get more information to give answers to questions which we will prescribe in the following paragraphs of this paper.

### 2. HEALTH AND SAFETY: A BIG PROBLEM

#### 2.1 Accidents during construction

When we read the different safety-reports from various countries, we find the Construction Industry has a high rate of accidents, serious accidents and fatal accidents in comparison to other kind of industries. If we reckon with 'all industries', the Construction Industry has in most countries twice-time more serious (incl. fatal) accidents than we find to the total industry.

And, we have to mention that the published figures of different countries are often not correct: they all speak from 'reported accidents'. What happens in the field of 'not reported accidents' is unknown, and often a fatality after some months of sickness followed on an accident, is not counted as a fatal accident. Also we do not know anything about the figures of 'nearly-accidents'.

So, speaking of 'unsafe situations', we only have some speculations.

#### 2.2 Safe and unsafe situations

Thinking about safety, we state here that there is no safe or unsafe situation in an absolute way. Accident prevention is only possible if we can foresee certain unsafe situations, unsafe working circumstances, unsafe actions of management or of the workers.

Can we weigh in one way or another, the chance of occurrence of certain unsafe working conditions? And if so, will such a situation lead to an accident? Why yes or why no? In what way or to what extent will count our own experiences: in what way are we remembered to unsafe situations, to possible accidents? Can we imagine certain unsafe circumstances? How can we prevent those accidents, which never have happened before?

### 2.3 Backgrounds of accidents

Every accident will have a certain background, an environment in which through certain unsafe circumstances or unsafe acting it may occur.

When we define an accident as: 'a sudden default of an availability, caused by an unattended disturbance of the usual course of events, or of the fixed way of working', we can try to find out why such accidents will happen. The causes can be brought back to: wrong methods, wrong means, wrong actions, poor working climate, poor organization, wrong mentality, poor management.

But, when we speak about those accidents as a sudden default, we forget that through certain unsafe working conditions, our health can be destroyed by poison, radiation, noise, stress, ..... These causes are not sudden actions, but very slow influences which bring damages in our body after several years.

So our problem field is much wider than looking after 'accidents': it includes unsafety in its totality. We see and recognize only the top of the 'ice-berg of unsafety'.

### 2.4 Factors of influence

Each worker on a building site works under certain circumstances which will be regulated by several factors. Some of these factors can be influenced by management; some of them are bound to the worker himself and cannot be directed by management. These latter factors are coming from his own environment, family conditions, social problems, etc. The first mentioned factors come from this special job, on that special site, constructed by this very contracting company.

The worker does his job under all these conditions, and suddenly there is that accident! Why, why now and why did it not happen before or to the other workers?

Under what kind of conditions, on what kind of work, on which site, in what organization, to which workers, come accidents to a realization?

## **3. SAFETY AND COSTS**

### 3.1 Costs of accidents

In some countries a lot of attention is paid to the cost-consequences of accidents. We think it is good to be aware of the costs of accidents, to know how we can invest in prevention measures of those accidents and incidents.

However, we have the impression that cost calculations of accidents are mostly used for insurance-calculations and not for accident prevention in a direct way. In American literature we read about:

- Insurable costs
- and:
- Not insurable costs.

The insurable costs vary in different countries also in different ways, due to different social legislation. The not insurable costs are the other costs which are to be paid by the employers or by the employees.

All costs are losses to the society, which could be prevented when no accidents should occur.

### 3.2 Costs of accidents-prevention

On the other hand we can count the costs of all the prevention measures, and we can imagine that the more prevention measures we take, the lesser accidents will occur.



### 3.3 The safety-costs-line: optimum costs

When we count the costs of safety-measures to the costs of accidents together, we find a curve which gives us the relation between safety and costs (fig. 1).

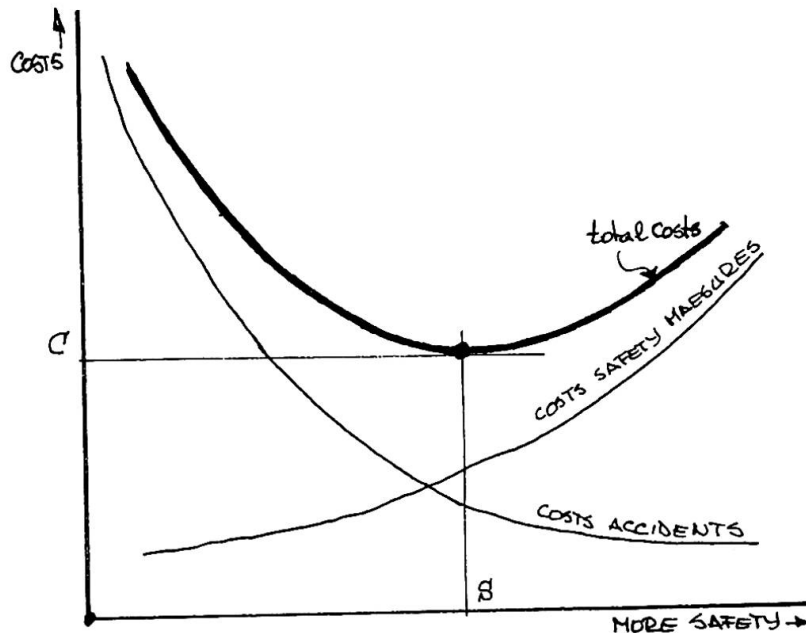


Fig. 1: Safety and Accident Costs

It is clear that we can imagine us one point in this curve in which we can speak about optimum costs. From an economic point of view, this point will bring the biggest profit to the employer.

### 3.4 The safety-costs-line: optimum safety

In Tokyo we discussed also the following question: (fig. 2)

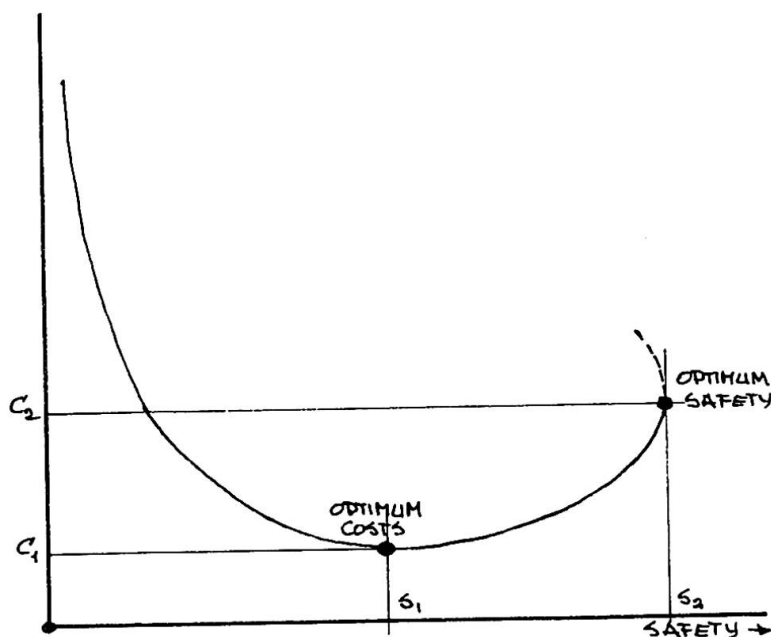


Fig. 2: Minimum Costs or Maximum Safety?

If we put in more safety-measures, it can be that the total costs will rise again, but that we have a safer construction-site. Is there one point where we can speak of optimum safety? And what happens after that? Putting in still more safety-measures, will give relatively more costs, but will it also give us more safety?

Some contractors think that too much safety measures, give us after such a point no more safe, even unsafer working circumstances (fig. 2).

Questions are:

- Do we recognize such statements?
- Have we any research-results on this subject?
- Should we think in terms of maximum-safety or in terms of minimum costs?

### 3.5 Safety-costs line on each construction site

When we think in such a safety-concept, we state that each construction site will have its own safety-costs-curve. The shape of this line will give an impression of the kind of work which will be constructed on that site. Every construction work will have his special problems in the way the work will be done, technical but also in the field of health and safety (fig. 3).

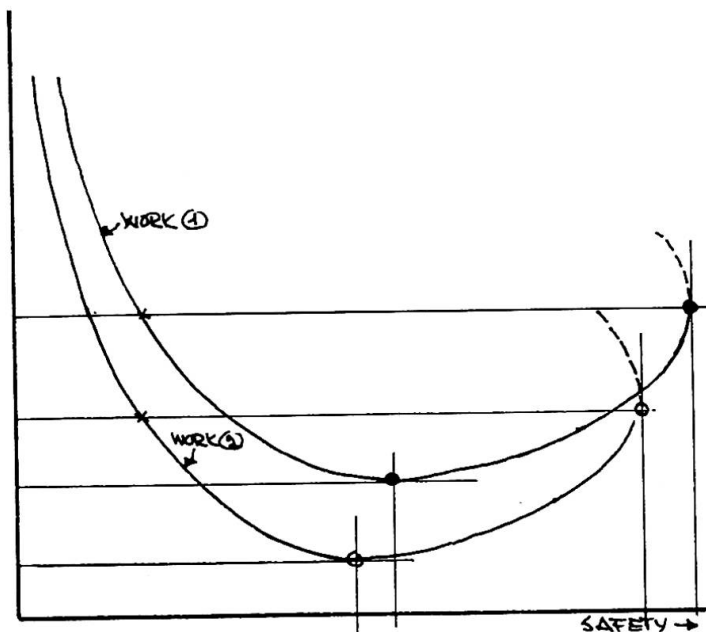


Fig. 3: Every Construction-site has its own safety-conditions

## 4. ACCIDENTS

### 4.1 Ratio, Statistics

In all countries, we try to find statistical data to get an information in this field of health and safety.

We try to think in terms of ratio, as:

- Accident-ratio
- Sickness-ratio.



In all countries these ratios look like each-other, but they all differ in one way or another; it is impossible to compare them. The ratios are calculated along two directions:

- Accident Frequency (AF)
- Accident Heaviness (AH) or: Accident Severity.

To compare Accidents, with Health, it should be good to compare also:

- Sickness Frequency (SF)
- Sickness Heaviness (SH) or: Sickness Severity.

To compare the figures of different countries, we should count these ratios in the same way.

We suggest:

1.  $A.F. = \frac{\text{number of reported accidents}}{\text{number of men years}} \times 100 (= \text{----}\%)$
2.  $A.H. = \frac{\text{number of reported lost days}}{\text{total worker days/year}} \times 100 (= \text{----}\%)$
3.  $S.F. = \frac{\text{number of reported sick-cases}}{\text{number of men years}} \times 100 (= \text{----}\%)$
4.  $S.H. = \frac{\text{number of reported lost days}}{\text{number of worker days/year}} \times 100 (= \text{----}\%)$

When we act also, we can compare different countries if the data brought into the ratio are reliable and counted in the same way.

Therefore some questions are still there:

- What are accidents?
- What are reported accidents?
- When do we count the lost day? In my opinion that must be already the first day of absency and not the 4th or the 8th day! That means: often other data than we use in different countries due to our social securities.
- How are those data 'reported': how many are not 'reported'?
- We count the real days, and not some additional day-figures which depend on the severity of the accident itself: the loss of fingers, hand or eye should be registrated in another way.

If we handle on this way, we come to the following quotation for the Netherlands in round figures in the construction industry (approx.):

$$\begin{aligned}
 \text{HEALTH } S.F. &= \frac{485,000}{350,000} \times 100 = 138.57\% \\
 S.H. &= \frac{9,650,000}{77,000,000} \times 100 = 12.53\% \\
 \text{SAFETY } A.F. &= \frac{18,000}{350,000} \times 100 = 5.14\% \\
 A.H. &= \frac{450,000}{77,000,000} \times 100 = 0.58\%
 \end{aligned}$$

## 4.2 Causes of accidents

We mentioned already the influences from outside: initiated by social -, family -, wheather -, etc. conditions as one of the range of causes of accidents.

A second group of causes is: personal short-comings. To this group we reckon: not knowing, not capable to do the work, not wishing to do such work, wrong mentality, ....

The next group can be mentioned under the title of: unsafe actions, to which belong: unqualified activities, unsafe working place, safety devices put out of order, use of unadeqaute equipment, unsafe loading or unloading, unsafe working conditions, unsafe way of joining elements, unsafe working near -, on - and - with moving equipment, disturbances in the work, not using personal protection.

The following group is brought together under: unsafe situations. With this group we enter the field of management: poor working organization, insufficient protection, unsafe working sites, unsafe use of equipment, unsafe ventilation, vibrations, noise, unsafe clothes, inadequate personal protection, wrong mentality.

## 4.3 Accident-effects

All countries try to give an impression of the effects of accidents to human beings. We shall try to give some output-data from several countries.

### 4.3.1 Japan:

In 1978 there were 118.568 reported injured workers: fig. 4:

injured workers	1978	
	total	+%
civil work	45,546	38
building work	64,086	54
equipment work	8,936	9
total	118,568	100
deaths	1,583	1.75

Fig. 4: Injured workers Japan (1978)

In 1981 Japan counted 1173 fatal accidents: fig. 5:

causes fatal acc.	total	%
falling	425	36.2
break-down	91	7.8
collapse	97	8.3
machinery	425	36.2
electricity	48	4.1
fire, explosion	18	1.5
handling	10	0.9
others	59	5.0
total	1,173	100

Fig. 5: Fatal accidents Japan (1981)





#### 4.3.2 England

In 1978/79/80, England reported the following list of causes of accidents and of injured people (fig. 6):

causes and injured people	1980		1979		1978	
	total	fatal	total	fatal	total	fatal
1. stepping in striking against subjects	2279	-	2487	-	2723	1
2. collision with materials	151	8	194	10	257	9
3. working with tools	2434	-	2112	1	2323	-
4. working with equipment	2967	28	3154	33	4314	27
5. falling heights	4401	65	4663	55	5044	56
6. falling flat	3933	2	4357	1	4198	-
7. falling materials	1652	10	1829	10	2368	14
8. other accidents	3190	6	3221	-	3861	3
9. occupational diseases	178	7	175	9	183	10
10. unknown	8305	1	8814	-	7714	-
Total	29,490	127	31,006	119	32,980	120

Fig. 6: Causes of accidents England ('78/'79/'80)

#### 4.3.3 The Netherlands

For The Netherlands we find the following figures (fig. 7):

causes and injured people		1980		1979	
		total	fatal	total	fatal
1.	stepping in nails	886	0	846	0
2.	materials	6969	6	8659	5
3.	tools	3083	0	2764	2
4.	equipment	955	4	479	3
5.	falling heights	262	5	122	2
6.	falling flat	2381	1	3001	4
7.	falling from ladders	827	2	772	1
8.	other accidents	1527	11	285	3
9.	occupational diseases	114	0	127	0
10.	unknown	35	1	14	0
	total	17,039	30	17,066	20

Fig. 7: Causes of accidents The Netherlands ('79/'80)

#### 4.3.4 Germany

In Germany we find figures of the building industry in comparison to the total industry. We give a quotation of accidents, of serious accidents and of fatal accidents in fig. 8. (In Germany an accident is counted as every incident which causes an absence of men for more than three days).



year	menyears building industry in % of total ind	accidents to 10.000 my		serious accidents		fatal accidents	
		build ind	total ind	build ind	% total ind	build ind	% total ind
1970	10.7	154.81	99.63	86.66	16.9	51.0	17.0
1971	10.7	156.99	95.23	94.80	18.4	59.7	20.0
1972	10.5	151.28	88.23	93.64	19.0	51.5	19.0
1973	10.4	139.42	85.16	93.33	19.7	54.5	20.3
1974	9.9	122.88	76.35	89.23	19.3	46.7	19.1
1975	9.3	114.80	68.14	79.78	19.0	42.5	20.5
1976	9.6	121.87	73.37	76.36	19.4	43.2	20.6
1977	9.5	118.76	72.15	78.50	19.6	39.6	19.9
1978	9.4	120.70	70.78	74.81	19.3	35.0	18.2
1979	9.7	119.85	72.56	75.10	18.4	39.2	19.6
1980	9.7	120.92	71.69	76.31	19.1	36.9	20.4

Fig. 8: Figures of Germany

#### 4.4 Some considerations

If we look to the different way of data-gathering, we think we have to ask ourselves to what purpose we want to collect them. If we take safety as an starting point we want to collect such an information which will give us the background of:

- Causes of accidents (falling, striking, ...)
- Seriousness of accidents (part body, fatal)
- Amount of accidents (total, proportional)

The information should give us all accidents and the accidents which caused injuries to people: inside on the working place and outside by passing people, neighbours, not workers.

The in par. 4.1 suggested ratio-figures will give us some information, with which we could compare different countries and different industries.

Figures of accidents to every 10.000 manyear will also give us some clear information, when also the first day of absency is counted.

The combination of causes and of damaged parts of the body, could give us information to better ways of protection and of those parts of the building proces that should be changed to make it possible to work in a safer way.

As an example we give for the Netherlands the year 1980 (fig. 9):

Causes	1	2	3	4	5	6	7	8	9	10	TOTAL
Part of the body:											
1. Head	0	612	76	80	31	90	46	124	0	1	1060
2. Eyes	0	811	135	14	2	11	7	90	0	7	1077
3. Hand(s)	0	2854	2342	460	24	353	140	479	77	8	6737
4. Foot	886	1471	299	227	56	1024	258	220	0	8	4449
5. Inside	0	635	106	123	117	649	217	232	37	5	2121
6. Other	0	586	125	51	32	254	159	382	0	6	1595
Total	886	6969	3083	955	262	2381	827	1527	114	35	17039
Time of absence:											
0 - 1 week	497	1971	844	186	27	498	150	347	1	12	4533
1 - 3 weeks	380	4080	1934	585	134	1471	458	823	8	20	9893
3 - 6 weeks	5	591	204	114	34	218	122	240	49	0	1577
6 -13 weeks	3	195	56	38	27	105	46	62	30	2	564
13 - more weeks	1	126	45	28	35	88	49	44	26	0	442
Hospital	7	325	145	88	70	175	78	151	0	2	1042
Fatal	0	6	0	4	5	1	2	11	442	1	30

1 = stepping in nails  
 2 = materials  
 3 = tools  
 4 = equipment  
 5 = falling heights  
 6 = falling flat  
 7 = falling ladders  
 8 = other accidents  
 9 = occ. diseases  
 10 = unknown

Fig. 9: Figures of The Netherlands ('80)



## 5. THE SAFETY PLAN

If we really want to come to safer working conditions in our construction industry, we have to work with a safety plan.

Such a safety-plan must be supported by the board of the company and the topmanagement of the organization, it should be brought into action and be advised by the safety-department, when necessary advised by an external adviser.

The safety must be known by every member of the organization, brought into action on each site and introduced to every newcomer at the start of each work.

The safety is based on the following considerations:

- Reduce human suffering
- Reduce loss of materials
- Promote morale
- Promote productivity
- Reduce insurances-rates
- Reduce costs.

And such a program should cover:

- The purpose of the plan itself
- The scope of that plan
- The responsibilities to management and workers
- The establishment of a safety committee
- The safety- and toolbox-meetings
- The measures for personal protection.
- The instructions to be given
- The organization of safety-publications
- The different plans for external assistance
- The measurements for care and transportation of injured people
- The investigation of accidents and unsafe situations
- The incident-and accident reports
- The feedback to the organizations.

Thinking along those lines we come to a safety-decision-sceme; when we look now to the construction work on our sites, we recognize the human factors and the material factors. We both should analyse them, to weigh certain chances. Is the risk acceptable or not? If yes, we do the work in the way it is foreseen and prescribed to realise. If we foresee an anacceptable risk, we have to decide to do it in another way.

But, even when we take the calculated risk, there could happen something we do not want, or something that is not acceptable but what was not foreseen as such! In the working situation an accident could happen now or it doesn't happen. In both situations we have at this moment unsafe working conditions.

Only in the case of a real accident we meet damages and injuries.

Thinking in a better way along safety-decision-trees could bring our industry to a higher level of our safety-performance.