TEMPORARY WORKS

HPC Inspire

We're Hinkley Point C's Education Programme in Somerset and the wider South West region. And we're here to help young people at school or college learn about the huge opportunities the construction and operation of Hinkley Point C has to offer them.

www.edfenergy.com/hpcinspire

Subjects

This activity supports curriculum learning at Key Stages 3 and 4:

- Maths
- Physics
- Combined Sciences

Part 1: Temporary works at Hinkley Point C

Watch **this film** to learn more about the largely unknown – but hugely important – area of construction called temporary works.

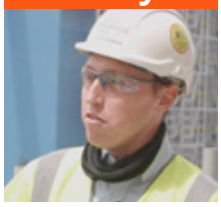
Q. What are temporary works?

A. _____

_____

_____

Joe says:



"What I enjoy most about temporary works is that it's more about first principle engineering rather than looking at the design requirements of a structure."

Joe says:

"I don't know why temporary works isn't more widely known outside the industry. Historically there's been more focus on designing permanent works when you're at university, rather than the day-to-day site delivery aspect of engineering. But that might be changing; for instance, City University in London now offers a Masters course in Temporary Works and Construction Method Engineering."

Q. How much of Hinkley Point C is temporary works related?

A. _____

Q. What subjects does Joe recommend you study to get into temporary works?

A. _____

Q. Was Joe always interested in temporary works?

A. _____

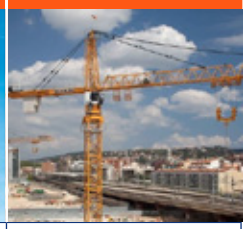
Q. What does Joe say it's like to work at Hinkley Point C?

A. _____

Part 2: Follow up activities

A lot of tower cranes are used at Hinkley Point C to lift components into the construction site. It's the job of the temporary works team to ensure that the foundation for the crane is designed to keep the crane stable.

The crane team has looked at the items of plant to be lifted and determined the best crane for the job is the Wolfkran 1250B – see the table below.

Model	Wolffkran 1250 B	Potain MR 608	Liebherr 630 EC
			
Jib Length (m) (This is the length of the crane arm)	80	60	80
Height (m)	41.5	51	80
Load capacity at Maximum Radius (t) (This is the maximum the crane can lift at the maximum distance from the crane)	14	9	5.2
Counterweight Mass (t) (This is what the crane uses to counteract the load it's going to lift)	75.8	60	50
Jib Mass (t)	29.8	14.9	22.1
Slewing Structure Mass (t) (This is the mass of the crane cab and structure that spins on the top of the tower)	80.2	63.3	50
Tower Mass (t) (This is the mass of the tower section that the crane sits on)	70	87.6	100
Tower footprint area width x depth (m)	3 x 3	2.5 x 2.5	2.45 x 2.45

Use the table on page 2 to answer the following questions. If you get stuck, see the hints on page 7.

Q1. What's the total weight of the unloaded crane?

A. _____

Q2. What's the total area of the tower affected by the wind? (Clue: multiply the area by 0.2*)

A. _____

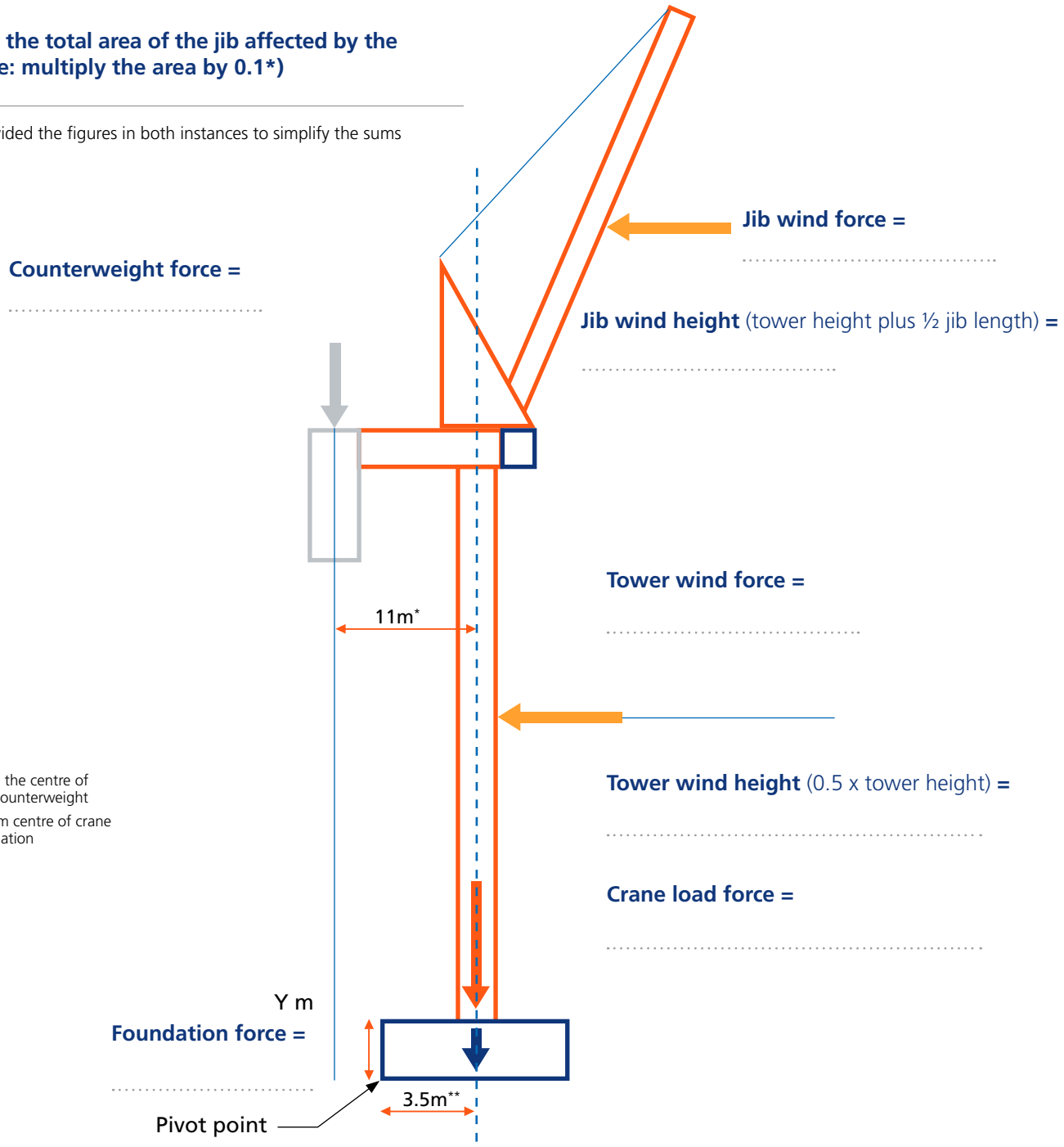
Q3. What's the total area of the jib affected by the wind? (Clue: multiply the area by 0.1*)

A. _____

*We have provided the figures in both instances to simplify the sums

Q4. Fill in the missing information on the drawing below, remembering that:

- You may need to use your answers from the previous questions
- Force = Mass x Acceleration and we have assumed gravity acceleration is 10m/s^2, so 1t = 10kN
- For the wind load, remember that Force = Pressure x Area using a wind pressure of 1.5kN/m^2
- If you get stuck, see the hints on page 7



* Distance from the centre of crane to the counterweight

** Distance from centre of crane to the foundation

Q5. The temporary works team needs to design a foundation to ensure the crane is stable, due to wind loads and loads from the counterweight. To do this, you need to take moments about the bottom corner of the base to work out its required size.

Answer the questions below, using your answers from the previous sections and the drawing. Remember that:

- Moment of a force = force × distance
- If you get stuck, see the hints on page 7

a) Calculate the overturning moments (i.e. The forces / moments trying to make the crane tip over) **for:**

i. Wind on jib (kNm)

A. _____

ii. Wind on tower (kNm)

A. _____

iii. Counterweight (kNm)

A. _____

iv. Total (kNm)

A. _____

b) Calculate the restoring moments (i.e. the forces / moments stopping the crane from falling over)**:**

i. Crane (kNm)

A. _____

ii. Foundation (kNm)

A. _____

c) Determine the height of the concrete foundation (Y) (m)

A. _____

d) Now we have worked out the size of the foundation, what is the total load of the crane and foundation? (kN)

A. _____

e) What is this in Tonnes? (t)

A. _____

f) What is the pressure under the foundation? (kN/m²)

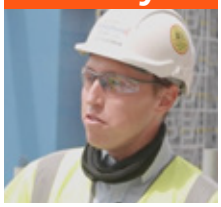
A. _____

NB: The area of the foundation is 7x7m. From the diagram, it is shown as 3.5m from the centre to the edge of the concrete

g) To ensure the foundation does not slide, we need to make sure there is enough friction between the concrete foundation and the ground. If F=μR, what does μ have to be to resist the wind loads?

A. _____

Joe says:



"Working in temporary works involves constant problem solving. You often need to adapt to sudden changes off the cuff, so you have to be pretty resilient. Being able to communicate effectively with people on site is hugely beneficial in this role. It's not just delivering technical information, but also knowing how to communicate with a range of people from all levels and backgrounds."

Part 3: Jobs in temporary works

Complete the two fact files below.

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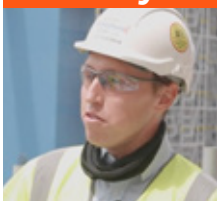

"I always wanted to be an engineer. Both my dad and grandad are – but on the mechanical side instead. I was more interested in civil engineering because it gave me the option to travel and the skills you learn are incredibly transferable."

Civil engineer (https://careers.startprofile.com/page/occupation?SOC=2121)

What is civil engineering?	
What are some of the tasks civil engineers carry out?	
What's the annual salary?	
What are the entry requirements?	

Joe's career path to Hinkley Point C

- GCSEs
- A-Levels (Maths, Physics, IT and Design & Technology)
- Master of engineering degree (MEng) in civil engineering
- Chartered Engineer – Member of the Institution of Civil Engineers (CEng MICE)
- Worked in the UK and Australia in roles, such as: Graduate Engineer, Site Engineer, Section Engineer, Senior Engineer, and Senior Project Engineer
- Joined Hinkley Point C as Temporary Works Coordinator – Conventional Island

Structural engineer:

https://nationalcareers.service.gov.uk/job-profiles/structural-engineer

What do structural engineers do?	
What are some of a structural engineer's day-to-day tasks?	
What salary range can you earn?	
What are the different ways you can get into this role?	

Further reading:

Forces (KS3): https://www.bbc.co.uk/bitesize/guides/zttfyrd/revision/7

Pressure (KS3): https://www.bbc.co.uk/bitesize/topics/z4brd2p/articles/zk6kw6f

Moments, levers and gears (GCSE – AQA): https://www.bbc.co.uk/bitesize/guides/ztjpb82/revision/1

Careers in civil engineering: https://www.ice.org.uk/what-is-civil-engineering/how-can-i-become-a-civil-engineer

Learn more about the role of scaffolding at Hinkley Point C – and what it's like to be an apprentice: https://www.youtube.com/watch?v=z7RNx7LLL2Y&list=PLXeIrBe86r_Kg8-XGXzarZeIevl3TyCGi&index=4

Next steps:

More films on jobs and apprenticeships at Hinkley Point C: https://www.youtube.com/playlist?list=PLXeIrBe86r_Kg8-XGXzarZeIevl3TyCGi

Young HPC – our skills development programme for 16-21 year olds: www.edfenergy.com/younghpc

Young HPC toolbox – careers advice and tools: https://www.edfenergy.com/energy/nuclear-new-build-projects/hinkley-point-c/education-and-skills/young-hpc/tool-box

Jobs and training at Hinkley Point C: https://www.edfenergy.com/energy/nuclear-new-build-projects/hinkley-point-c/jobs-and-training

HPC Jobs Service – sign up for job alerts and learn about different roles at HPC (post-16s only): https://hpcjobsservice.edfenergy.com

Hints for the follow-up activities

Q1. Total weight of the unloaded crane = the sum of the counterweight, jib, slewing structure and tower

Q2. Total area of the tower affected by the wind = width x height x 0.2

Q3. Total area of the jib affected by the wind = width x length x 0.1

Q4. Jib wind force = total area of the jib affected by the wind (your answer to Q3) x wind pressure (1.5kN/m^2)

Counterweight force = counterweight mass x gravity acceleration

Tower wind force = total area of the tower affected by the wind (your answer to Q2) x wind pressure (1.5kN/m^2)

Crane load force = (jib mass + slewing structure mass + tower mass) x gravity acceleration

Q5.
a) i. Overturning moment for wind on jib = jib wind force x jib wind height

a) ii. Overturning moment for wind on tower = tower wind force x tower wind height

a) iii. Overturning moment for counterweight = counterweight force x counterweight height

b.i) Crane restoring moment = crane load force x distance from centre of crane to the foundation

b.ii) Foundation restoring moment = foundation force x distance from centre of crane to the foundation

c) In order to prevent the crane falling over, the restoring moment (6,300 + 4,287.5*Y) must equal or be larger than the overturning moment (9,394).

d) Total load of the crane and foundation = crane load force + counterweight force + (foundation force x height)

e) To calculate the answer in tonnes, divide by 10

f) Pressure under the foundation = Total load of crane + foundation / area of the foundation

g) F=μR: (Friction (F) = the friction coefficient (μ) multiplied by the reaction force (R)
μ = (jib wind force + tower wind force) / total load of the crane and foundation

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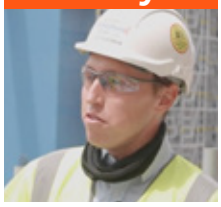
Part 1: Temporary works at Hinkley Point C

Watch **this film** to learn more about the largely unknown – but hugely important – area of construction called temporary works.

Q. What are temporary works?

A. Temporary works are engineered solutions to support a building or structure in its temporary phase or to allow us to build the structure itself – like supporting the tower cranes, plant and machinery, or the workforce.

Joe says:



"What I enjoy most about temporary works is that it's more about first principle engineering rather than looking at the design requirements of a structure."

Joe says:

"I don't know why temporary works isn't more widely known outside the industry. Historically there's been more focus on designing permanent works when you're at university, rather than the day-to-day site delivery aspect of engineering. But that might be changing; for instance, City University in London now offers a Masters course in Temporary Works and Construction Method Engineering."

Q. How much of Hinkley Point C is temporary works related?

A. Most of the site! Most buildings are in a temporary state – either being supported by temporary works or they are going to support temporary works on top of them. Temporary works is the construction engineering that allows us to build.

Q. What subjects does Joe recommend you study to get into temporary works?

A. Maths and Physics to work on the technical side; or communication subjects for the coordination side – such as English and/or technical drawing.

Q. Was Joe always interested in temporary works?

A. He didn't know temporary works existed when he was at university. It was only through his career that he became interested in the more pure 'how are we going to build this tomorrow' type of engineering.

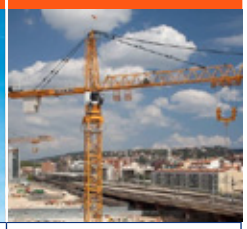
Q. What does Joe say it's like to work at Hinkley Point C?

A. He finds the scale of things so impressive: from the massive teams on site to the huge concrete pours and delivering one of the biggest construction sites in Europe.

Part 2: Follow up activities

A lot of tower cranes are used at Hinkley Point C to lift components into the construction site. It's the job of the temporary works team to ensure that the foundation for the crane is designed to keep the crane stable.

The crane team has looked at the items of plant to be lifted and determined the best crane for the job is the Wolfkran 1250B – see the table below.

Model	Wolffkran 1250 B	Potain MR 608	Liebherr 630 EC
			
Jib Length (m) (This is the length of the crane arm)	80	60	80
Height (m)	41.5	51	80
Load capacity at Maximum Radius (t) (This is the maximum the crane can lift at the maximum distance from the crane)	14	9	5.2
Counterweight Mass (t) (This is what the crane uses to counteract the load it's going to lift)	75.8	60	50
Jib Mass (t)	29.8	14.9	22.1
Slewing Structure Mass (t) (This is the mass of the crane cab and structure that spins on the top of the tower)	80.2	63.3	50
Tower Mass (t) (This is the mass of the tower section that the crane sits on)	70	87.6	100
Tower footprint area width x depth (m)	3 x 3	2.5 x 2.5	2.45 x 2.45

Use the table to answer the following questions. There are hints to students if they get stuck.

Q1. What's the total weight of the unloaded crane?

A. 75.8t + 29.8t + 80.2t + 70t = 255.8t

Q2. What's the total area of the tower affected by the wind?

A. 3m x 41.5m x 0.2* = 24.9m²

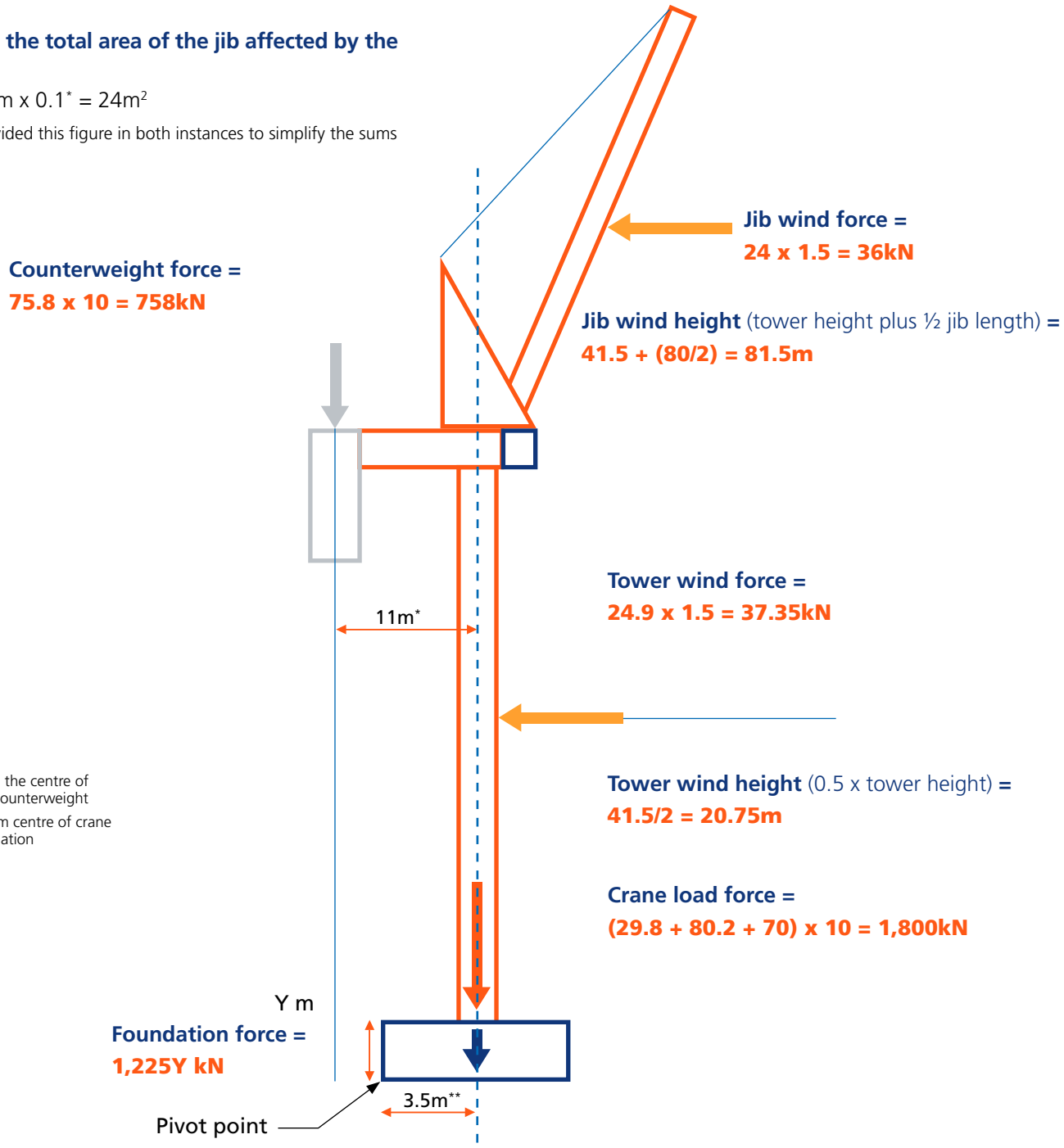
Q3. What's the total area of the jib affected by the wind?

A. 3m x 80m x 0.1* = 24m²

*We have provided this figure in both instances to simplify the sums

Q4. Fill in the missing information on the drawing, remembering that:

- You may need to use your answers from the previous questions
- Force = Mass x Acceleration and we have assumed gravity acceleration is 10m/s², so 1t = 10kN
- For the wind load, remember that Force = Pressure x Area using a wind pressure of 1.5kN/m²
- If students get stuck, there are hints to help them



* Distance from the centre of crane to the counterweight

** Distance from centre of crane to the foundation

Q5. The temporary works team need to design a foundation to ensure the crane is stable, due to wind loads and loads from the counterweight. To do this, you need to take moments about the bottom corner of the base to work out its required size.

Answer the questions below, using your answers from the previous sections and diagram. Remember that:

- Moment of a force = force × distance
- There are hints for students if they get stuck

a) Calculate the overturning moments (i.e. The forces / moments trying to make the crane tip over) **for:**

i. Wind on jib (kNm)

A. 36 x 81.5 = 2,934kNm

ii. Wind on tower (kNm)

A. 37.35 x 20.75 = 775.0kNm

iii. Counterweight (kNm)

A. 758 x (11-3.5) = 5,685kNm

iv. Total (kNm)

A. 2,934 + 775.0 + 5,685 = 9,394kNm

b) Calculate the restoring moments (i.e. the forces / moments stopping the crane from falling over)**:**

i. Crane (kNm)

A. 1800 x 3.5 = 6,300 kNm

ii. Foundation (kNm)

A. 1,225Y x 3.5 = 4287.5Y kNm

c) Determine the height of the concrete foundation (Y) (m)

A. 9,394 = 6,300 + 4,285.5Y so Y = 0.72m

Here's a more detailed breakdown: 9,394 = 6,300 + 4,287.5Y. If we take away 6,300 from both sides we get 3,094 = 4,287.5Y. Divide both sides by 4,287.5 to get 0.72 = Y

d) Now we have worked out the size of the foundation, what is the total load of the crane and foundation? (kN)

A. 1,800 + 758 + (1,225 x 0.72) = 3,440kN

e) What is this in Tonnes? (t)

A. 3,440/10 = 344t

f) What is the pressure under the foundation? (kN/m²)

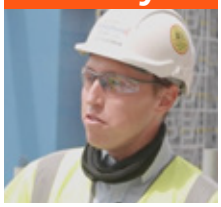
A. 3,440 / (7x7) = 70.2kN/m²

NB: The area of the foundation is 7x7m. From the diagram, it is shown as 3.5m from the centre to the edge of the concrete

g) To ensure the foundation does not slide, we need to make sure there is enough friction between the concrete foundation and the ground. If F=μR, what does μ have to be to resist the wind loads?

A. (36 + 37.35) / 3,440 = 0.021

Joe says:



"Working in temporary works involves constant problem solving. You often need to adapt to sudden changes off the cuff, so you have to be pretty resilient. Being able to communicate effectively with people on site is hugely beneficial in this role. It's not just delivering technical information, but also knowing how to communicate with a range of people from all levels and backgrounds."

Part 3: Jobs in temporary works

Complete the two fact files below.

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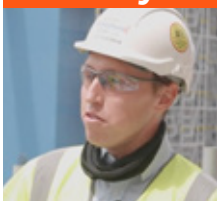

"I always wanted to be an engineer. Both my dad and grandad are – but on the mechanical side instead. I was more interested in civil engineering because it gave me the option to travel and the skills you learn are incredibly transferable."

Civil engineer (https://careers.startprofile.com/page/occupation?SOC=2121)

What is civil engineering?	Civil engineers undertake research and design, direct construction and manage the operation and maintenance of civil and mining engineering structures.
What are some of the tasks civil engineers carry out?	Being a ivil engineer can involve: ▶ Undertaking research and advising on soil mechanics, concrete technology, hydraulics, water and waste water treatment processes and other civil engineering matters ▶ Determining and specifying construction methods, materials, quality and safety standards and ensuring that equipment operation and maintenance comply with design specifications ▶ Designing foundations and earthworks ▶ Designing structures such as roads, dams, bridges, railways, hydraulic systems, sewerage systems, industrial and other buildings and planning the layout of tunnels, wells and construction shafts ▶ Organising and planning projects, arranging work schedules, carrying out inspection work and planning maintenance control ▶ Organising and establishing control systems to monitor operational efficiency and performance of materials and systems.
What's the annual salary?	£45,760
What are the entry requirements?	Civil engineers usually possess an accredited three or four-year degree in civil engineering or engineering science; or an accredited Higher National Diploma or Certificate.

Joe's career path to Hinkley Point C

- GCSEs
- A-Levels (Maths, Physics, IT and Design & Technology)
- Master of engineering degree (MEng) in civil engineering
- Chartered Engineer – Member of the Institution of Civil Engineers (CEng MICE)
- Worked in the UK and Australia in roles, such as: Graduate Engineer, Site Engineer, Section Engineer, Senior Engineer, and Senior Project Engineer
- Joined Hinkley Point C as Temporary Works Coordinator – Conventional Island

Structural engineer:

https://nationalcareers.service.gov.uk/job-profiles/structural-engineer

What do structural engineers do?	Structural engineers help to design and build large structures and buildings, like hospitals, sports stadiums and bridges.
What are some of a structural engineer's day-to-day tasks?	In this role you could: ▶ Develop engineering plans using computer software ▶ Investigate the properties of building materials like glass, steel and concrete ▶ Advise on which material is best for the job ▶ Work out the loads and stresses on different parts of a building ▶ Use computer models to predict how structures will react to the weather ▶ Work out ways to improve energy efficiency ▶ Inspect unsafe buildings and decide whether they should be demolished ▶ Prepare bids for contract tenders ▶ Supervise project teams ▶ Give progress reports to clients and senior managers ▶ Work out why and how buildings have collapsed, like after an earthquake.
What salary range can you earn?	Between £22,000 as a starting salary, up to £70,000 when you have more experience.
What are the different ways you can get into this role?	▶ A university course ▶ A college course ▶ An apprenticeship ▶ Working towards the job.

Further reading:

Forces (KS3): https://www.bbc.co.uk/bitesize/guides/zttfyrd/revision/7

Pressure (KS3): https://www.bbc.co.uk/bitesize/topics/z4brd2p/articles/zk6kw6f

Moments, levers and gears (GCSE – AQA): https://www.bbc.co.uk/bitesize/guides/ztjpb82/revision/1

Careers in civil engineering: https://www.ice.org.uk/what-is-civil-engineering/how-can-i-become-a-civil-engineer

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Next steps:

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