



# **Work, Health and Living Conditions for Construction Workers on Large-Scale Construction Projects**

**A Danish Study, November 2003**



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The *Work, Health and Living in Camps* project, which ran from 2000 to 2003, explored living conditions for construction workers employed on the large-scale developments seen in Denmark in the past twenty years or so. It aimed especially on the establishing the impact on workers' health and general welfare of the type of life typically associated with such projects: the strenuous work, long hours and on-site housing in so-called construction camps. Finally, on the basis of the findings, the project was asked to elaborate preventive measures. A special government grant provided funding for the project. In the course of the work several substudies were carried out by CASA – Centre for Alternative Social Analysis, the Carl Bro Group (an international consulting company) and the National Institute of Occupational Health (NIOH).

The cross-section study revealed arduous conditions for workers on the Metro development in Copenhagen and widespread locomotor problems among construction workers. Among commuters who travelled more than 60 km to work each day the study recorded poorer recovery rates and a more stressful life than among workers that used on-site accommodation. A comparative study of conditions in construction camps in Denmark, Sweden and Norway found higher standards in Norway than in the other two countries. In Denmark and Sweden, on-site accommodation for employees obliged to work far from home is considered a private matter that is not regulated. In Norway, such temporary housing is regulated by law and negotiated settlements among employee and employer organisations. The cohort study showed that work on the big developments is extraordinarily dangerous. A mortality and morbidity substudy followed construction workers employed before 1996 over a four-year span (1996–2000). The data emerging from this study were compared with similar data on all economically active males in Denmark. Among other things, the study revealed a higher incidence of disorders of the cardiovascular, respiratory, digestive and musculoskeletal systems and connective tissues.

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# 1 Introduction

For the first time in Denmark, a study has looked at the conditions for construction workers employed on large-scale developments with temporary accommodation and working time contracts requiring 10–12 hour shifts. The *Work, Health and Living in Camps* project focused on the joint impact of hard physical work, long hours and temporary accommodation in construction camps on workers' health and well-being.

The issue came to the fore in Denmark in connection with the 1989–98 construction of the Storebelt Bridge (connecting Zealand with Funen) – the biggest operation of its kind on Danish soil ever, embracing not only road and rail bridges, but extensive tunnel work as well. At its height, about 4,000 workers were employed. But alarm bells were ringing; accident frequency was high and the conditions under which some workers were housed were poor.

It was 2000 before the study could begin. By then, the bridge and tunnel works on the Øresund Bridge linking Denmark and Sweden were complete and work on the construction of a fast underground and surface rail service known as the Copenhagen Metro had begun. The study includes workers engaged on all three projects: Storebelt Bridge; Øresund Bridge; and the Copenhagen Metro.

Wherever building and construction work is done, there are certain common features. They turned up in the Danish projects too.

- Mobile labour within and across country borders
- Long hours and/or long on/off cycles (extended periods of work, interspersed with extended periods at home)
- Extended periods spent away from home

The knowledge generated by the *Work, Health and Living in Camps* project is therefore of international significance. The findings presented in this report cover both workers who lived in the construction camps and those who commuted back and forth each day as well.

The *Work, Health and Living in Camps* project began in 2000. The special government grant that funded the project was managed by the National Labour Inspectorate. The Centre for Alternative Social Analysis (CASA) worked together with the Carl Bro Group (an international consulting company) on the project. The analysis institute SFI-Survey collected data on the construction workers included in the cohort study. NIOH paired registry data and ran analyses for the cohort study. The institute also carried out a study of the physiological effects of long working hours on a group of workers living in the construction camps.

## 1.1 Hypothesis and areas of concern

The study explores working and living conditions for workers employed on the large-scale construction works. The sheer scale of the projects and the vast numbers of workers required to complete them resulted in exceptional patterns of everyday life. Many of the workers came from far afield and had either to make use of the so-called ‘construction camps’ or travel daily long distances to work and back.

Contracts were signed which stipulated extended hours and on/off cycles. Instead of the normal 7.4 hour working day, workers had to endure a physically demanding job often in noise and air polluted surroundings for 10–12 hours at a stretch, with limited time to rest and recharge their batteries in between.

The hypothesis advanced by the study is that the stress and strain involved in working on large-scale developments exceed levels in the building and construction sector on the whole. It was assumed in addition that the risk to health would be aggravated and life in general put under increased strain, particularly in areas do with life style, social networks and family life.

The study aimed therefore at exploring the wider impact of this combination of heavy physical work, long hours and construction camp accommodation on workers’ health and welfare and to identify precautionary measures.

## 1.2 Method

The project consisted of two major studies: a cohort study and a cross-section study.

### 1.2.1 The cohort study

The purpose of the cohort study was to establish long-term effects on workers’ health. In this case, the study would be retrospective, as the members of the cohort had worked on already completed infrastructure projects in relation to the timing of the study. This group of people (the cohort) was examined to determine morbidity and mortality rates in the years following work on the development projects. Inasmuch as a certain interval is required to measure long-term effects (mortality and morbidity), the figures presented here relate to a four-year period (1996–2000) during which construction workers employed before 1996 were followed up. The study is therefore limited to the *Storebelt development*, and the workers will consequently be referred to as the *Storebelt workers*. Our findings were compared with data on ‘all economically active men in Denmark’. Adjustments were made to compensate for age distribution differences.

The study also looked at the incidence of traumas requiring hospitalisation. The whole cohort was included in here, that is, workers who were taken on initially on the Øresund Bridge and Copenhagen Metro developments. The emerging data were subsequently compared with similar data on all males employed in the Danish building and construction sector.

### **1.2.2 The cross-section study**

The main focus of the cross-section study was the first phase of Copenhagen's Metro development, a project that was managed by *Comet*, the Copenhagen Metro Construction Group. The cross-section study included a number of substudies of the Metro development, including a study of the working environment and construction camps (2001); a questionnaire survey (2000); a qualitative interview survey of construction workers (2000–01); a study of the physiological ramifications of long hours on a group of workers living in construction camps (2000–01); and finally a study of the regulations, standards and management of construction camps in Norway and Sweden (2000).

In the cross-section studies, the term *Metro workers* covers the *campers*, i.e. workers who lived in the construction camps, and the two groups of non-campers, the *commuters* and *locals*.

## 2 Background information and findings

### 2.1 Metro workers

On the basis of information emerging from the responses to the questionnaire, we were able to form a picture of the typical “Metro worker 2000” (see Figure 1).

The figure introduces the key analytical variables:

- The main working time schedules
- Whether the Metro workers stayed in the camps or lived at home and made the return journey every day. This latter group is subdivided into ‘locals’ and ‘commuters’ depending on the distance covered between home and work.

The figures also gives us the vital statistics, i.e., age, nationality, education, gang/shift data and experience of earlier large-scale developments where temporary housing was provided for workers. Further details on life in the construction camps were obtained from the workers who used them.

We see that the typical Metro worker is a 41-year-old Danish national (72% were Danish, 25% Swedish). While most of the Swedish workers used the accommodation provided in the construction camps, only slightly over half of the Danes did so. The Metro workers generally had experience from work on other big developments: 80% had worked on at least one similar project with a construction camp, 44% on two or more projects, generally the Øresund Bridge and Storebelt developments.

The 68% marriage/partnership rate essentially echoes the rate among Danish males in general. There were no significant differences in the marriage/partnership rate between campers and non-campers, nor in relation to previous experience of housing in construction camps. There is therefore nothing to indicate that ‘camp life’ is either a single-male phenomenon or that it splits families.

Not quite half of the campers and non-campers reported having dependent children in the household. The 71% of spouses/partners of campers in paid work also echoes the general situation among Danish women of working age. The typical camper’s spouse/partner looks after the children, does the housework *and* has a paid job in addition.



## 2.2 Working hours

Working hours in the Danish building and construction sector are no different from the rest of Danish society, that is, a 37-hour five-day week. On the Storebelt development, in contrast, contracts stipulated a 10–12 hour working day pressed into cycles of 1–2 weeks on followed by a period off (at least seven consecutive days). These contracts were in fact put in place in an effort to cater to the many employees who lived at considerable distances from the construction sites, and who therefore needed on-site accommodation. The cyclical system meant that employees could be at home for longer periods at a time in between work periods. To fit these contracts in with current settlements the employee and employer organisations agreed to use the ‘Shiftwork Agreement’, initially to cover the tunnel works, but later widened to cover the entire project. The Shiftwork Agreement had actually never been applied in the building and construction sector before; it was primarily an industrial settlement. With the adoption of the Shiftwork Agreement as a general framework, the only regulatory instruments defining working times were two provisions in the Working Environment Act, one which stipulated that the non-working period separating working days shall be no less than 11 hours, and another requiring that each week shall contain a continuous non-working period of at least 24 hours. These regulations had a considerable influence on the working time schedules prevailing in the sector up to then, and would come to define practice in subsequent large-scale construction projects.

In the Metro development three basic working time schedules were in force:

1. Normal working week
2. A schedule with long working days and extended weekends
3. A schedule with long working days and seven or more consecutive days off

Which of the three schedules applied varied from site to site and sometimes from gang to gang. The schedule used by an individual gang would be the result of discussions partly within the gang and partly between the gang and the developer. On the Metro development, the prevailing schedule was the weekly cycle schedule. Responses to the questionnaire (2000) indicated that half of the Metro workers worked to this roster, 33% to the extended weekend roster, leaving only 15% working ‘normal’ hours. In addition, almost every fourth worker worked shifts including nights.

Each schedule had several variants. The most widespread ‘week-off’ model (41%) had a 5–2–5–9 roster, that is, 5 workdays Monday to Friday with Saturday and Sunday off, 5 workdays followed by 9 days off. Next came

the 7–7 roster, with cycles of 7 workdays of 11 hours each and 7 days off. This schedule was used by 10% of the Metro workers.<sup>1</sup>

## **2.3 Housing**

In connection with large-scale developments, an area either on or near the site is often provided where employees can park their own caravans or rent a room. These areas are called construction camps. The initiative to provide a camp may come from the employees themselves or the developer. In the former case the camp will often be little more than a section of land where caravans can be parked at little cost. In general there will be no services such as electricity, water or waste disposal. In the latter case, such services will generally be in place along in most instances with temporary housing with single, double or four-bed rooms available for employees to rent.

### **General requirements to accommodation in relation to transient construction sites in Denmark, Sweden and Norway**

A study of accommodation and relevant legal requirements in Norway and Sweden made it clear that while Sweden and Denmark are relatively similar, they both differ considerably from Norwegian practice.

The Swedish and Danish working environment laws do not set out minimum requirements regarding accommodation provided for employees who for periods of several days at a time (are obliged to) work far away from home. No settlements have been negotiated that regulate minimum accommodation standards. Accommodation remains, therefore, the job of – and expense for – the developer in question who needs skilled labour for a given construction project. Conditions can therefore vary widely. Accommodation is organised and managed by the developer. Generally speaking, in Denmark and Sweden, a lodger pays for his room and board. It provides a strong incentive for people to squeeze as much as they can out of allowances and tax deductions. Board and lodging arrangements – and the chance of saving money – make up part of the compensation for working far away from home.

Norway presents a contrasting picture. There, provisions in the Working Environment Act and negotiated settlements specify standards related to housing, utensils and welfare facilities along with the provision of food, an opportunity to pursue recreation activities, travel expenses etc. Figure 2 illustrates the differences in accommodation conditions in the three Nordic countries.

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<sup>1</sup> While a construction project is under way, working hours and schedules can change quickly and frequently. The details given here represent a picture ‘frozen in time’ (August–September 2000).

**Figure 2: Regulations pertaining to transient construction site accommodation – Denmark, Sweden and Norway**

	Denmark	Sweden	Norway
Working Environment Act.....	No	No	Yes
Negotiated Settlements.....	No	No	Yes
Travel allowance – distance (km).....	100	70	60
Accommodation allowance – amount (in national 2003 kroner) .....	535	325	3–400
Accommodation standards specifications .....	No	No	Yes
Corporate standards policy .....	No	No	Yes

### **Construction camps for the Metro workers**

During phase 1 of the Metro development, two camps were created by Comet, the developers. They were situated at Nordhavn and Refshalevej in Copenhagen, and bore the names of their locations. Certain features were common to both camps: both were located in remote parts of the city in industrial or harbour areas and they both lacked shops and other welfare facilities in the vicinity. Both were divided into an area for caravans and the temporary accommodation buildings. From the outside, the accommodation resembled vertically assembled containers or sheds. At Refshalevej rooms were either single or double, while at Nordhavn there were only single rooms. The two camps varied considerably with regards to standards of the rooms. Every room in the Refshalevej camp had a self-contained cooking area, a shower and a toilet. At Nordhavn, kitchens were communal and there were three toilets and four showers for every 26 rooms. Conditions for those who lived in their own caravans were extremely poor in both places. There were no communal kitchen facilities and there were more than ten people to every toilet and bath.

Both camps had communal areas and a bar run by the occupants. At Refshalevej, a privately run canteen was available just outside the camp where workers could buy food at normal canteen prices. At Nordhavn the occupants had themselves organised the sale of light meals and refreshments from the bar.

As Figure 1 shows, most of the campers used their own caravans. A minority had found other accommodation outside the developer’s camps, principally on other camping sites.

## **2.4 Camper or commuter?**

As Figure 1 illustrated, the Metro workers were used to big construction projects, and many had tried life both as campers and commuters. The choice between travel and on-site accommodation is made by weighing the practical sides of commuting, the likelihood of economic compensation for running two households, the possibility of driving together with others, and

how much the worker and his family want him to come home every day and/or whether he wants to live in a camp.

That said, the main factor is the distance between home and the construction site. The results of the questionnaire survey showed that tolerable commuting distances changes to intolerable commuting distances at around 90–120 km each way. Table 1 shows that while 69% of the campers live more than 120 km from the development site, 63% of the non-campers live less than 91 km away. About a fifth of both groups live in the border zone, 91–120 km, which indicates that the decision to stay at the site or commute is made within this margin of tolerance.

**Table 1: Distance between home and camp/construction site for campers and non-campers. Metro workers. In per cent**

Distance	Campers N 217	Non-campers N 138
1 – 60 km.....	8	49
61-90 km.....	6	14
91-120 km.....	17	20
121-150 km.....	12	7
Over 150 km.....	57	1
No information.....	1	9
Total.....	101	100

For construction workers, there is one essential factor that tips the balance in favour of using on-site accommodation, and that is compensation for board and lodging expenses,<sup>2</sup> paid in compliance with tax legislation concerning tax-exempted travelling expenses for employees that are required to travel by their work. The rules are changed continually, but in recent years they included work on developments such as the Metro project. That said, eligibility for tax exemption depends on a range of criteria that have to be met and endorsed by the worker’s local tax authority. In general, tax exemption for travel expenses is not an option if the distance between home and work is under 100 km.

We note in addition that a decision to commute correlates with the possibility of driving together with others. In the questionnaires, 70% of the commuters who travelled more than 60 km each way reported travelling both ways with others, while only 27% did so of those who lived within 60 km of the construction camp or site. Travelling together represents money saved and people can also take turns to sleep on the journey.

The everyday life of both campers and commuters is structured by the long working days and extended periods off work of varying duration. In relation

<sup>2</sup> The standard rate was 519 Danish kroner per diem in 2001.

to these factors, everyday life differs for members of the two groups. This is described in the next two sections.

## **2.5 Everyday life**

### **The working period for campers**

In the camps, life is divided into working periods during which employees work and live on the construction site, and periods off work where employees have an opportunity to live at home and pursue other interests. The everyday life of the campers can therefore be said to cover three distinct areas: 1) work, 2) time off on-site (in the camp) and 3) time off at home. Time off on-site can be considered an aspect of working life: one is still 'at work', as travelling home is unfeasible. For construction workers who live beyond the commuting threshold, accommodation near the construction site is essential to keep the job.

Workdays consist of work followed by recuperation for the next day's work. With a 12-hour day and transport to and from the camp, only a few hours are left for recreation – if there is going to be enough time left to get a decent night's sleep. The campers themselves describe a typical workday as consisting of work, meals, a little TV, occasionally spending time with others on the camp, and sleep. In addition there may be shopping to do, clothes to wash, calls made to the family back home.

Campers who have tried the combination of long hours and commuting are in no doubt about the advantages of the camp. As a commuter, a worker is not of much use to his family when he finally gets home of an evening. At the same time, there is hardly enough time to spare for him to take things easy because of the time consumed by the long trip and the domestic chores he will unavoidably be 'landed with' at home. Camp accommodation makes the separate more complete. The construction worker can devote his attention to food, rest and sleep.

But it is a life style that can be difficult to tackle. Camp life requires the ability to withstand boredom and to resist the temptation of 'the bottle and get to bed on time', as the workers put it.

The results of the qualitative interviews and the questionnaire show, however, that some workers drink to excess at the expense of decent food and a good night's sleep while living in the camps. At the same time, very many succeed in structuring their lives during the working periods, and are careful to get as much sleep as they can. On the other hand, only about every fifth camper reports sleeping 8 or more hours per night on average during the working periods. If there is to be any time to relax after completing other time-consuming activities such as getting to and from places,

preparing and eating meals etc. then sleep must be confined to 7–7.5 hours per day as reported by nearly 4 out of 10.

### **The working period for commuters**

A commuter returns home every day after work. As commuters work under the same conditions (long hours and extended working periods) as everybody else, their everyday life is similarly divided into working periods during which they ‘turn on the door step’, and the periods which they can spend time at home.

The commuters stress the advantages of returning home every evening, but they and their spouses/partners say it is a very difficult life, characterised not least by his tiredness. Furthermore, the number of days he has off work has a major impact on getting daily life and family to function. Without these extended periods off work, home life can become pretty hectic, with him away 16 hours at a time.

### **Rest period and family life**

For both campers and commuters, the rest period is condensed freedom. It gives them space to pursue other interests more coherently. Many of the men put their building skills to use in their rest periods too: they improve their homes, repair cars or motor bikes, give friends and acquaintances a hand. It is around freely chosen activities like these, which the men themselves associate with their home life, their spare time tends to revolve.

But normal home life continues despite his presence. From a family perspective, his time off work is simply a period when the family can lead a ‘normal family life’ with its usual activities – eat meals together, invite friends and family home, take part in the children’s pursuits etc.

This situation is the same for the families of both the camper and the commuter. The difference between them lies in the acute contrast for the families of the campers between working periods when he is always away, and the rest periods, when he is always at home. Apart from telephone calls from work, everything the camper’s family does together, family discussions and practical jobs in the home, needs to be located to his rest periods. For the commuter’s family, separation is not as total; there is, after all, some daily contact. Given the working time schedules prevailing in the Metro development at the time of the study, with weekends in a two-week work schedule typically spent in the camp, workers can be away from home from 4 days to several weeks at a time, with time for recharging the batteries at home lasting from 3 to 9 days. On balance, workers are far more away from home than they are at home.

The camper’s family develops ‘parallel’ everyday lives. During the working periods while the man is away at the camp, the woman looks after house

and home. She is the head of the family or its 'anchor'. She has responsibility for raising the children and spending time with them. She has to make decisions of importance to the family, and organise things like keeping in touch with other family members and friends.

The absence of the man impacts therefore on family relations. His spouse/partner and children lead their own lives of which he is not part. One could say that a contract develops between the woman and the children which can not be revoked the minute he crosses the threshold.

The campers showed in the interviews an awareness that family life for them required things 'backstage' to function properly, that their spouse/partner could manage on her own. They also realised that, in practice, there was little they could do but accept that their spouse or partner and children would find their own ways of doing things, and that they would play a diminished role in the children's upbringing. The campers illustrate the situation with things said by their children: 'Dad, you don't decide things round here, mum does.' But alongside the realisation of their limited role, they also express how much they miss their family while they are away at work. It's the 'other side of the coin'.

### **Working time schedules and the family**

Working time schedules – and changes to them – have a wide impact on home life structure. And it seems that the four-day week and similar schedules create more problems than others which include whole weeks off. For the men and spouses/partners we interviewed unstable working time schedules are not unknown, and most prefer whole weeks off because it makes for a less hectic time. With the four-day week, the three days the family is together tend to be relatively hectic. On the other hand, an argument in favour of the four-day week is the that his days off match everybody else's, that is, all have the weekend off. Overall then, this speaks for keeping the weekends out of the working periods as far as possible, whether it is a four-day week or the 5–2–5–9 roster mentioned above with two weeks on and nine days off with a weekend at either end.

## **3 Findings**

### **3.1 Mortality and morbidity**

The most important findings of the study concern the implications of work on large-scale construction projects for the health of the workers. We found a higher mortality incidence and higher morbidity rates across a range of disorders among workers on the Storebelt project when compared with all economically active men in Denmark.

#### **Mortality**

The standardised mortality ratio was 135 (95% confidence levels 105–171). That is, the mortality rate among Storebelt workers was 35% higher than would normally be expected in the period 1996–2000.

#### **Morbidity**

Morbidity among Storebelt workers is significantly higher and is expressed mainly in diseases affecting the cardiovascular, respiratory, digestive and locomotor systems. We find an overrepresentation of diseases whose likely cause is lack of rest (cardiovascular and digestive disorders) or physical stress due to factors in the working environment (respiratory and locomotor system disorders).

**Table 2: Standardised hospitalisation ratios (SHR) for selected diagnosis among 5.791 bridge construction workers followed up for hospitalisation 1996 to 2000. Standard: all economically active men in Denmark**

ICD-10 code	Diagnosis	All hospital cases				In-patients					
		Cases	Exp.	SHR	95% CI	Cases	Exp.	SHR	95% CI		
A00-B99	Certain infectious and parasitic diseases.....	124	89.8	<b>138</b>	115.8	182.5	71	49.1	<b>145</b>	113.0	182.5
C00-C97	Malignant neoplasms .....	130	122.4	106	89.4	116.9	70	75.7	93	72.1	116.9
C00-C14	Malignant neoplasms of lip, oral cavity and pharynx.....	5	2.6	192	62.2	384.4	3	2.3	131	27.2	384.4
C15-C26	Malignant neoplasms of digestive organs .....	10	10.3	97	46.7	184.5	10	10.0	100	48.2	184.5
C30-C39	Malignant neoplasms of respiratory and intrathoracic organs .....	8	7.4	108	46.4	233.8	8	6.7	119	51.2	233.8
C43-C44	Melanoma and other malignant neoplasms of skin .....	9	9.1	99	45.5	188.4	4	4.9	81	22.1	208.1
G00-G99	Diseases of the nervous system.....	170	104.2	<b>163</b>	140.3	189.5	67	47.4	<b>141</b>	109.5	179.5
I00-I99	Diseases of the circulatory system .....	350	260.3	<b>134</b>	121.1	149.3	236	171.0	<b>138</b>	121.5	156.8
I20-I25	Ischaemic heart diseases.....	103	69.7	<b>148</b>	121.8	179.2	72	54.1	<b>133</b>	104.1	167.6
I21	Acute myocardial infarction.....	39	28.7	136	96.6	185.7	27	23.6	114	75.2	166.1
J00-J99	Diseases of the respiratory system.....	235	182.6	<b>129</b>	113.2	146.2	137	102.3	<b>134</b>	113.3	158.4
J00-J06	Acute upper respiratory infections.....	25	20.3	123	79.6	181.4	10	8.2	121	58.2	223.0
J10-J18	Influenza and pneumonia.....	44	37.1	119	86.3	159.4	41	26.6	<b>154</b>	110.6	209.1
J20-J22	Other acute lower respiratory infections	4	4.2	96	26.2	246.3	2	1.5	134	16.0	482.6
J40-J47	Chronic lower respiratory disease .....	56	38.0	<b>147</b>	111.4	191.5	19	11.1	<b>171</b>	103.1	267.4
J60-J70	Lung diseases due to external causes ..	5	1.5	<b>325</b>	105.2	757.8	0	0.5	0	0.0	574.9
K00-K93	Diseases of the digestive system .....	505	399.2	<b>127</b>	115.9	138.0	306	214.9	<b>142</b>	127.3	159.3
K25-K27	Peptic ulcer.....	44	24.9	<b>176</b>	128.2	236.8	23	11.7	<b>197</b>	125.1	296.0
K25	Gastric ulcer .....	17	10.5	162	94.6	260.1	8	5.0	160	68.9	314.9
K26	Duodenal ulcer.....	24	13.1	<b>184</b>	117.8	273.4	14	6.1	<b>231</b>	126.1	387.1
K40	Inguinal hernia .....	90	87.7	103	82.5	126.1	69	44.4	<b>155</b>	121.0	196.8
K70	Alcoholic liver disease.....	11	5.9	186	92.6	332.0	10	4.3	<b>231</b>	110.7	424.1
L20-L30	Dermatitis and eczema .....	17	17.7	96	55.9	153.6	1	2.0	49	1.5	272.2
M00-M99	Diseases of the musculoskeletal system and connective tissue.....	873	631.4	<b>138</b>	129.4	147.8	276	169.5	<b>163</b>	144.7	183.3
M16	Coxarthrosis .....	15	12.3	121	68.0	200.3	7	6.8	104	41.6	213.5
M17	Arthrosis of the knee .....	41	30.3	135	97.1	183.5	15	8.4	178	99.7	293.6
M50	Cervical disc disorders.....	22	16.1	137	85.7	207.1	9	5.7	158	72.3	299.5
M51	Lumbar and trunk disc disorders .....	128	75.6	<b>169</b>	142.3	201,3	64	38.5	<b>166</b>	128.0	201.3

Figures indicating a statistically significant higher risk for Storebelt workers are printed in bold face.

Table 2 shows the distribution of the diagnosis groups we investigated, the numbers discharged from hospital after treatment, either from a casualty ward, out-patient treatment or under admission, and subsequently *only* for treatment requiring hospitalisation. There are 2,404 cases in all, of which 1,164 required hospitalisation. The highest number of cases were found in the group of diagnoses covering diseases of the musculoskeletal system and connective tissue. There were 873 such cases, of which 276 required hospitalisation.

The standardised hospitalisation ratio (SHR) in Table 2 was estimated by comparing Storebelt project workers with all economically active men in Denmark. With an SHR of 138 for the treatment of infectious diseases, it means that the Storebelt workers are treated 38% more frequently than all economically active men in Denmark.

NIOH found an increased risk of hospital treatment for infectious and parasitical diseases, diseases of the nervous system and cardiovascular system including atherosclerotic heart disease. In addition, a high relative risk was found for diseases of the respiratory organs including chronic diseases in the lower respiratory organs caused by external factors. There was further a higher relative risk of diseases of the digestive system including stomach ulcers, and diseases of the musculoskeletal system and connective tissues. In no selected diagnostic group did the Storebelt workers have a statistically significant lower risk.

Two of the disease categories we find overrepresented among Storebelt workers are diseases we expect to find among people in stressful work environments with a predominance of, for instance, long hours or shiftwork accompanied by too little sleep: diseases of the cardiovascular and digestive systems.

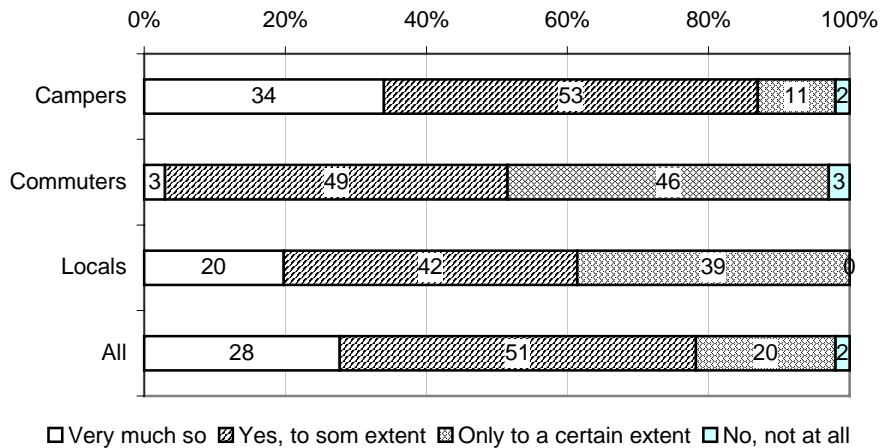
These results are noteworthy in light of the short follow-up period for this cohort study. Put differently, a statistically significant overrepresentation of the stated diseases among Storebelt workers is emerging after only a few years. The findings regarding cardiovascular and locomotor disorders are even more notable, as these are particularly widespread disorders which would require statistically extraordinary conditions to cause significant overrepresentation.

### **3.2 Rest**

The study of the Metro workers with long working hours confirms the earlier impression of rest and sleep deprivation. The majority (81%) sleep less than 7.5 hours in 24 during their working periods. A half (51%) reported feeling rested when they get up for work during the working week – while the other half report either ‘sometimes’ (35%), ‘not as a rule’ or

‘never’ (14%). Only 28% said that they felt able to relax after work; 51% said that this was the case ‘to an extent’. We found widely varying responses between the *campers* and *non-campers* (i.e., *commuters* who travel more than 60 km each way and *locals* who travel up to 60 km each way).<sup>3</sup> See Figure 3.

**Figure 3: Do you feel you can relax after signing off during the working week? Metro workers on long hours. Campers, commuters and locals. In per cent. N 282**



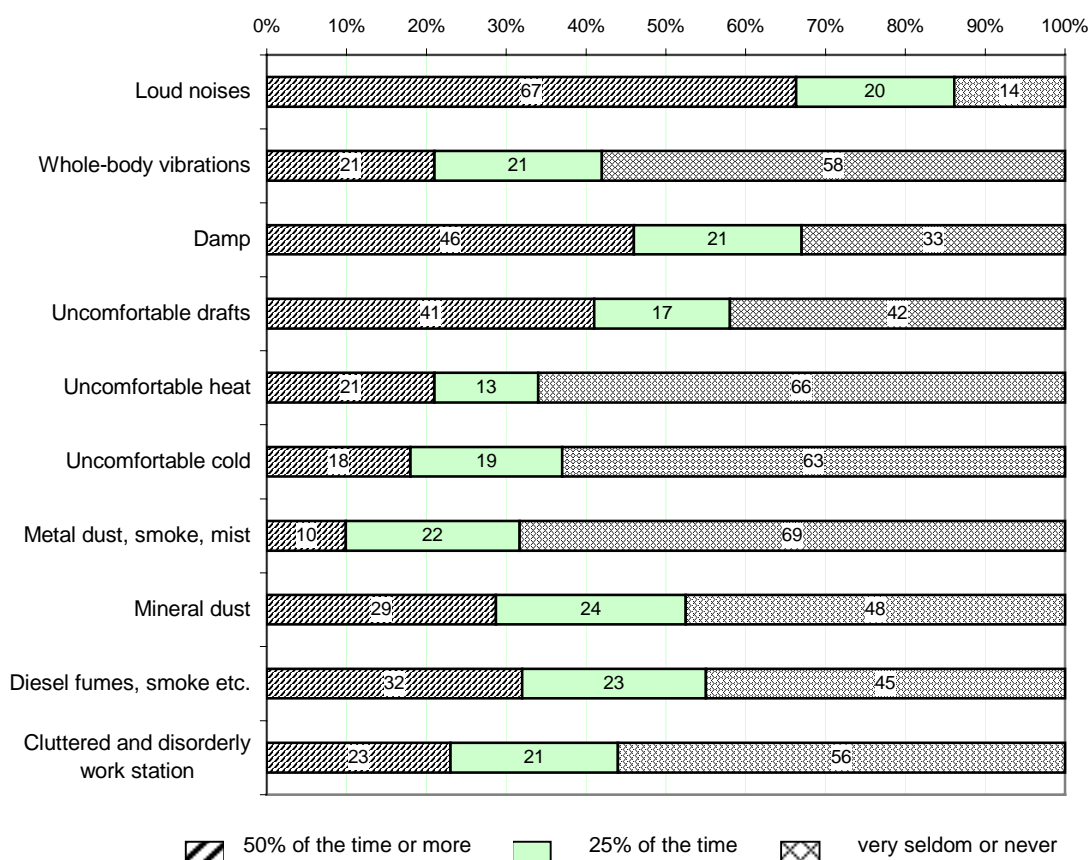
### 3.3 Working environment

The study also showed that the working environment put a greater strain on Metro workers than is normal for construction workers in general. We noted, for instance, a wider prevalence of certain strenuous bodily positions, especially among tunnel head workers; the same applies to hazardous environmental factors, see Figure 4.

<sup>3</sup> The difference between campers, commuters and local Metro workers with long hours is statistically significant when controlled for age, working time model, time of day/night of work, marital status and smoking/non-smoking in relation to questions concerning the possibility of relaxing after signing off from work and feeling rested in the morning during the working periods (logistical regression) and sleep per night during working periods (linear regression).

**Figure 4: Exposure to hazards in the working environment. Results in per cent of all Metro workers**

How much of your time at work would you say you are *currently* exposed to the following risks?



### 3.4 Impaired hearing and problems affecting the locomotor system

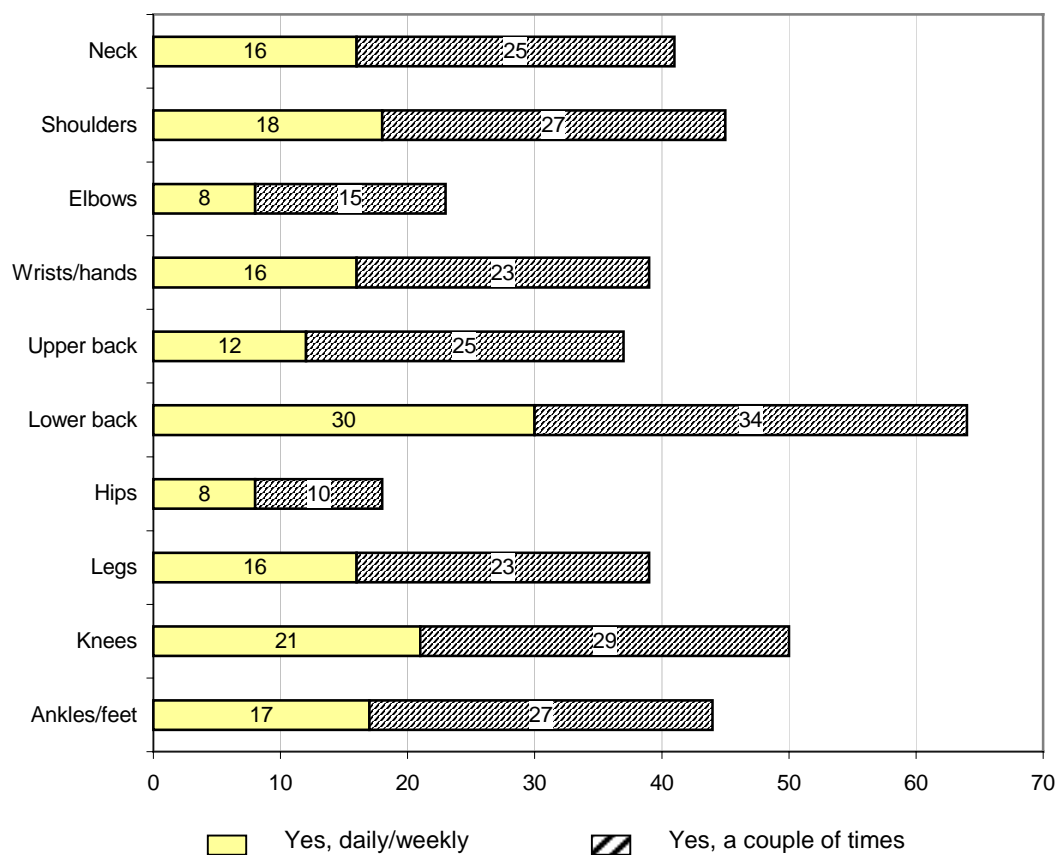
Almost every fifth Metro worker (19%) reports loss of hearing to the extent that they find it difficult to understand conversations among several people at the same time. This is a higher incidence of hearing impairment than we find among economically active men in Denmark, 13% of whom report impaired hearing, and is statistically significant.<sup>4</sup>

In response to the question ‘Have you experienced problems, pain or discomfort in the past three months in relation to...’ the parts of the body stated, the following distribution emerged. Those that reported ‘yes, daily’ or ‘yes, weekly’ are grouped separately from those that reported ‘yes, a couple of times’ (see Figure 5).

<sup>4</sup> The comparison is based on data obtained from the National Institute of Occupational Health Danish Work Environment Cohort Study (2000). Statistical significance was estimated after adjusting for age.

**Figure 5: Problems, pain or discomfort over the past 3 months. Results in per cent of all Metro workers. N 355**

Have you experienced problems, pain or discomfort in the past three months in relation to...



As Figure 5 shows, problems affecting the lower back had the highest incidence of locomotor disorders reported by the Metro workers with nearly two-thirds reporting problems, pain or discomfort in this area. Every other Metro worker reported having suffered from knee problems in the past 3 months. Other frequently reported problems concerned the neck (41%), wrists/hands (39%), the upper part of the back (37%) and ankles/feet (44%).

Problems affecting the lower back were explored in an earlier study by Damlund et al. (1983) as part of a wider study of attrition in labouring and concrete work.<sup>5</sup> 149 labourers and concrete workers were examined to establish the incidence and severity of the disorder. Damlund et al found that 31% had severe problems. They also tried to establish whether a correlation existed between lower back problems and previous work experience, but found no evidence to support such a correlation. They conclude, therefore, that problems of the lower back appear to be linked to the physically heavy work associated with labouring and concrete work.

<sup>5</sup> Damlund, M.; Gøth, S.; Hasle, P. and Munk, K. (1983): *Nedslidning i jord- og betonarbejdet – et frit, men hårdt erhverv*, Arbejdsmiljøfondet.

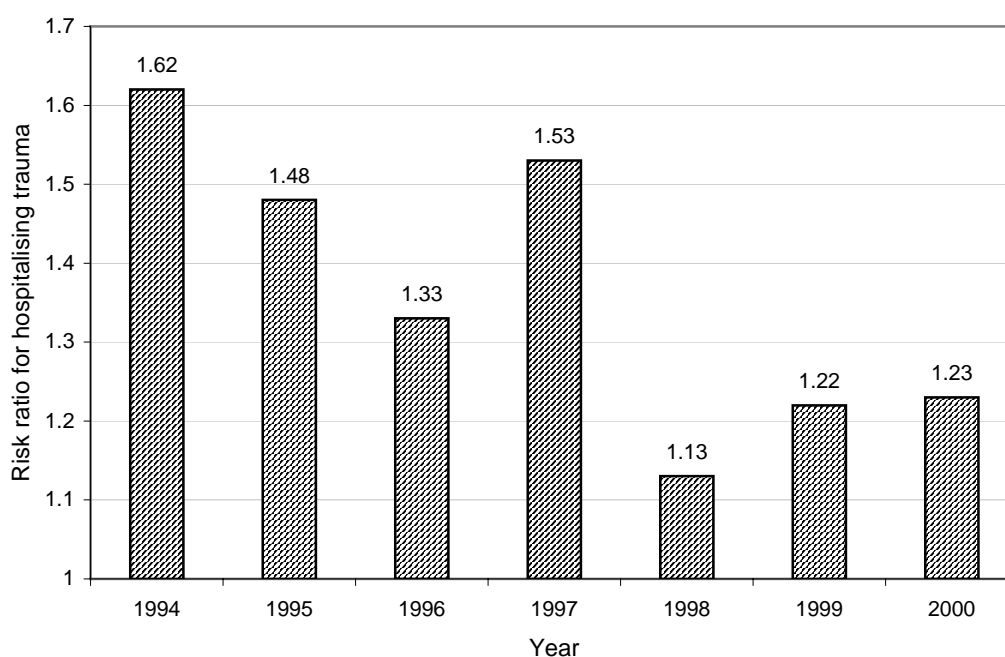
While lower back problems were not investigated in detail in the present study, our findings support Damlund et al.'s conclusion and indicate in addition that the prevalence of such problems among labourers and concrete workers has not diminished in the intervening years.

### 3.5 Accidents

In addition to the above we found a heightened accident risk. The study of the whole cohort showed a higher accident frequency in comparison with all employed males in the Danish building and construction sector (accident data are based on hospitalisation data for traumas – physical injury with external causes – sustained both on and off the job).

Figure 6 describes the year-on-year hospitalisation ratio for bridge and tunnel workers admitted for traumas compared with males in the Danish building and construction sector.

**Figure 6: Year-on-year risk ratios for traumas requiring hospitalisation among construction workers on large-scale developments. 1994–2000**

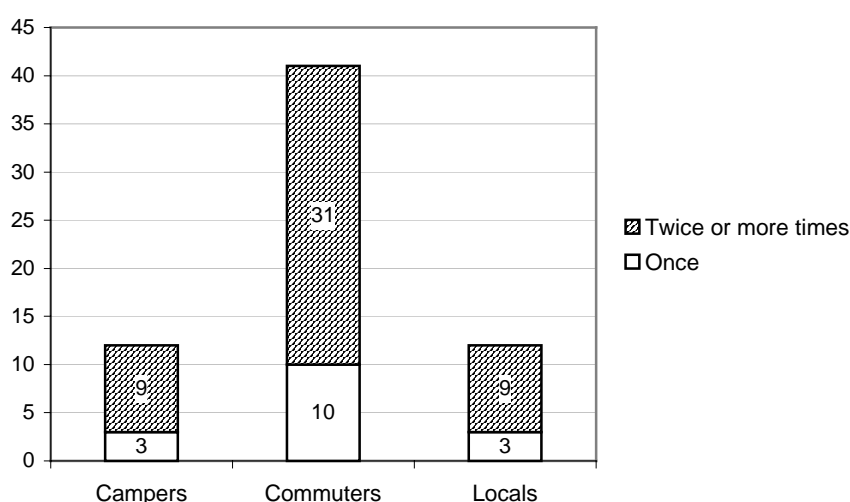


As the figure shows, the overall risk ratio (standardised for age and calendar year) for hospitalising traumas was 1.4 (the control group 'all employed males in the Danish building and construction sector' was set at 1.0). It signifies a 40% higher risk, and is statistically significant. The relative risk year-on-year ratio has followed a declining path, and at the end of the period was no longer significantly different from the ratio for all employed males in the Danish building and construction sector, though it remains higher.

The decline may be explained by a more determined effort to improve the working environment and prevent accidents in the Øresund Bridge and Copenhagen Metro developments in recent years.

The figures above cover all accidents requiring hospitalisation. We were unable to explore traffic accidents specifically. On the other hand, information from the survey of Metro workers indicates that long-distance commuters (those who travel over 60 km each way) pose a significant risk on the roads.

**Figure 7: Per cent who experienced falling asleep at the wheel or nearly falling asleep while driving to or from work over the past month. Metro workers by status: campers, commuters and locals. N 343**



The Metro workers were asked the following question: ‘Have you personally over the past month experienced falling asleep behind the wheel or nearly fallen asleep while you drove to and from work?’. 41% of the commuters answered yes, and 31% reported that it had happened more than once (see Figure 7).

### 3.6 Everyday life

The analysis of the everyday life of construction workers and their long working hours reveals specific health risks for the two non-camping groups, but particularly for the long-distance commuters. They have too little time to regain their strength. Commuters do not get enough relaxation or sleep between workdays. And because they are at home for such a brief period, sharing time with the rest of the family and enjoying the rewards of family life may in fact sap their strength even more. Compared with commuters, campers feel they are more rested and recharged, but are absent from their families for much longer periods. The construction workers who have a choice between living on-site or commuting must balance between a situa-

tion, on the one hand, in which they are always pressed for time and, on the other, of not seeing their family and home for longer periods.

### **3.7 Together on long hours**

The impact of long workdays can be approached from two angles. The first looks at how the length of the working day in itself structures the day and week, and, consequently, everyday life. That is to say that irrespective of the intensity and level of stress during work time, a 10–12-hour day will not leave much time for rest and restitution. The result is too little sleep. But apart from this, rest is not just a matter of sleeping 7.5 hours. It means having the time to relax after work so that sleep is *possible* – without needing to drink or use other ways of inducing sleep. Another immediate implication of the long hours – together with the geographical dimension – is how little time there is to spend with the family. As far as working time contracts in these projects are concerned, the family is a non-existent quantity. And the frequent changes in work schedules require of course constant adjustments to be made by the rest of the family. A third corollary of long working hours per se is the heightened accident risk – not just in the workplace, but off work as well, including on the roads.

The second approach is to look at the effect of long working days on health in the shape of recurrent work-related strains and stresses. We lack conclusive knowledge in this area, but we presume that a connection exists between the heightened prevalence of locomotor system disorders and the long working hours because the workers put in more hours of physically demanding work at a time without sufficiently lengthy breaks to enable the body to recuperate. For other disorders, such as hearing loss caused by a noisy environment, the impact is accumulative. It is not so much a question of daily hours, but the average spread over time. A further consequence of exposure to noise and other environmental hazards needs to be taken into account, however. Work in an environment polluted by noise and dust etc. for extended periods can be mentally exhausting too, and when the time to recuperate is inadequate, it may explain the prevalence of diminished psychological well-being and low energy levels, found also among the Metro workers. Beyond this, the impact of wider exposure to pressures in the working environment on the health of the construction workers must remain an open question.

### **3.8 The construction camp**

It was assumed at the start of the project that camp accommodation could in itself be onerous. The study has not verified this hypothesis entirely. The results of the questionnaire survey show that campers as a group slept more and felt more rested between workdays than the group of non-campers among the Metro workers. From the point of view of rest alone, we can

conclude that camp accommodation – given the long 10–12 hour workdays – makes more sense than commuting.

However, when the camp was built too little was done to deal with noise pollution and ensure that residents could purchase and prepare fresh food. Many campers want peace and quiet during their time off, and to prepare their meals in private. This is partly why 62% of the campers lived in caravans instead of renting a room. But with so many people staying in poorly insulated caravans without adequate kitchen facilities etc. there is cause for concern. It illustrates the need to ensure that camp inhabitants can lead a life of some privacy, by making sure that walls between the rooms are well insulated and, where possible, personal kitchen facilities are in place (where communal catering is not provided).

## 4 Discussion and conclusion

### 4.1 Discussion of findings

The results of the retrospective cohort study showing higher mortality and morbidity rates among construction workers on the Storebelt development who were taken on before 1996 is convincing evidence of a significantly higher risk to health for employees on large-scale construction projects which by no means can be considered acceptable. Among other things, we see a higher incidence of diseases indicative of sleep/rest deprivation (diseases of the cardiovascular and digestive systems) and related to environmental burdens (diseases of the respiratory and locomotor systems). It was not possible to investigate the impact of environmental burdens i.a. retrospectively, but we know that the nature of the work, the working environment, working time contracts and accommodation conditions in the three big developments are basically similar. The cross-section study's many substudies have generated knowledge about many aspects of the working environment, working hours, accommodation conditions and the daily life of construction workers employed on the Metro development. The cross-section study was unable to establish unequivocally a connection between the length of the working day and attrition. The information we gained from the questionnaire survey of Metro workers showed that most slept less than 7.5 hours during the working periods, that commuters did not sleep and rest as much as the campers, and that a strong correlation pertained between little sleep and diminished sense of psychological well-being and low energy levels. These results of the questionnaire survey are uncertain partly due to the uncertainty of the self-reported hours of sleep, partly because of the 61% response rate. But these circumstances do not detract from the correlations established by the data. The questionnaire survey substantiates in essence Swedish studies of construction workers under similar conditions.<sup>6</sup> With regard to the working environment, the questionnaire survey indicates higher exposure to noise, whole-body vibrations and unhealthy working positions in comparison with other Danish construction workers, and also that the prevalence among Metro workers of locomotor system problems, particularly affecting the lower back, is no less than was found 20 years ago among labourers and concrete workers.

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<sup>6</sup> Ørbæk, P., Kecklund, G., Seger, L. and Åkerstedt, T. (2000): *Arbetsvecka på 84 timmar. Trötthet, sömnmönster och stressreaktioner*, pp. 1–31. Report issued by Clinic of Occupational and Environmental Medicine, Lund University Hospital and National Swedish Institute for Psychosocial Medicine (IPM), Karolinska Institute, Stockholm and Ekstedt, M., Kecklund, G., Dahlgren, A., Åkerstedt, T. and Samuelson, B. (2001): *Kan dubbelskift vara en acceptabel arbetstidslösning? – effekt på återhämtning, stress och hälsa*. Stressforskningsrapporter 2001:301. IPM, Karolinska Institutet, Stockholm.

## **4.2 Conclusion and recommendations**

### **Conclusion**

The results taken together paint a very clear picture indeed of the extraordinary strains and stresses workers face on big construction projects, along with a significantly higher risk to health, neither of which can be considered to be acceptable. The higher incidence of cardiovascular, digestive, respiratory and locomotor disorders we take as a consequence of sleep/rest deprivation and pressures in the working environment. This links up to the unusually long hours spent performing heavy physical work in an unhealthy working environment, with insufficient time for rest and recuperation in preparation for the next day's work. The general conclusion must therefore be that the organisation of large-scale developments, with long hours, on-site accommodation or long-distance commuting, represents a considerable risk to the health of the employees. Preventative steps must therefore be taken. Given the relatively complex nature of the pressures involved, this may not necessarily be a simple matter.

### **Wider perspective on preventive measures**

The results set out above have implications not only for large-scale projects, but for the building and construction sector in general, and for other sectors with similar working hours, transport and housing options.

While the building and construction trade has always been a mobile sector, there is a trend towards greater mobility and longer hours.

In Denmark, several structural pressures are increasing long-distance commuting. House prices in the major cities, especially the Copenhagen area, have risen sharply, for instance, and in the provinces, where houses are more affordable, work is scant. Policy makers seems currently to be more inclined to encourage commuting. One proposal involves raising tax deduction limits for people in provincial areas where housing is abundant, but jobs are few. Speed limits on certain sections of the motorways are also being relaxed as well.

At the same time we note a wider fragmentation of the 'normal working week', among other things through new working time agreements which squeeze working hours into fewer and longer days. This development may well be greeted especially by people who need to travel long distances. We lack details concerning the extent, since working hours can be agreed locally between employers and employees, and this is not a discussion for or against specific work schedules. Our findings indicate that long hours and too many days at work without a break, and especially the combination of long hours and long-distance commuting, represent a heightened risk of rest deprivation and, in consequence, accidents at work and on the roads.

It is therefore essential to develop effective preventative mechanisms, primarily to protect the most vulnerable workers, i.e., employees on large-scale developments, but also to implement lessons to prevent problems emerging among other groups working under similar conditions with regard to hours, travel and on-site accommodation.

### **Preventative mechanisms**

The conclusions drawn from the study indicate a range of factors associated with higher risks of illness and accidents. They concern mainly inadequate rest, long hours, heavy physical and stressful work, housing and commuting. Steps must therefore be taken to:

- a) prevent damage to health and reduce risk of accidents
- b) promote welfare and take cognisance of the interrelationship between home, recreation and work
- c) ensure attractive jobs in future large-scale developments

Practically speaking, preventative steps should target:

- An improvement of the working environment, specifically with regard to heavy lifting, stressful working postures and environmental factors such as noise, dust and fumes
- Development of work schedules that balance long (but not too long) hours during the work periods with days off
- Efforts to regulate conditions for commuters by limiting travelling times and/or daily working time
- An improvement of accommodation and welfare facilities for campers

### **A brief elaboration of the recommendations**

**Working environment:** The findings, mainly from the Øresund Bridge project, suggest that a tailored effort to prevent work-related accidents has been very successful in bringing the accident rate down. It is essential to maintain efforts in this area. Similar steps have not been taken to address heavy loads, noise, dust and fumes. Our findings indicate that these problems increase the risk of disorders of the locomotor system, loss of hearing and respiratory disorders. Efforts here should be as carefully targeted as the steps listed above to reduce accidents.

**Working hours:** on the basis of the findings, there is an urgent need to regulate working hours to reduce pressures. There are two aspects here, the length of the working day and the number of consecutive days on the job. In this connection, it should be remembered that overtime, both in relation to daily working hours and the work period as a whole, reduces even further the time left to rest. The design of the work schedules and the constant changing from one to another have additional implications for workers' home and social life in general.

Commuting in combination with long hours: our findings show clearly that daily commuting over large distances combined with long working days represents a significant and unacceptable health risk both to the commuter himself and to others inadvertently involved in traffic accidents. But commuting over shorter distances in combination with long hours also creates difficulties with regard to achieving sufficient rest. Both could be addressed by regulating working hours, as stated above, and by designing an economic incentive packages that promote the use of on-site accommodation and discourage commuting.

Housing: the findings of the study show how essential it is that mechanisms be put in place to promote the following:

- Good sleeping habits, essentially by reducing noise
- Hygienic facilities for the storage and preparation of food, including a certain amount of privacy to prepare and enjoy meals
- Sufficient and healthy morning and evening meals at the camp
- Contact with family and friends at home, via telephone and Internet, for instance
- Opportunity for social interaction

In the management of the camp the following features should be in place:

- A permanent vice-host/camp manager, who should also contribute to the social life of the campers
- High cleaning standards
- Good washing facilities/laundry
- Simple, family-like leisure activities
- Regulations on smoking and drinking
- Catering: morning and evening meals, flexible meal times, so that people can get a bite to eat at ‘the wrong times’.

The overall thrust of the initiatives must essentially be to improve accommodation standards. To that end, the points listed above could form a basic standard for the establishment and running of construction camps.