Vertical Flame spread

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Introduction

The aim of this experiment is to clarify the ignitability of solid materials by burning them from up and downward.

Two different solid materials will be used during this experiment which are paper and reinforced plastics.

Both materials have almost the same thickness which is less than 2mm, and can be called thin materials.

Equipment used in this experiment are rig, lighter, thong, screw, stopwatch, safety glasses, and a video camera.

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Theory

- One of the most important criterias for materials in construction is their behavior in case of fire

- Llowest temperature at which a combustible substance when heated (as in a bath of molten metal) takes fire in air and continues to burn is ignitation temperature

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Table 1 Melting points and ignition temperature for different types of plastics

Melting points and ignition temperatures		
Plastic	**Melting Point Range**	**Ignition Temperature**
ABS	88°-125°	416°
Acrylics	91°-125°	560°
Cellulosics	49°-121°	475°-540°
Nylons	160°-275°	424°-532°
Polycarbonate	140°-150°	580°
Polyesters	220°-268°	432°-488°
Polyethylene ld	107°-124°	349°
Polyethylene hd	122°-137°	349°
Polypropylene	158°-168°	570°
Polystyrene	100°-120°	488°-496°
Polyurethanes	85°-121°	416°
PTFE	327°	530°
P.vinylideneclor	212°	454°
PVC	75°-110°	435°-557°

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- Ignition temperature of paper is 233 °C

- Paper is a material made of cellulose pulp, created mainly from wood, rags, and certain grasses, processed into sheets or rolls by deposits from an aqueous suspension.

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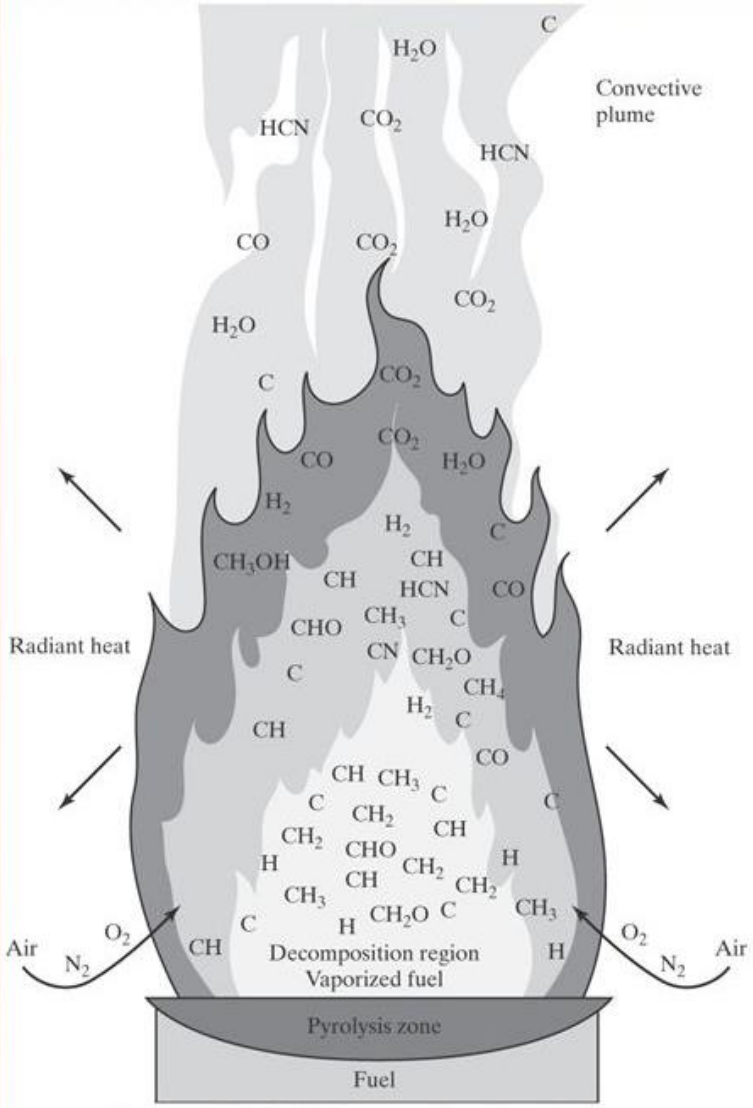
Ignition temperature.

- Combustion will continue until:
  1. Fuels are consumed.
  2. Oxidizing agent has been removed.
  3. Fuels are cooled below their ignition temperature.
  4. Flames are chemically retarded.

- Transfer of heat. :
  - Conduction.
  - Convection.
  - Radiation.
  - Direct flame contact.



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- Flame spread is the process in which the perimeter of the fire grows.
- The term flame spread specifically refers to the extension of the burning region, where the region is undergoing vaporization and therefore supplying the necessary fuel.
- Physical, chemical and geometric parametars influence the spreed of flame exspansion.
- The affecting parameters of the flame spread are: Surface orientation, direction of flame spread, size, initial fuel temperature, external radiant flux, roughness of the surface, wind flow velocity, gravitational effects and humidity.

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- The gravitational and wind effects are the most prominent factors affecting flame spread.
- The flows resulting from the fire buoyancy or the natural wind of the atmosphere can either assist, which is often referred to as wind-aided flame spread or inhibit, which is known as opposed flow flame spread.

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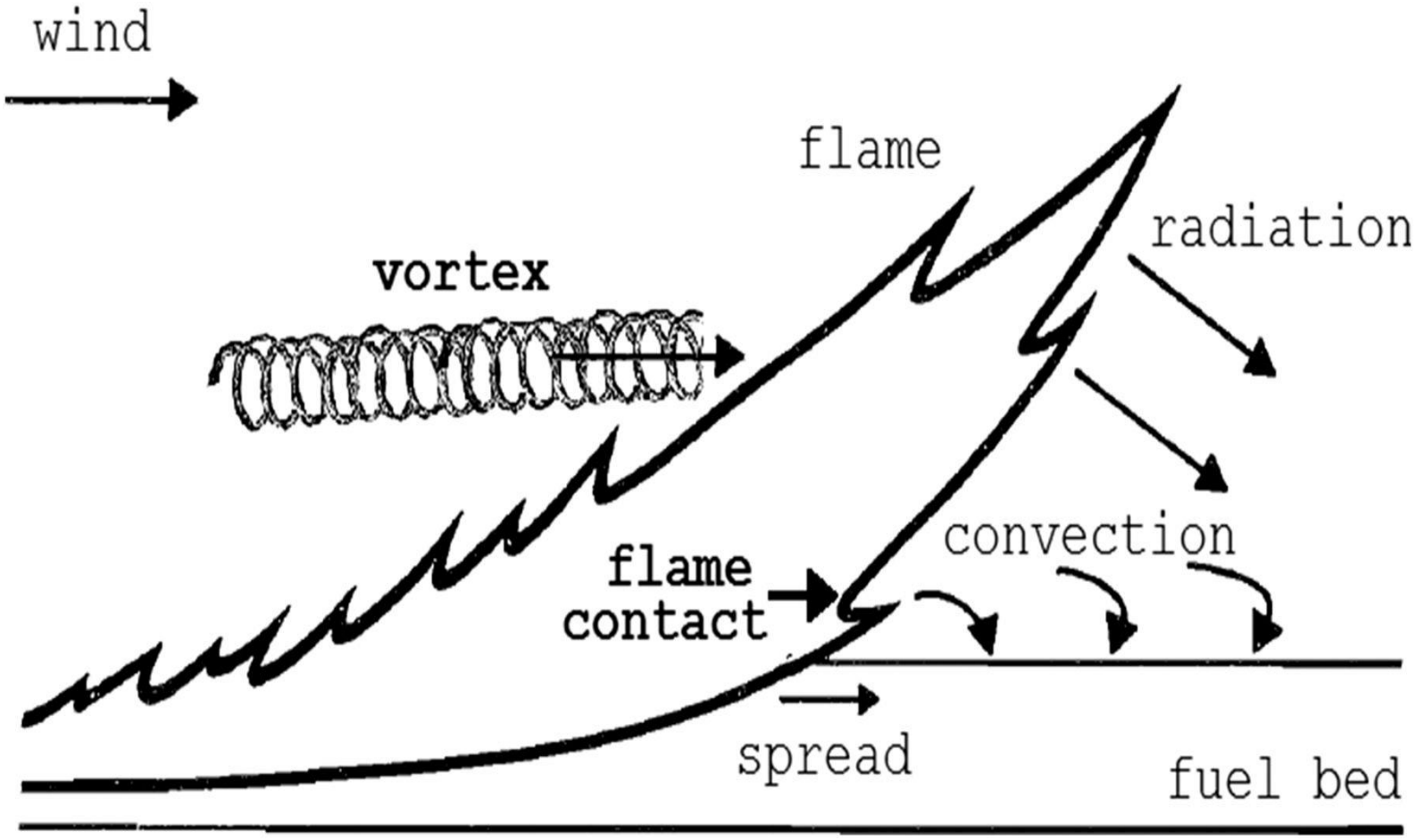

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Fire Spread By Conduction

- The fire will generally follow the heat or sometimes the heat from conduction may cause a new fire to ignite elsewhere. The heat from the fire is passed from molecule to molecule along the length of the material.
- Certain materials are better than others at conducting heat. Most metals conduct heat easily and quickly and they are called ***conductors***, alternatively certain plastics are very poor at conducting heat and they are called ***insulators***.

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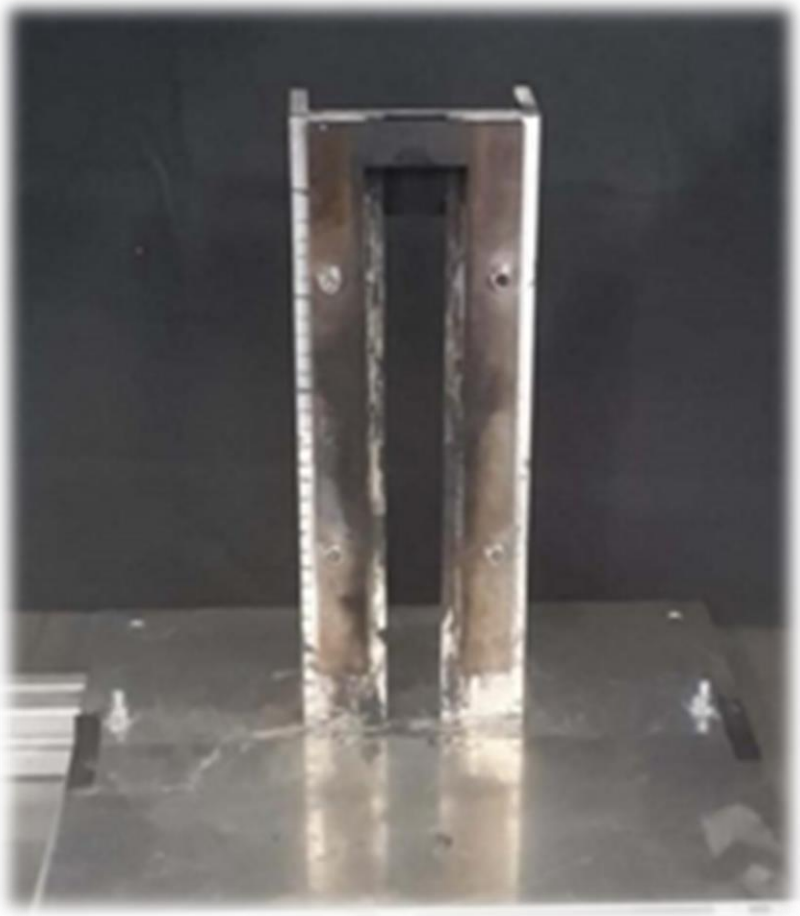
Method



Vertical flame spread velocity measuring device

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- Vertical flame spread velocity measuring device is used to calculate the flame spread height and calculate the time to ignition of a certain material. The device uses materials of 28cm x 5cm in cross sectional.
- The materials which are being used in this experiment are thin materials which are having a thickness less then 2mm (***paper and R.plastic***).
- The materials are checked before experiment starts, to check that they are clean and not having any hole in the surface.
- The material is being placed in the holder and being fastened to the rig, the camera is being placed next to the rig pointing in direction so that the side of the sample can be seen . Material is ignited once from top and once from bottom, and stopwatch starts when material start to ignite, position of the flame and time of burning being noted for each material.
- First the paper was ignited both upwards and downwards, and then R. plastic in the same order.

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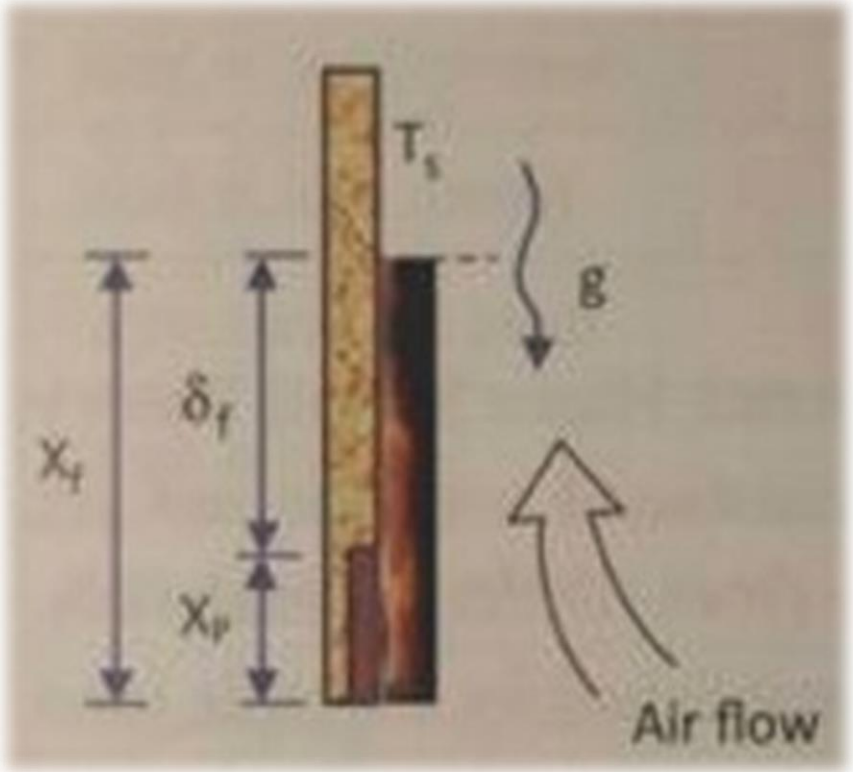

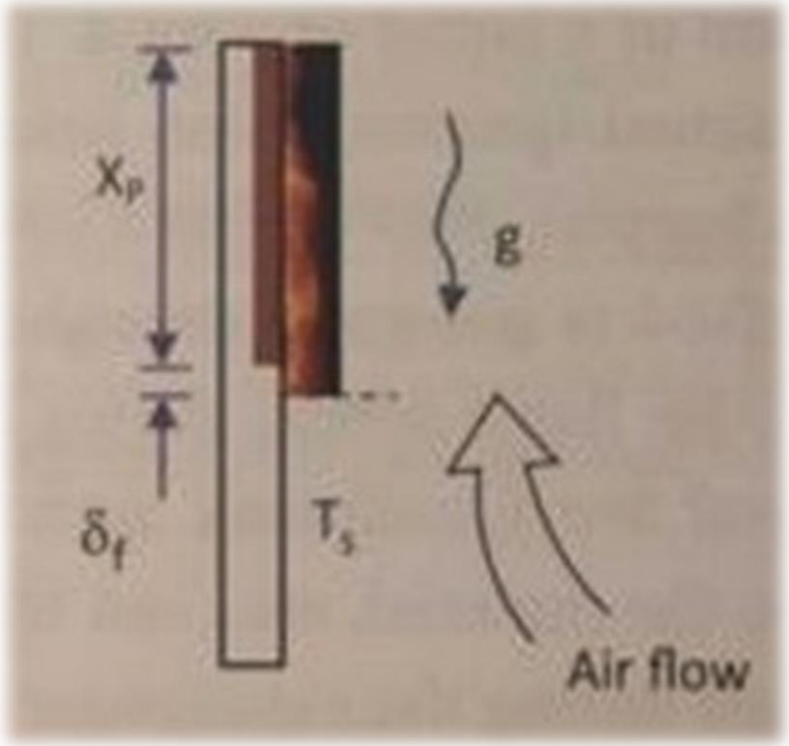

NATURAL FLOW UPWARD AND DOWNWARDS FLAME SPREAD

	Paper upward	Paper downward	R. Plastics upward	R. Plastics downward
t_{ig} [s]	9	28	70	133
$x_p+\delta_F$ [m]	0.28	0.07	0.28	0.28
v [m/s]	0.03111	0.00250	0.00400	0.00211

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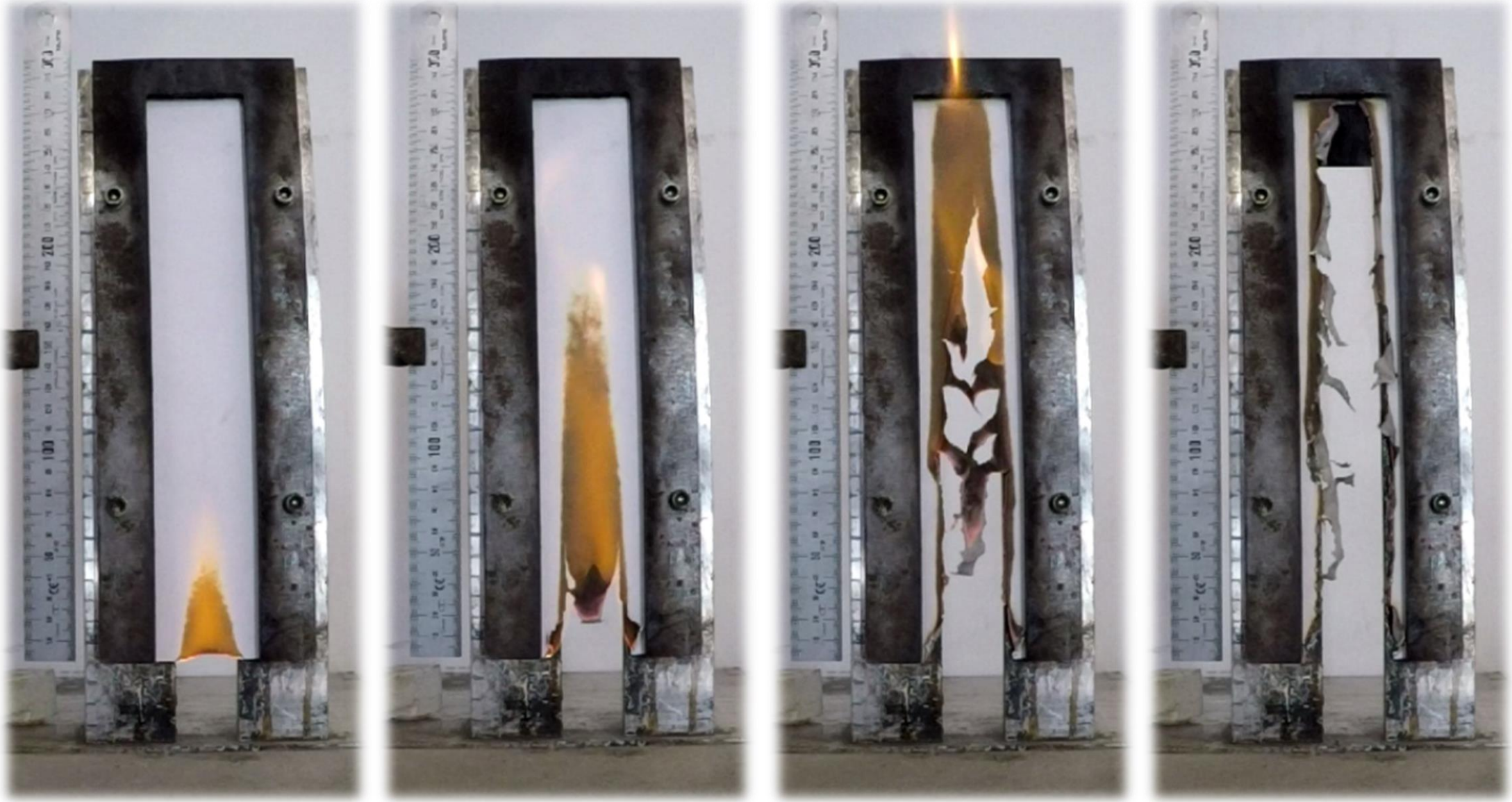

UPWARD FLAME SPREAD OF PAPER

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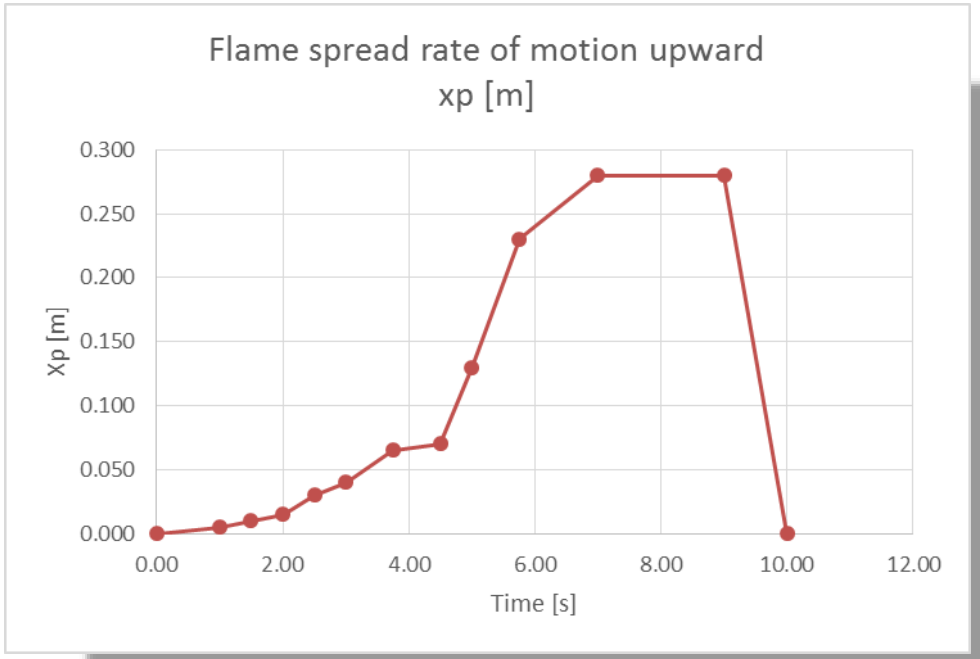

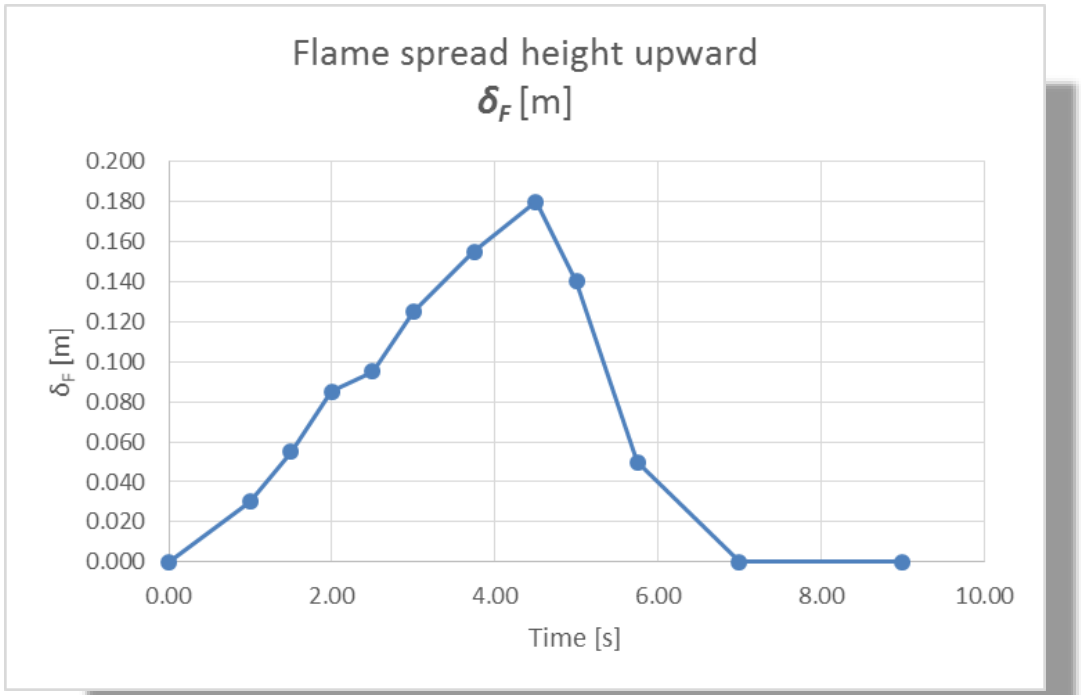

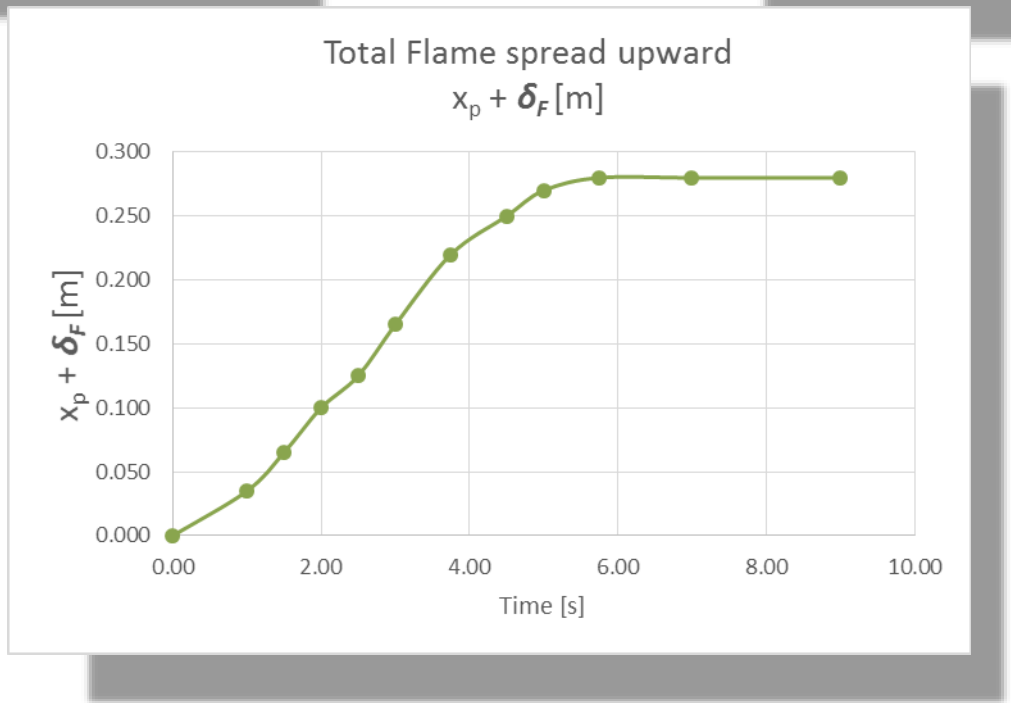

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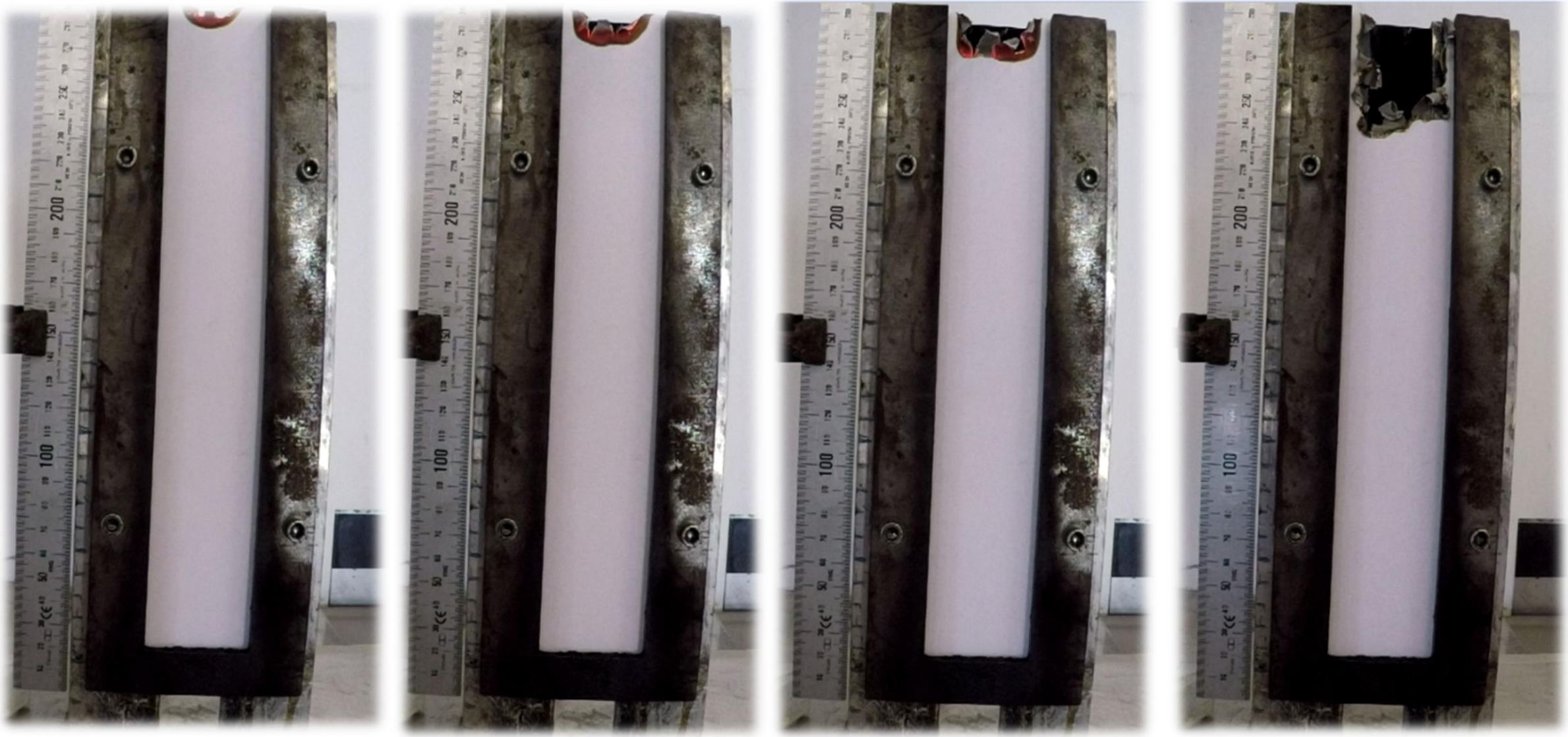

DOWNWARD FLAME SPREAD OF PAPER

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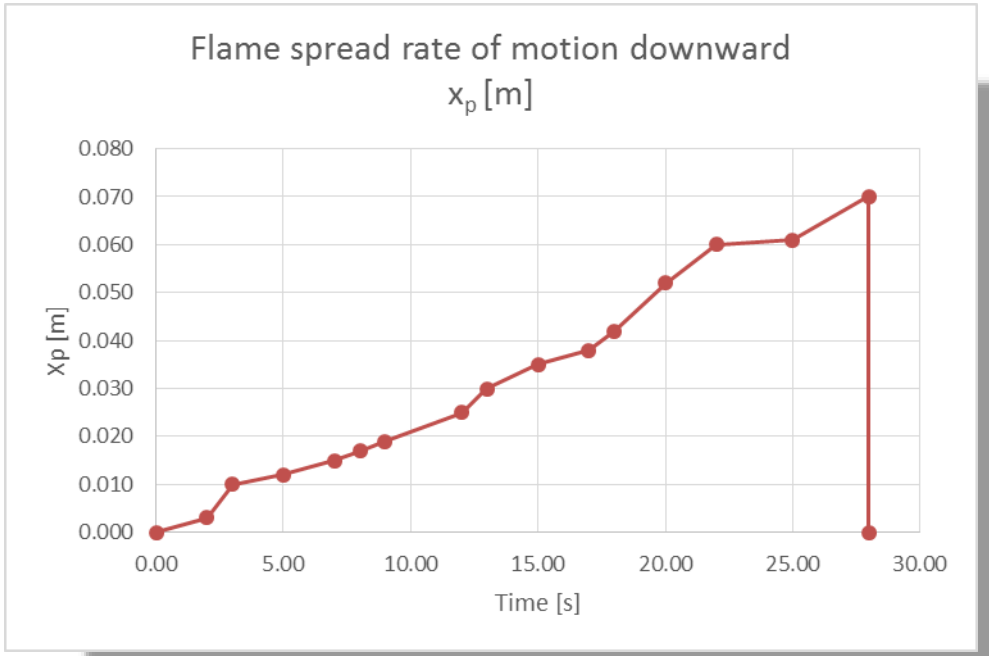

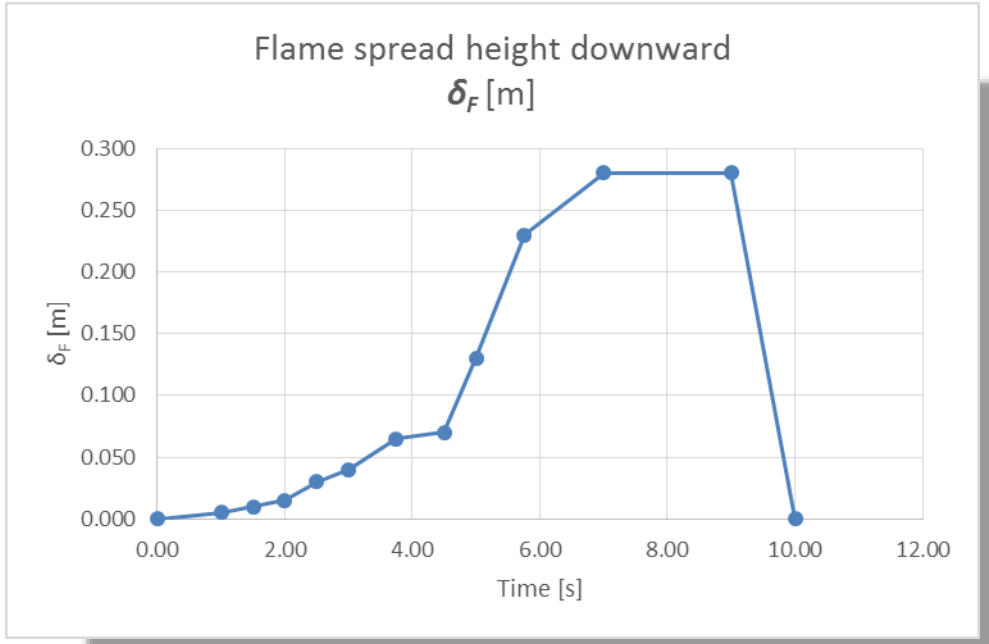

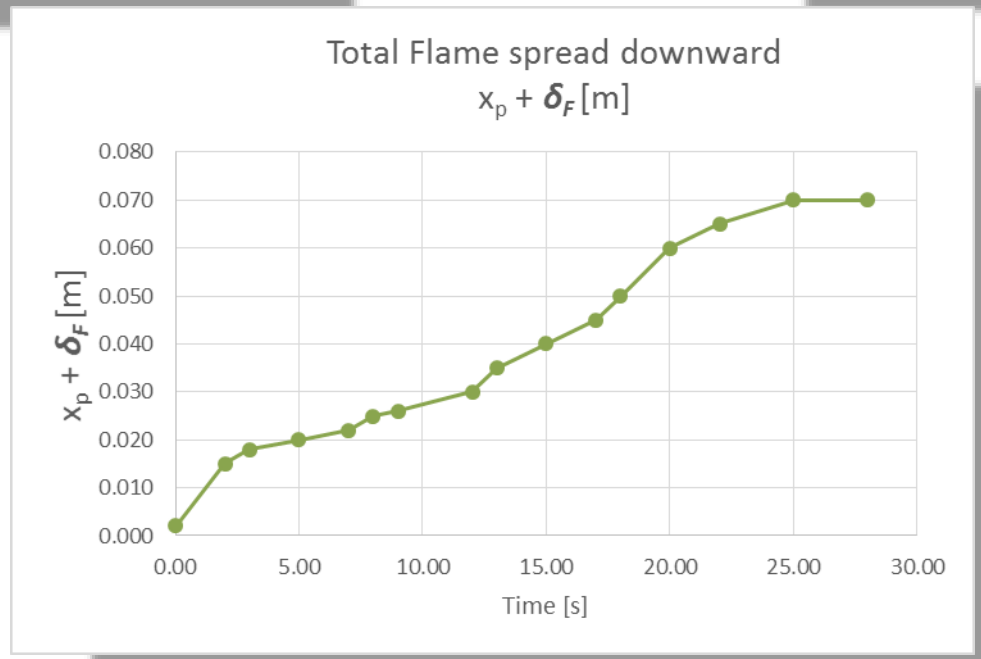

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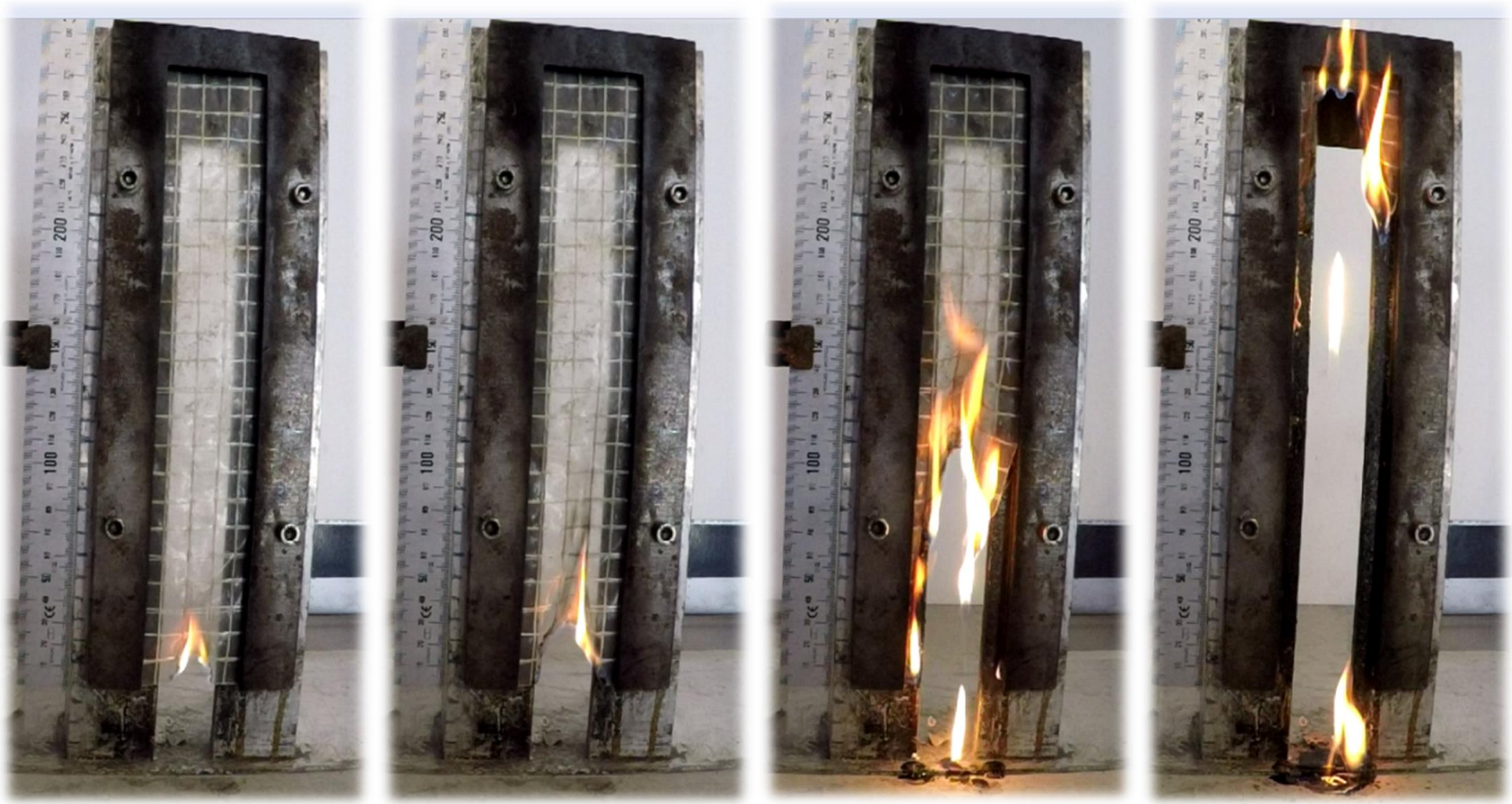
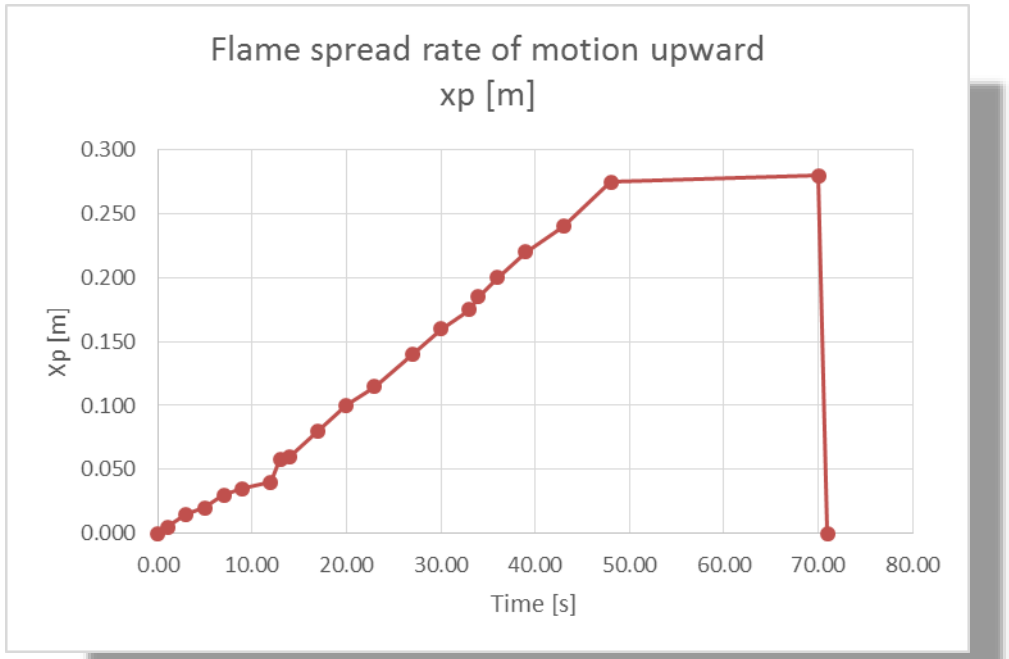
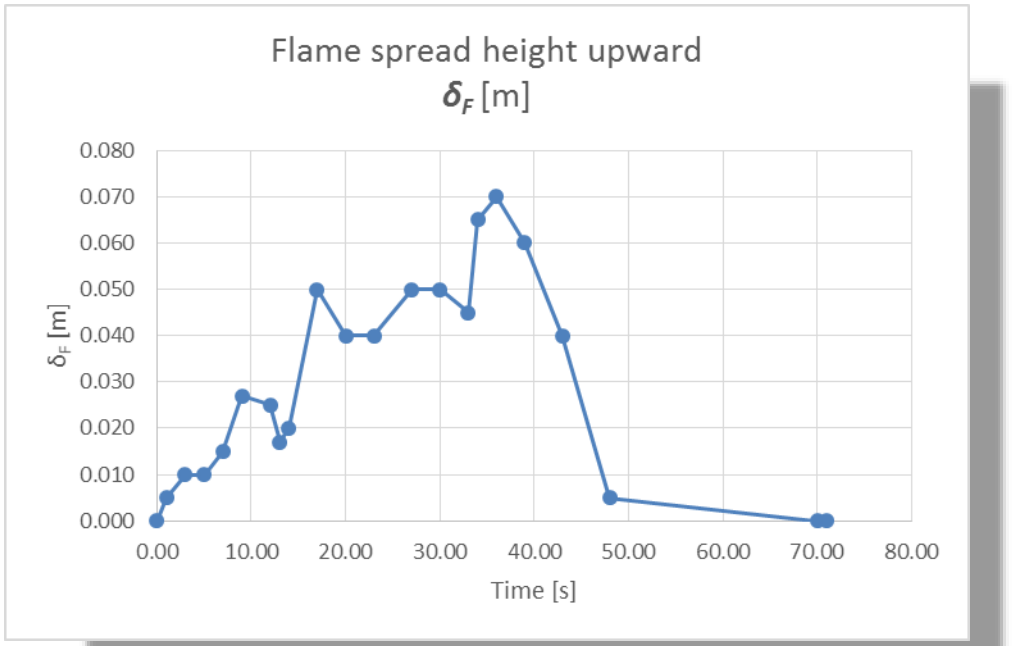
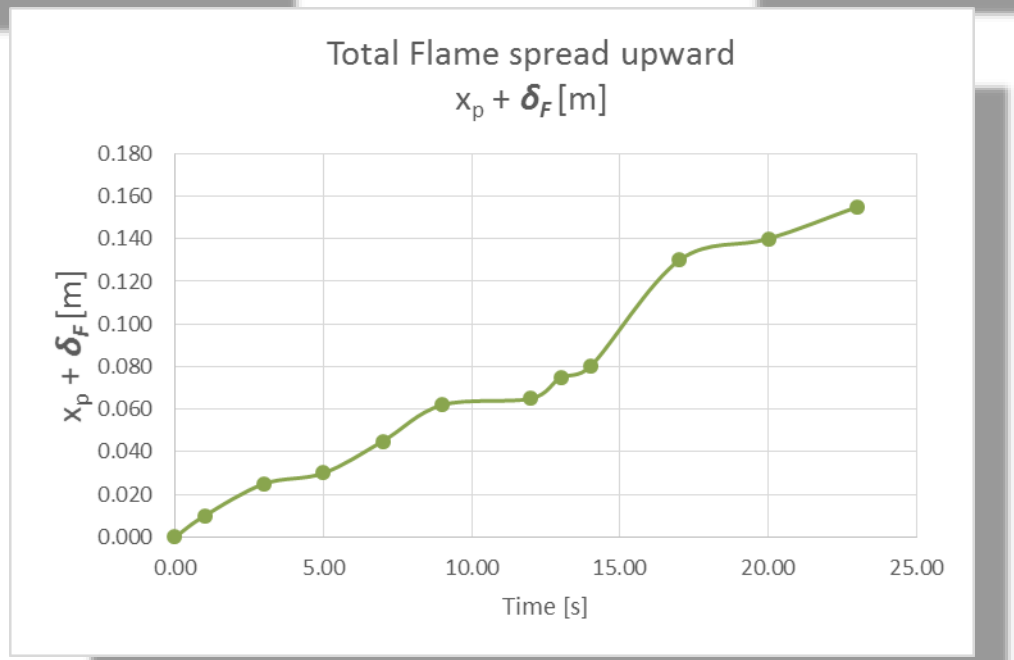


UPWARD FLAME SPREAD OF REINFORCED PLASTICS







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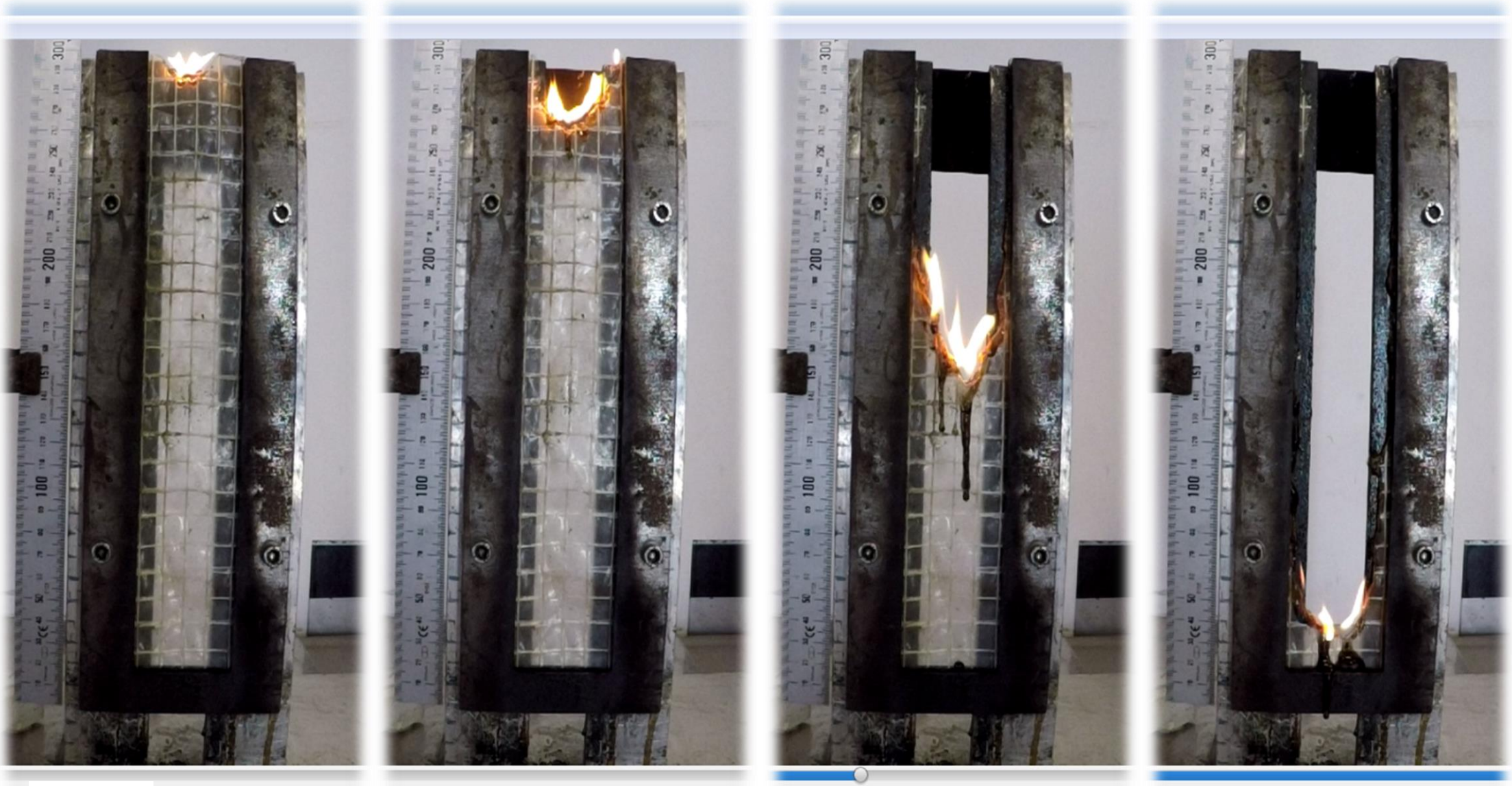

DOWNWARD FLAME SPREAD OF REINFORCED PLASTICS

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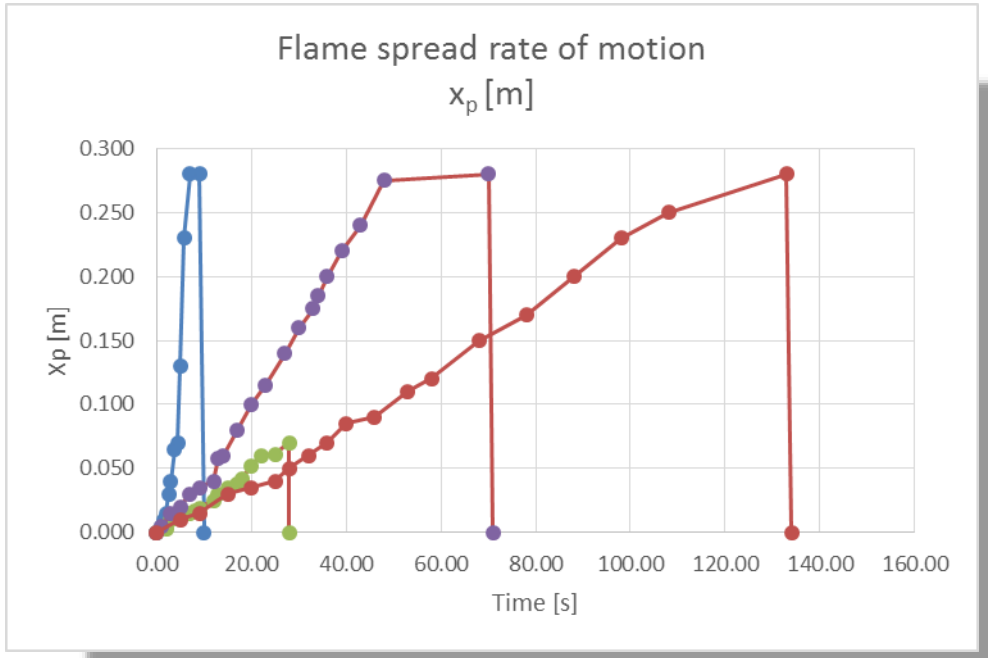

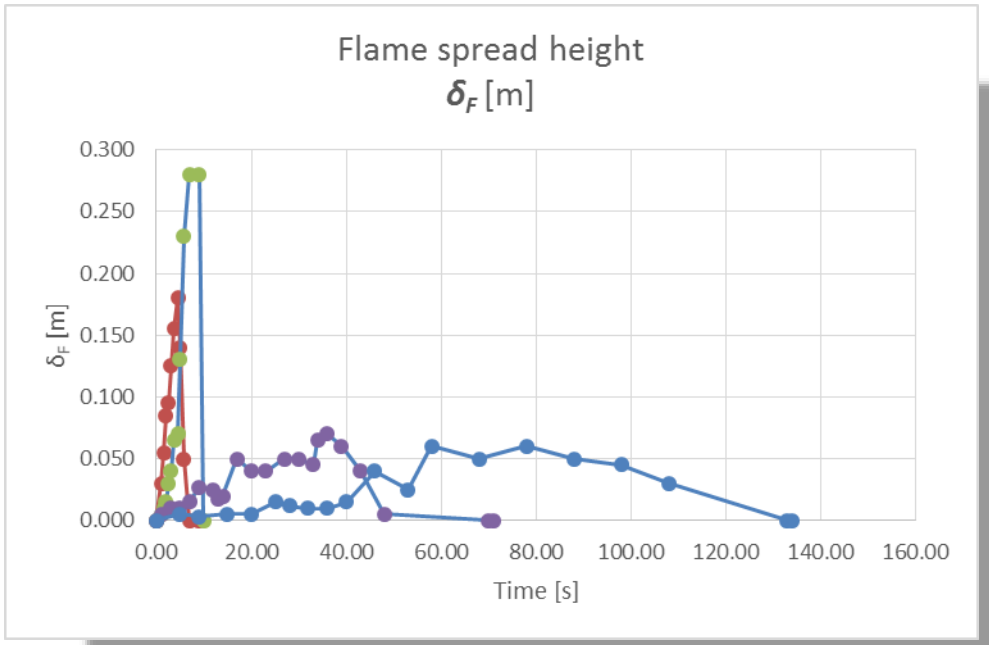

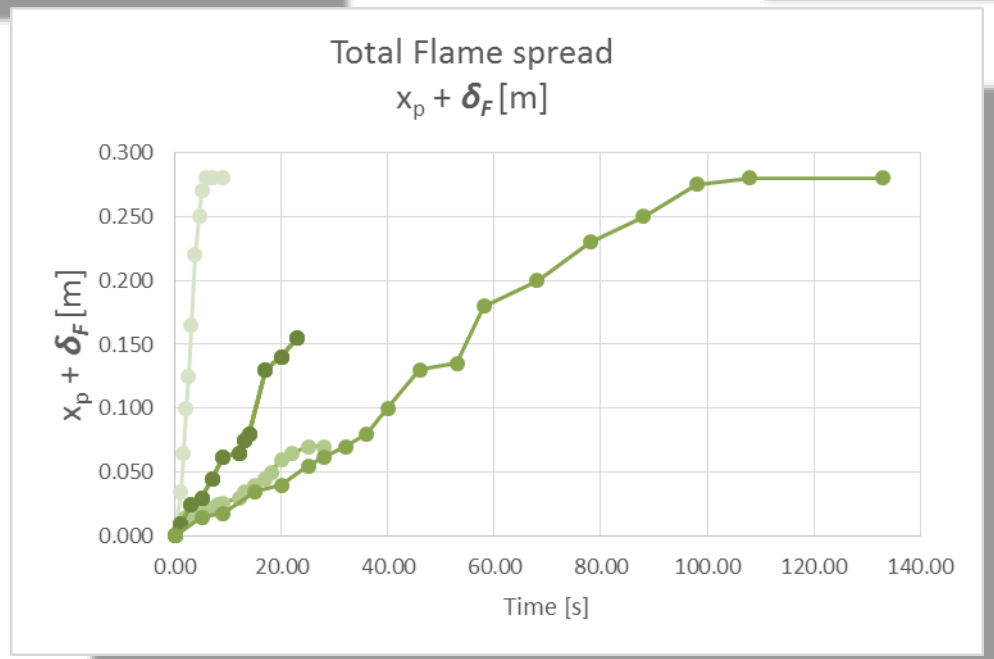

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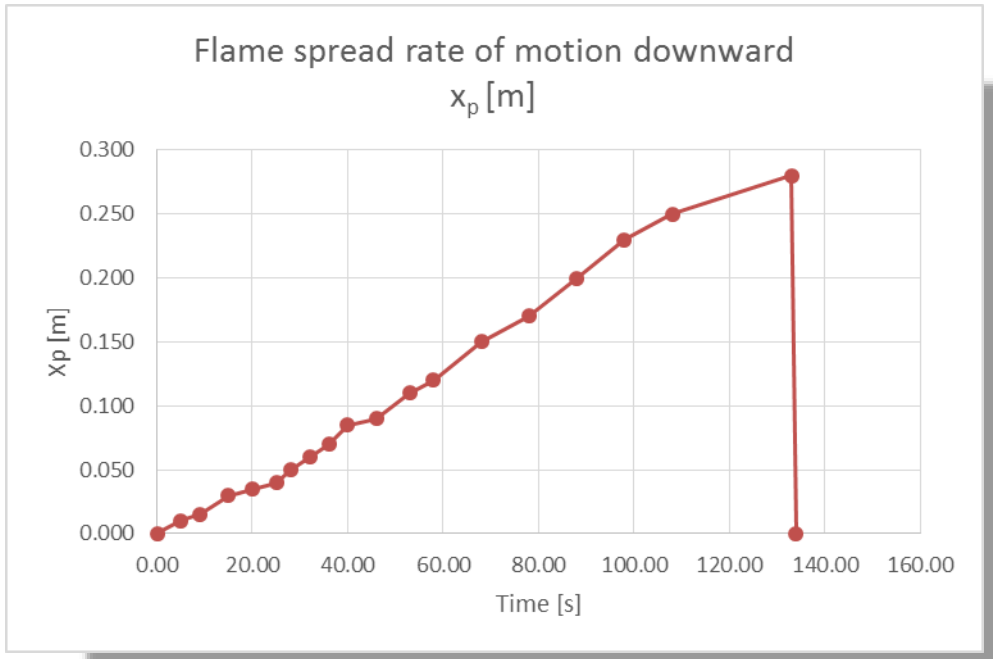

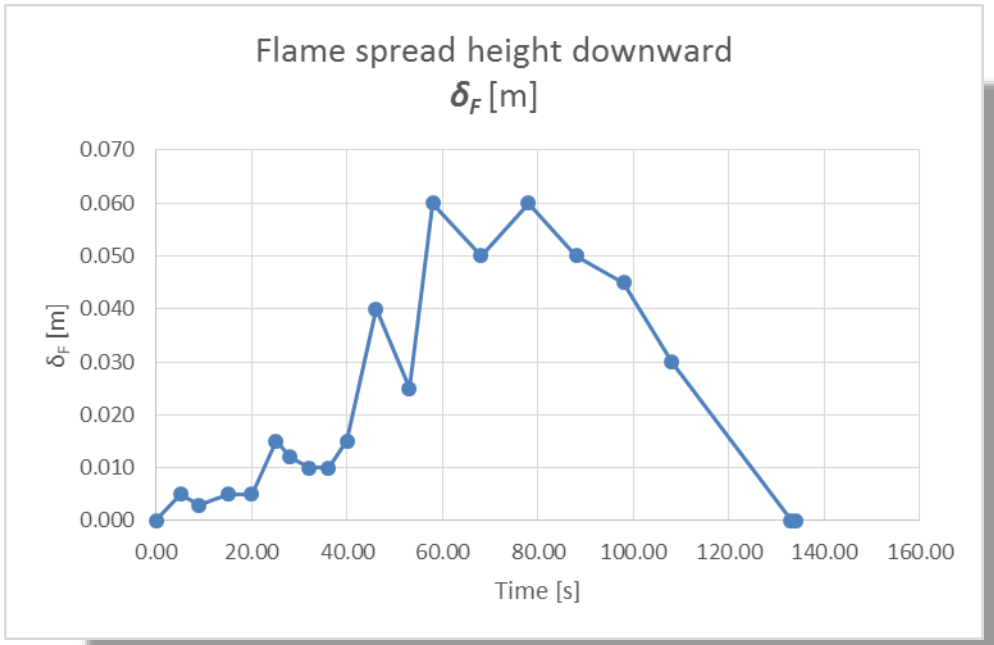

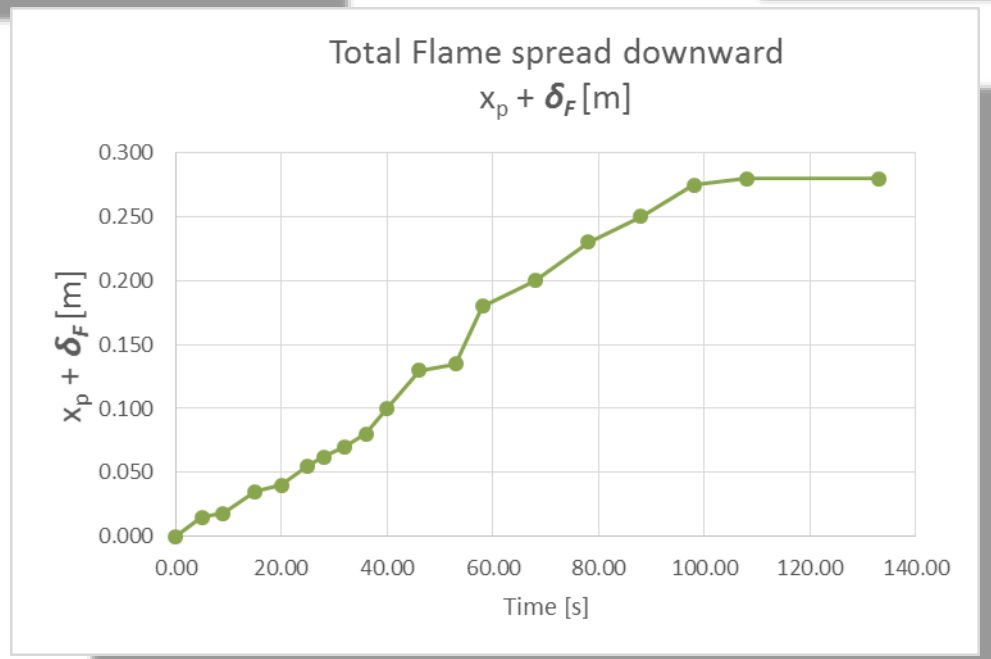

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conclusion

- Upwards burning materials are faster burning than downwards
- Paper burn faster than R. plastics
- Color is the same and it depends on the energy state of the molecules
- Temperatures inside materials are constant because they are thin objects.

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