

'Kicking the can down the road' – is tunnelling ready to address its fatigue risks?

[retitled by journal editor; "Waking up to fatigue"]

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Research conducted on Tideway with stakeholders who work in tunnelling suggests that current shift patterns and working arrangements in the sector are problematic: but addressing this is difficult given cost constraints, tight deadlines and the choices workers make to suit their personal circumstances. Tideway has thrown down the gauntlet by specifying that tunnelling shifts on the project must not exceed ten hours.

Fatigue is a major risk factor for accidents and ill-health. It was a contributory factor in many major incidents including Chernobyl, Bhopal, Exxon Valdez, Challenger space shuttle and the Three Mile Island disaster. It also accounts for around 25% of serious road traffic collisions.

Most research into work-related fatigue and its effects has focused on rail, manufacturing and health care. Relatively little has been undertaken in construction and even less specifically in tunnelling. It is, nevertheless, a recognised cause for concern. Discrete studies have been undertaken in recent years, particularly using movement monitors to track workers' sleep, but there have been no clear outcomes or recommendations from these.

Fatigue Research on Tideway

The Tideway tunnel is a 25km 'supersewer' under the River Thames in London. Construction on the 7m diameter tunnel began in 2016 with completion scheduled for 2024. Three joint ventures are involved, comprising eight tier 1 contractors.

Tideway made an early commitment to reduce fatigue on the project, specifying in their Works Information that tunnellers should not work shifts longer than ten hours. They have also engaged in a range of interventions to mitigate risks that arise from shift work including review and comparison of different patterns, worker engagement and training, and the use of fatigue management plans. They engaged Loughborough University to carry out a scoping study to determine what is already known in the UK tunnelling sector about fatigue and sleepiness.

This paper describes the five key outcomes from a stakeholder workshop and follow up survey. The workshop involved a structured discussion around fatigue in UK tunnelling, based on attendees' experience throughout their careers. The discussion considered: causes of fatigue, the impact of fatigue, how fatigue is managed by the industry, and what barriers are preventing successful fatigue management. Eight key stakeholders employed on Tideway or similar projects attended (health & safety professionals, tunnelling engineers, works managers etc). In the subsequent follow up survey, the attendees plus fourteen additional stakeholders from similar backgrounds were asked to confirm how strongly they agreed with each of 38 points summarising the workshop discussion, how important each was for the sector to consider, and how easy they would be to address.

Other elements of the fatigue research conducted included interviews with 50 frontline Tideway workers and managers and an expert discussion on the use of fatigue prediction tools such as the HSE Fatigue and Risk Index (FRI). These will be reported in detail elsewhere, but their findings were broadly in line with the findings of the stakeholder workshop.

Outcome one: Fatigue is a significant issue in tunnelling

Findings Participants felt strongly that fatigue is an issue in the tunnelling sector, specifically the length of shifts, the number of consecutive shifts and rotation between different shifts.

“The tunnelling industry is aware of the effects of fatigue but continues to kick the can down the road on major projects”

- Shift patterns are driven by the culture of the industry: tight deadlines, low profit margins, and 24/7 working are the accepted norm.
- Despite some variation in shift patterns in recent years, e.g. on Crossrail and Tideway, many tunnelling projects still work to the traditional shift patterns 7-4 7-3, (twelve-hour shifts, seven days and seven nights with four, then three days off in between).
- Shifts described as ‘twelve hours’ may in practice be thirteen hours or longer if workers need to travel to the tunnel face before they start work.
- Commuting contributes to fatigue. For example, in London this might involve travel for 60-90 minutes each way, with some workers travelling in excess of two hours each way.
- Workers might travel for several hours each way to see their families at weekends.

Discussion The concerns raised by participants, which were based on their own personal experience and that of the teams they had managed, are well founded. For example, there is evidence that accident risk increases as shifts get longer (increased risk of 27.5% for a 12 hour shift compared to 8 hours has been suggested), and that accident risk appears to increase over sequential night shifts.

Calculations using the HSE’s FRI show the 7-4 7-3 shift pattern to peak at 47.9 for fatigue and 1.8 for risk. This means an almost 50% chance that workers on the shift will struggle to stay awake at work; and a risk of accident 80% higher than the average for workers on a baseline working pattern (which is taken within the FRI as being two x twelve hour days, two x twelve hour nights, then four days off). Figure 1 shows the impact of the 7-4 7-3 shift pattern on the opportunity workers have to sleep between their shifts.

The risk of error or poor performance is likely to increase after being awake for 16 hours or longer. As Figure 1 shows, tunnellers might still be at work after almost 24 hours awake on their first shift of a new series. There are further risks for those who are traveling home after their block of work shifts and may be driving when they have been awake for twenty hours or longer.

“We’d leave at one o’clock on a Monday morning to get to work for seven o’clock and work twelve hours. I’m not saying that’s right, but I didn’t really see it as a problem at the time.”

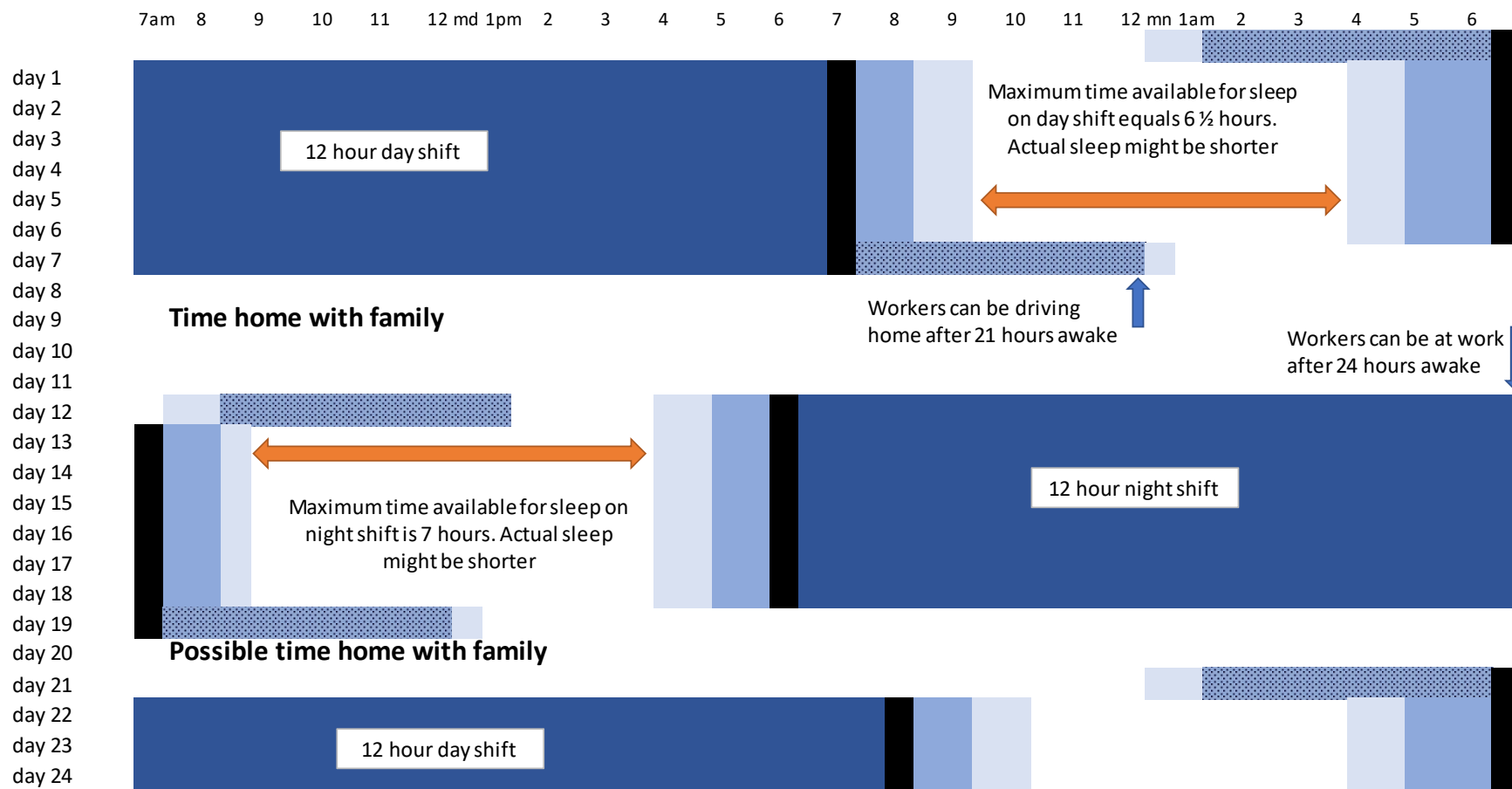


Figure 1 Potential Impact of a 7-4 7-3 pattern on sleep opportunity and periods of waking

Work time
Travel to and from face
Local Commuting
Long distance commute
Food/personal time
Time available for sleep

Assumptions:

- 30 minute travel to and from tunnel face (worst case scenario, not universal practice)
- One hour commute home from work
- 90 minute commute to work (to allow for contingency)
- Five hours to travel home to family for remote workers
- One hour to dress and eat before leaving for work in the morning
- One hour to relax and eat on arrival home after a day shift
- 30 minutes to relax and eat on arrival home after a night shift

Outcome two: Lack of clarity around the best shift pattern

Findings Participants recognised that finding an optimal shift pattern is difficult because of the variability between workers and their personal circumstances and preferences.

- The traditional 7-4 7-3 is the preferred shift for workers who travel to London from places such as Newcastle or the north west of Ireland, as it allows long breaks to travel back to family every three weeks.
- Tunnelling has traditionally been an industry that pays well (in a recent documentary about the Channel Tunnel, one worker commented that in the late 1980s he was earning around £50,000 per year, ten times what he could earn in a manufacturing role), but salaries are reportedly relatively lower now. Workers may therefore seek out shift patterns that give them the highest income, regardless of the impact it has on them personally. For example, where workers are hourly paid, they may favour patterns such as 7-4 7-3 which give them a 56 hour average working week, in preference to shorter hours. (This may become less of an issue as projects look for alternative payment models.)
- Workers who live close to a work site are more likely to favour eight hour shifts which give them more time with their families.
- Those who cannot tolerate particular shift patterns leave the industry. Therefore, the workforce is made up of largely of those who tolerate the existing demands.
- Existing research has not provided a clear answer to the question ‘what are the best shifts?’ For example, it was discussed that in a recent study, workers on 8-hour shifts slept less than those on 12-hour shifts, possibly due to increased opportunities for social activities, particularly when living away from home.

“it’s going to be really difficult to get the change, unless we can get some research that fairly clearly pinpoints in a particular direction”

Discussion Assessment with the HSE FRI shows eight hour patterns to be potentially better than twelve hour ones in terms of minimising risk and fatigue. However, this is only part of the picture. Tideway’s own analysis demonstrates that changing to eight hour patterns (such as 7-3 7-2 7-2) results in remote workers being able to visit their families less often and for shorter periods of time. This could have an adverse impact on the health and wellbeing of workers. Additionally, these patterns increase the number of workers required which increases costs (and might be difficult to achieve if there is a shortage of workers). They also increase the number of shift changeovers required each day, which is an additional risk factor. Other 8 hour shift patterns such as continental patterns (e.g. three days, two lates, two nights, two or three days off) have similar challenges: risk and fatigue levels drop substantially but the patterns are unrealistic for a workforce living away from home. They also involve a drop of 25% in working hours and consequently in pay. Therefore, a change to an eight hour pattern is not a straightforward solution.

Outcome three: Where the solutions might lie, and the main barriers to these

Findings Research participants identified a range of things which influence fatigue in tunnelling. Figure 2 shows those which they considered to be most important to address.

- There was a strong feeling that real improvement could be achieved only with a culture change at the highest levels of the industry, and embedded throughout the sector.
- Culture change will not be easy to achieve as it means the sector recognising that jobs will take longer and cost more.
- The responsibility of the client was emphasised: to set the expectations which drive projects. Otherwise, successful bids will always be those which focus on the cheapest options.

“All the jobs outside London are still twelve hour shifts, nothing’s changed. And the client’s driving that.”

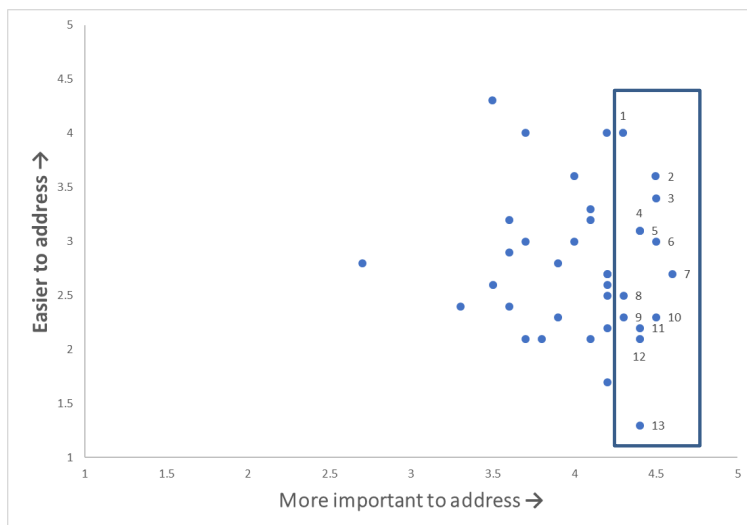


Figure 2: Things which were identified as important when considering fatigue in tunnelling

Things which are most important (with the easiest to address shown first)

1. More research and investment should be directed to investigating fatigue
2. Fatigue is increased by working more shifts consecutively.
3. Working longer shifts increases fatigue.
4. Fatigue would be reduced if every project dedicated enough money to fatigue management.
5. Clients exacerbate fatigue by applying pressures for financial reasons.
6. Fatigue would be reduced if clients better understood the benefits of managing fatigue.
7. A fatigued worker is more likely to have an accident when driving home.
8. There is a lack of clear regulation concerning fatigue and tunnelling.
9. Fatigue would be reduced if there was willingness to change the culture of the tunnelling industry.
10. Fatigue would be reduced if operating margins were higher to reduce the financial pressure.
11. Long commute times to work increase fatigue.
12. Fatigue makes it harder for people to concentrate at work.
13. Social factors such as family life and having children influence fatigue at work.

- Improved training and education of both the workforce and of managers was identified as being quite important and relatively easy to achieve.
- Continued improvement in the quality of the work environment e.g. through good ventilation and lighting was also identified as easy and quite important.
- There was a belief that gathering more evidence on the consequences of fatigue was important, in order to persuade the industry decision makers that they need to act.

Discussion Some participants felt that further research on the harm caused by fatigue would drive change. In fact, there is already evidence to show the adverse impacts of long working hours. Additionally, there is evidence of the health risks from shift work and night work, which have been linked to an increased risk of cancer as well as diabetes, digestive problems, obesity and heart disease. However, such evidence is not specific to tunnelling and may not have high enough visibility in the sector to influence change.

The main barriers to change are the financial challenges. These are substantial. Construction in the UK generally operates at low margins, with the top 100 contractors (by turnover) declaring profits of only 2.5%. This leaves little scope for changing working patterns unless there is strong evidence that

the benefits of change outweigh the disadvantages. There is a need for strong research evidence assessing the impact of different solutions, taking into account a very wide range of factors: accident risk, productivity effects, costs, worker wellbeing and the realities of worker recruitment. The construction of Bank station for Transport for London, is currently investigating the impact of changing from twelve hour to eight hour shifts. In addition, on one of the Tideway sites, a working pattern of five (11 hour) days, two days off and four (11 hour) nights, three days off was trialled which allowed the site to operate for 24 hours during the working week but to close down (or to schedule maintenance) at the weekend. Such patterns often arise from the need to avoid noisy work over weekends due to community constraints, but may carry an added advantage for work scheduling. Carefully planned research on projects such as these is important to really test out these alternatives in practice and give clients confidence that change is possible and beneficial.

Outcome four: Challenges for middle managers

Findings Fatigue in tunnelling isn't only an issue for frontline workers.

- There were concerns raised about those in management and professional roles, particularly those in middle management. This group were reported to be under high pressure and often working extremely long hours
- Those working shifts typically do up to an hour at either end to allow hand over time with their opposite number, making 'twelve' hour shifts 13 hours or longer. They do this as they are motivated to do the job well; and additionally, there are often management expectations that they will stay behind to hand over
- Those working 'regular' day shifts similarly start work early and finish late. They also work during the weekends on emails and other non-site duties, in order to keep up with demands; and often end up on 24 hour call as they have no one else to hand responsibility to when they are not at work

"you take a lot of work home with you as a manager in order to keep the job running. This is the hidden fatigue. I have worked till past midnight twice already this week to keep up with the workload."

Discussion As with frontline workers, sleep deprived managers are at increased risk of fatigue, with potentially adverse impacts on safety and health. For example, fatigue and sleep loss can result in rigid thinking, which in turn can lead to poor decision making (e.g. an inability to change direction or try a different approach, despite clear evidence to recommend this. This has been identified as one of the contributors to the Challenger space shuttle accident). Additionally, there is a risk of burnout. This is not exclusive to management roles, nor is it caused solely by long working hours. However, it will increase the risk that engineers and middle managers may leave jobs or even the sector if they find the impact on themselves and their families to be too great. They may have more transferable skills than many frontline workers, and therefore more options to leave if they find the work intolerable.

Long working hours for middle managers are about more than shift patterns, they also reflect cultural expectations in the sector. This needs to be addressed therefore as part of a broader approach to mental health, considering management styles and skills, reasonable expectations and job demands and control.

Outcome five: Industry is improving in fatigue management

One encouraging message from the workshop was a belief that the sector is improving in its management of fatigue, particularly in its willingness to question whether certain shift patterns are acceptable. It has also progressed in the development of fatigue management plans and processes to support the workforce with mental health issues. Improvements have also been seen in the physical environment – better management of ventilation and dust exposures, reduced physical demands and improved welfare facilities.

Some also expressed the view that the culture was changing amongst the construction workforce, particularly for young professionals and engineers. It was suggested that they were less willing than the previous generation to work extended hours, and that they had an expectation of continuing with sport and social activities which were incompatible with shift working. This might contribute to future change in the sector, particularly if it becomes difficult to recruit to jobs that demand long hours or have challenging shift patterns.

Final thoughts

The tunnelling sector is waking up to fatigue as an issue. All the participants in this research recognised that the status quo is not an option and that change is needed.

However, simply switching from twelve hour shifts to eight hours is an inadequate solution - a narrow approach to a complex issue, and one which introduces new problems as well as increasing costs. In fact, a hierarchy of control approach would identify that rearranging shifts in this way is essentially an administrative solution to the risk of fatigue and suggest that more effort be put into addressing the problem at source. A more satisfactory solution in the longer term therefore might be to design out the expectation of 24/7 working: this might need to be supported by the development of new technologies which do not rely as strongly on continuous operation. Other factors to consider when seeking solutions are the impact of various commercial models, whether labour is employed directly or sourced through sub contractors or agencies, and whether or not workers are hourly paid. Shared responsibility is also important – the need for the sector to provide safe working arrangements and the expectation on the workforce to ensure they are fit for work.

Considerable culture change will be required if fatigue in tunnelling is to be properly addressed. Tunnelling is a sector which seeks to deliver construction quickly and cost-effectively and relies on its workers to support this approach. A recent comment by the CEO of Crossrail, that “We are working around the clock with our supply chain and Transport for London to complete and commission the Elizabeth line” typifies this. Tideway’s challenge to the sector to plan shifts that do not exceed ten hours says as much about values and priorities as it does about working hours. It has thrown down the gauntlet: time will tell whether the sector is ready to pick it up.