Tall Buildings & Earthquakes
Teacher's Notes

Aims

This pack is aimed at reinforcing National Curriculum material at KS4 in Physics in an enjoyable, applied way. It is aimed at students who may potentially go on to study A-Level Physics and has been designed with 1 hour lessons in mind. Additional material is included for able students as well as suggestions for coping with weaker students. In this pack there may be some overlap with the Chemistry syllabus, depending on which examination board is used.

Curriculum content

This lesson covers:
- Earthquakes
- Wave types

Key skills:
- Group work
- Problem solving
- Evaluation

Methods covered are:
- Practical work
- Investigation
- Plotting a graph
- Manipulating equations
- Understanding inequalities

Preparation

Photocopy worksheets for students.

Worksheet 1: Instructions for activity (one per group)
Worksheet (on 220 gsm card): Cut-outs for the model buildings
Worksheet 3: Individual extension worksheet

Equipment required

A4 thin card - 220 gsm (4 sheets per set of 3 models)
Sellotape
Double sided tape (optional to improve the presentation of the models)
Paper fasteners (butterfly clips) (8 per set of 3 models)
Graph paper for the extension worksheet

Timing targets

This pack is designed for a 1 hour lesson, although it contains extension material. A model lesson is outlined below to give timing guidelines:

Start	5 mins	
Presentation	10 mins	PowerPoint presentation
Practical work (model building)	25 mins	Worksheet
Evaluation and testing	10 mins	
Tidy up	5 mins	
Wrap up	5 mins	Comments on findings and application

Worksheet 3 – Extension work

Guidance

- This pack involves comparing three buildings of different designs undergoing an earthquake. Groups can make the three buildings and then test them.
- Group sizes can vary although groups of four may work well.
- If students are unfamiliar with the concept of transverse and longitudinal waves, a simple demonstration with a 'slinky' spring can help to visualise the wave properties.
- The paper buildings do not exactly represent the way in which buildings are made, but are used here to illustrate how different structural setups can stand up but behave differently under earthquake conditions.
- The three videos show how the tests should work. These are primarily for the Teacher's information, rather than to show to the class.

Points to emphasise

- Earthquakes vary in strength and the ground response will be different for each earthquake.
- The model buildings are representations of buildings to illustrate different building structure's behaviour.
- The buildings are made with two walls so that deflections and the behaviour of the floors can be seen better.
- The first building is representative of a poorly built building, which experiences large deflections and falls apart.
- The second building is representative of an earthquake resistant design which undergoes deflection, but is flexible enough not to sustain major structural damage or collapse.
- The third building is representative of a well built building which is too rigid. The 'bracing members' represent stiff materials for walls and beams, which cause the building to topple rather than crumble.
- Although buildings need to be flexible this is not the only way of preventing catastrophic damage during earthquakes.
- Flexible buildings are less likely to collapse during an earthquake, but there is no guarantee. Every earthquake situation is different and therefore even if the building is flexible, other factors may still cause the building to collapse.

Mixed abilities

The extension worksheets are provided for homework and are more complex than the lesson content. If students work in groups they will be able to share the task of constructing the three buildings.

Presentation notes

Side 3

They may have learnt about other types of plate boundary in Geography or may have different names for them.

Slide 6

It is very difficult to design against earthquakes, since each one is slightly different. There are so many factors to consider than even with new technologies sometimes old buildings survive earthquakes whereas newly designed ones do not.

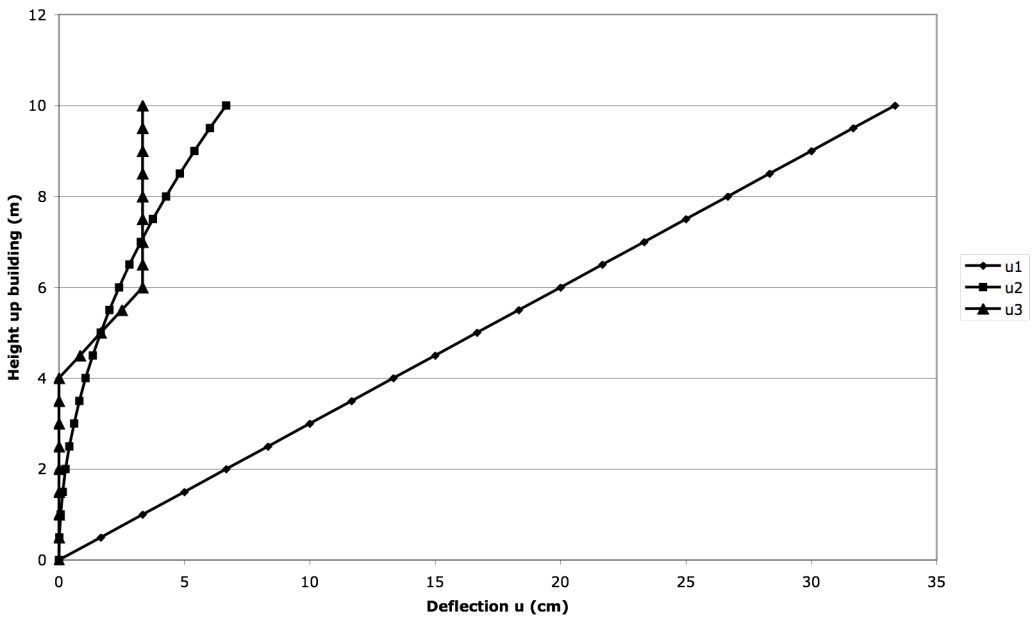
Answers

Building 1 should 'unzip' and thus collapse completely.
Building 2 should flex but keep its structural integrity
Building 3 should flex but then come loose from the tray and pivot around the base (pencil), representing the building falling over.

Building 2 is the best design since although the displacement of the building is large, it is flexible and therefore does not collapse. Buiding 1 is under-reinforced, whereas building 3 is too stiff. Some flexibility needs to be incorporated into building design to withstand earthquakes.

Extension Worksheet Answers

1. Graph shown below:



2. The straight line gives the largest deflection.

3. The buckle shape gives the smallest deflection.

4. The buckle shape is more representative of a building with one floor half way up since the floor will restrict the movement of the wall. The right angle join between the wall and the floor will be more likely to stay at 90° so the wall may buckle at a point just above or below this.

5. Factors that may affect the deflection are:
   - The presence of floors
   - The oscillation frequency of the earthquake
   - The magnitude of the earthquake
   - The location of the epicentre
   - The ground conditions
   - The foundation design
   - The structure of the walls
   - The strength of the materials
   - Whether the building has undergone previous earthquakes
   - The duration of the earthquake