About joining

Putting it all together

Almost all engineered products are made from a number of **components**. In other words, they have several bits and pieces that have to be **joined together**. And choosing the best way to join them together is essential.

Joints are either **mechanical** or **electrical**; let's look at mechanical joints first. Mechanical joints can be split into three main categories:

Permanent joints: These are - surprise, surprise - permanent. In other words, you'd have to destroy the joint if you wanted to dismantle the components (for example, super glue, welding metal, soldering)

Temporary joints: A temporary joint can be dismantled without damaging any of the product's components (for example, nuts and bolts)

Flexible joints: These ones are used when two components have to be joined, but one or both of them have to move (for example, a hinge that joins a door to a doorframe).

So those are the three main categories. Within those categories there are loads of different types of joint. You've got rivets, welds, solder, nails, screws and glues - to name but a few. And within these categories there are countless variations - bolt and nut, stud and nut. Maybe you need a single-riveted lap joint or a vertical splice joint. Will you be using cheese head screws, a set screw or maybe a counter sink? And as for bonded joints... will you use a tongue and groove, butt or a simple strap? How about a scarf? You get the point - there's a lot to choose from!

There are numerous British Standards that can be used to test various joints. They are extremely specific, so we clearly can't provide a test for every type of joint here. In industry, sophisticated machinery would be used to apply force to joints. There are limitations on what you can do in a college or school workshop. Imagine you wanted to test two bits of steel that had been joined with six rivet joints. There's no way you'd be able to pull them apart without some hefty machinery.

However, the methods of testing for strength (in other words, the ways a joint can fail) are often very similar in numerous British Standards. So the joint tests provided here show you how to compare the strength of various bonded joints under different types of force:

- joints in tension (when the force is pulling at right angles to the joined surface);
- joints in cleavage (when the force is tending to pull two edges of the joint apart);
- joints in shear (when the force is pulling the pieces in opposite directions along the joint);
- joints in peel (when force is applied to one edge pulling apart the joint).

About joining

Electrical joints

Electrical joints are the joints that connect the various components in an electrical circuit. Like mechanical joints, they can be **permanent** (soldered or crimped), or **temporary** (bolted, clamped or plugged in).

It's important you know how to make various electrical joints. So we've included a Standard Procedure. Like the Comparative Tests, this gives a specific procedure, so if you or anybody else followed the procedure, you'd make electrical joints to the same high standard.

CT 0006:2003 Methods of testing joints -

Part 1: Preparing test specimens for bonded joints

Part 2: Comparing the strength of bonded joints in shear

Part 3: Comparing the strength of bonded joints in tension

Part 4: Making permanent electrical joints: soldering

COMPARATIVE TEST CT 0006-1:2003

Methods of testing joints - Part 1: Preparing test specimens for bonded joints

1 Scope

This Standard Procedure can be used to make test specimens for testing the strength of different bonded joints. It shows how to make nine types of bonded joint:

- Simple lap
- Bevelled lap
- Double stepped lap
- Scarf
- Simple strap
- Double strap
- Simple butt
- Tongue and groove butt
- Scarf and groove butt

Specimens can be used for testing joints in tension, joints in cleavage, joints in shear and joints in peel.

2 Definitions

joints in tension (when the applied force is pulling at right angles to the joined surface);

joints in cleavage (when the force is tending to pull two edges of the joint apart);

joints in shear (when the force is pulling the pieces in opposite directions along the joint); and

joints in peel (when force is applied to one edge pulling apart the joint).

3 Principle

There are numerous ways of making a bonded joint. To test the different strengths of these joints it is important to make test specimens that can be tested and compared.

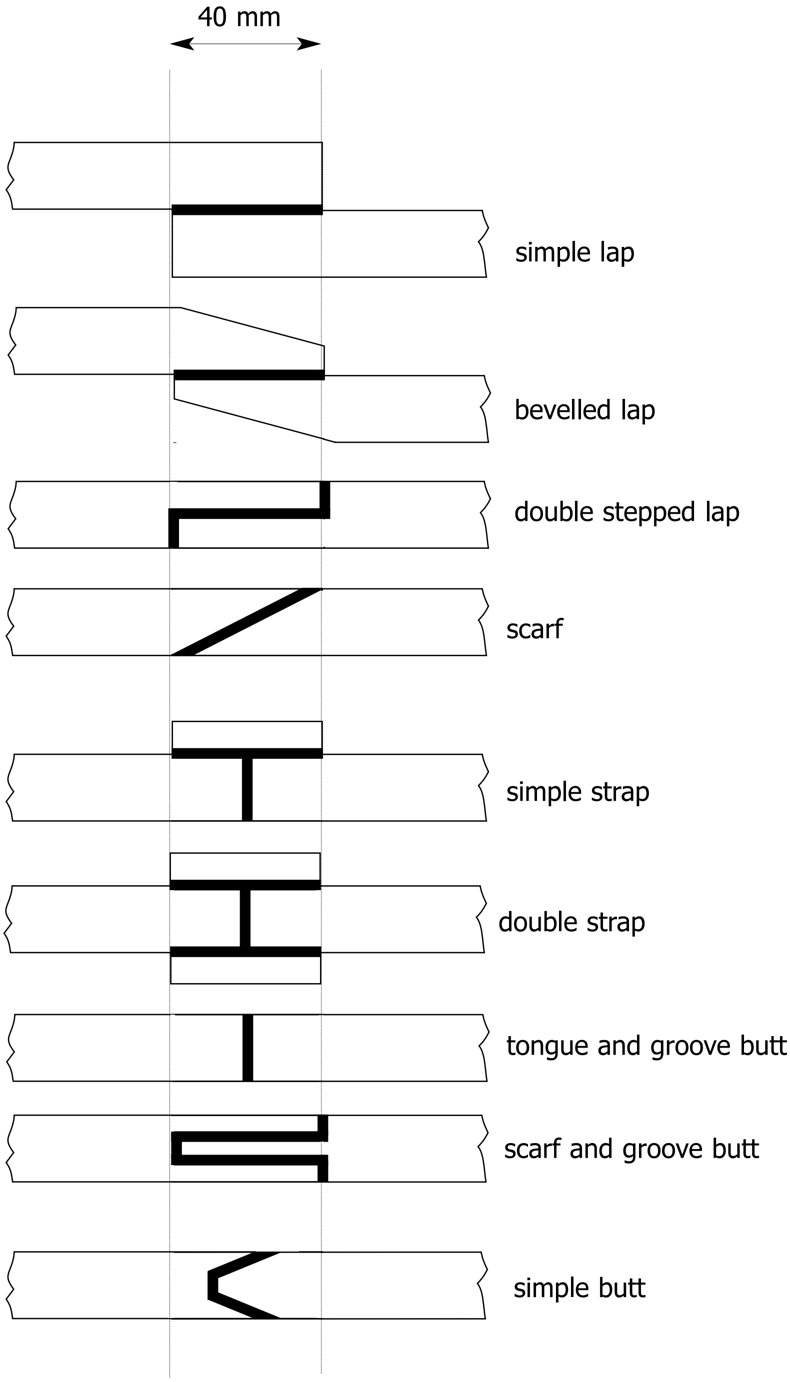
4 Apparatus

- For each joint being made:
- Two pieces of balsa wood, 10 mm thick, 150 mm long, 30 mm wide
- For a simple strap joint, an extra piece of balsa wood (5 mm thick, 30 mm wide and 30 mm long) will be needed (two pieces are needed for the double strap joint)
- Suitable cutting tool
- Balsa cement

6 Procedure

- Use the diagrams (figure 1) to cut one edge of each piece of balsa wood to make the required joint
- Spread an even coating of balsa cement (approximately 1 mm thick) on both surfaces to be stuck
- Put the joint together, applying an even force for 30 seconds.
- Leave to dry for five minutes

figure 1


40 mm
simple lap
bevelled lap
double stepped lap
scarf
simple strap
double strap
tongue and groove butt
scarf and groove butt
simple butt

COMPARATIVE TEST CT 0006-2:2003

Methods of testing joints - Part 2: Comparing the strength of bonded joints in shear

1 Scope

This Comparative Test allows comparison of the strength of bonded joints in shear, using test specimens made following SP 0006-1:2003.

2 Principle

Forces can act in different ways on a bonded joint.

3 Apparatus

- Clamp and stand
- Drill, or other suitable cutting tool to make a 5 mm diameter hole in a piece of balsa wood
- 10 g mass hanger and masses
- 100 g mass hanger and masses

4 Test specimens

Test specimens should be made by following SP 0006-1:2003. At least two specimens for each type of joint should be tested.

5 Procedure

For each type of joint being compared:

- drill a 5 mm diameter hole, in the centre of the test specimen, 25 mm from one end of the test specimen (see figure 1)
- set up the apparatus as shown in figure 2
- slowly add 10 g masses until the joint fails (breaks)
- record the mass, in kilograms, required to break the test specimen (NOTE: 1 kg = 1000 g)
- if the joint does not fail using the 10 g masses, use a new test specimen and repeat the experiment using 100 g masses
- Repeat the experiment using another test specimen of the same joint

6 Expression of Results

For each joint being compared:

Calculate the force required to break the test specimens using the equation:

$F = m \times 9.8$

where

F is the force required to break the test specimen, in newtons;

m is the mass required to break the test specimen, in kilograms;

9.8 the force in newtons due to gravity.

Calculate the average force required to break the test specimens (do this by adding all the forces and dividing the total by the total number of specimens tested).

7 Test Report

Your test report should include:

(a) reference to this Comparative Test

(b) the average force required to break each type of joint

(c) a table putting the different types of joint in order of strength

figure 1

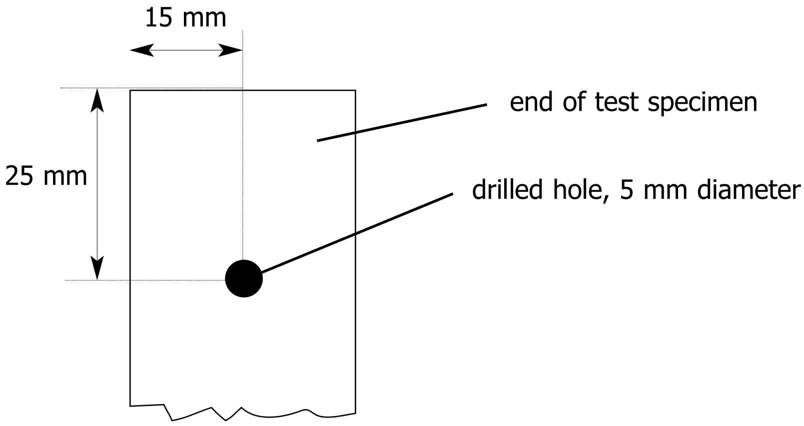
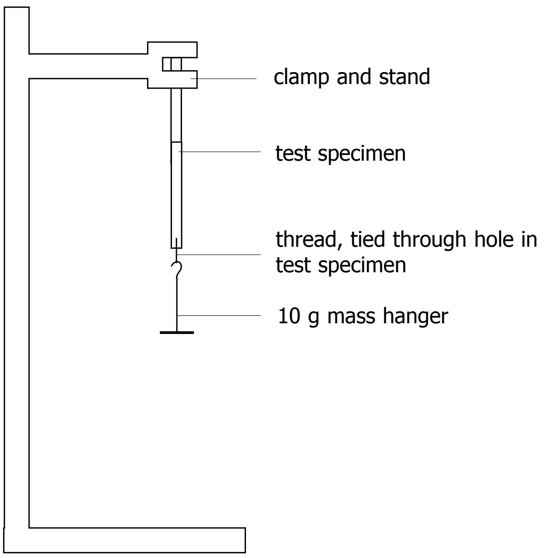


figure 2



COMPARATIVE TEST CT 0006-3:2003

Methods of testing joints - Part 3: comparing the strength of bonded joints in tension

1 Scope

This Comparative Test allows comparison of the strength of bonded joints in tension, using test specimens made following SP 0006-1:2003.

2 Principle

Forces can act in different ways on a bonded joint.

3 Apparatus

- G-clamp
- Drill, or other suitable cutting tool to make a 5 mm diameter hole in a piece of balsa wood
- 10 g mass hanger and masses
- 100 g mass hanger and masses
- thread

4 Test specimens

Test specimens should be made by following SP 0006-1:2003. Four specimens for each type of joint should be tested.

5 Procedure

For each type of joint being compared:

- drill a 5 mm diameter hole, in the centre of the test specimen, 25 mm from one end of the test specimen (see figure 1)
- set up the apparatus as shown in figure 2
- slowly add 10 g masses until the joint fails (breaks)
- record the mass, in kilograms, required to break the test specimen (NOTE: 1 kg = 1000 g)
- if the joint does not fail using the 10 g masses, use a new test specimen and repeat the experiment using 100 g masses
- Repeat the experiment using another test specimen of the same joint

6 Expression of Results

For each joint being compared:

Calculate the force required to break the test specimens using the equation:

$F = m \times 9.8$

where

F is the force required to break the specimen, in newtons;

m is the mass required to break the test specimen, in kilograms;

9.8 the force in newtons due to gravity.

Calculate the average force required to break the test specimens (do this by adding all the forces and dividing the total by the total number of specimens tested).

7 Test Report

Your test report should include:

(a) reference to this Comparative Test

(b) the average force required to break each type of joint

(c) a table listing the types of joint tested, in order of strength

figure 1

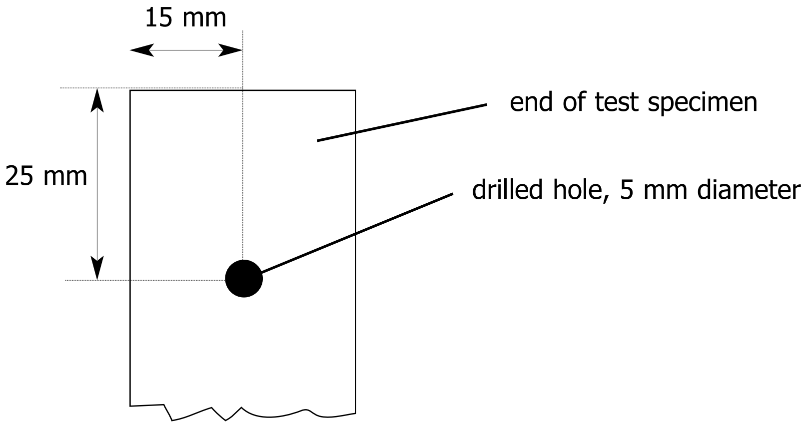
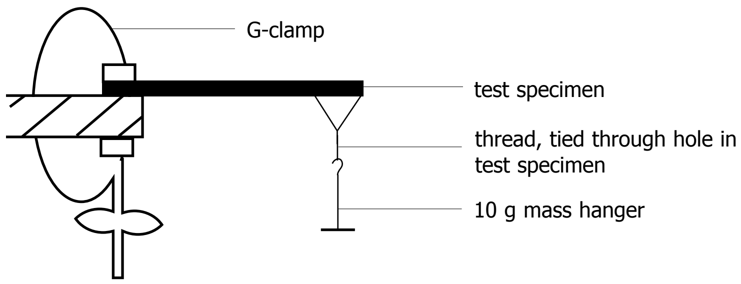


figure 2



Methods of testing joints - Part 4: Making permanent electrical joints: soldering

1 Scope

This Standard Procedure details a method for soldering joints in an electrical circuit

2 Principle

There are many ways to make a joint in electrical circuits. Joints can be permanent or temporary. One of the most common permanent joints is solder.

Soldering uses tin alloy solder, which has a low melting temperature. This is melted using a soldering iron and coated on the two components being joined.

3 Apparatus

- wire cutters and wire strippers
- 1.5 V battery in battery holder with metal tags
- soldering iron and stand
- rosin-free flux cored solder
- two leads to be connected to the battery holder, with plug sockets at one end
- wet sponge
- voltmeter (or multimeter set to voltage)

4 Test specimens

There are no test specimens.

5 Procedure

- Use a pair of wire strippers to take 1 cm of insulation off the end of each lead.
- Turn the soldering iron on and wait for it to get hot.
- When the iron is hot, clean the bit using the wet sponge. Make sure its surface is coated with a thin film of fresh solder by carefully touching some solder against the bit.
- Touch the iron against one of the tags on the battery holder so it warms up. At the same time touch some solder against the tag so it melts and produces a thin layer of solder on the tag.
- Do the same for the bared end of the lead (this process is sometimes called tinning).
- Touch the soldering iron against the tag and, at the same time, bring the bare end of the lead into contact with the tag.
- Remove the bit as soon as there is a layer of molten solder joining the wire to the tag.
- Be careful not to move the joint while it cools down.
- A good solder joint is shiny. If it's rough, touch the bit of the iron to the tag and add some solder until you get a better joint.
- Clean the bit of the soldering iron on the wet sponge and repeat with the other tag and lead.

6 Expression of Results

To check the soldered joints are working, connect the plug sockets to the voltmeter (see figure 1) and check the voltage across the battery.

7 Test Report

Your test report should include:

(a) reference to this Standard Procedure

(b) whether the soldered joints worked first time.

figure 1