Master Thesis - Appendix

APPENDIX

"A locally producible plastic plate press for bottom-up recycling in low-resource settings"

A design assignment commissioned by
The MMID Foundation

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Master Integrated Product design

Disclaimer
The master thesis to which this documet provides the appendices is written in context of the master Integrated Product Design at the faculty of Industrial Design Engineering at the Delft University of Technology in The Netherlands.

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A.1. EXISTING PLATE PRESSES

A.1.1. PRESSES THAT CAN BE BOUGHT NOW

1. C R Clarke R30 Sheet Press
- £3150.00 (€3568.48)
- Max sheet size: 457 x 305 x 2 or 3mm
- Plastic granules placed in a material cassette, then loaded into system. Hotplates are activated and the hydraulic clamp presses the material, forming a plastic sheet. Finished sheet would require post processing, such as sawing off rough edges.
- https://www.rapidonline.com/c-r-clarke-r30-sheet-press-34-8564

2. Sheet Press – Manual (SPM/50×105)
- cost unknown
- Flatbed size: 1250 x 2500mm
- Hand operated. Rotary controls spin gears which in turn, spins a threaded rod (worm gear) to bring the clamp down. Used for pressing down corrugated cardboard sheets. Potential for forming plastic sheets due to large flatbed and clamp surface. Uniform pressure applied throughout surface area. If used for plastic granules, thickness would depend on amount of plastic loaded into system and level of force applied.
- http://www.primemachines.net/products/p11.htm

3. Hydraulic Sheet Pressing Machine
- 195000 INR (€ 2 517.32)
- Flatbed size: 1524 x 2540mm
- Presses corrugated cardboard sheets to remove warpage.
- Hydraulic powered pressing. Uniform pressure applied throughout surface area. Has same potential as previous example. This system includes a reversible switch, allowing either the top or bottom plate to vertically move.
- http://www.monugraphics.net/pressing-machines.html#hydraulic-sheet-pressing-machine

4. Hottronix MAXX Series Digital Clam Press
- $1175.00 (€986.56)
- Flatbed size: 406.4 x 508mm
- Made for applying graphics to textiles. Heaters are integrated into plates, thus providing uniform heat distribution as well as clamping force. It has potential to be used for plastic sheet forming, it does not take up much vertical space like examples (2) and (3) as force is diagonally applied by hand. If the plates were made bigger to produce a larger sheet, the device might require two-handed operation.
- https://screenprintsupply.com/stahls-heat-presses/

5. Y32-200 Hydraulic Press
- $14016.00 (€11768.16)
- Flatbed size: 406.4 x 508mm
- Applies 200-ton vertical force for industrial scale deep drawing, stamping, blanking and compressing plastic/deformable materials. Uses hydraulics to apply 200-ton force. is too excessive for the purposes of PPP2, however the use of 4 pistons can inspire the device's structure and function.
- https://www.alibaba.com/product-detail/Y32-200-Hydraulic-Press-for-processing_60587590705.html?spm=a2700.7724857.main07.260.b877a4elTc5KP

6. WICKERT Plastic Press
- Cost unknown
- Max sheet size: 6,500 x 3000 mm
- Extremely rigid construction, leveling device, tool cleaning, automatic feed and removal. An ideal plastic press, however too expensive for use in Angola. The features included in this press could serve as inspiration for features to include in the PPP2 press.
- http://www.itb-bv.nl/kunststof-persen/

7. Heat MX
- $ 88,000,-
- www.maderaplastica.com.mx
- Video HEATmx: https://youtu.be/-tZRkA5VvCQ
- Video HEATmxS: https://youtu.be/FROVHGcYTHM
- https://youtu.be/lBPKheZ7Ra0

- Document below by HEAT mx

HEATmx MACHINES

Mexican technology with more than 40 years of experience, developed for the use of plastic waste post urban, agricultural and industrial consumption; delivers plaques or solid and resultant boards to be applied in situations of intemperie, salid humidity, corrosion and necessities of high life, replacing wood, steel, aluminum and other materials. Versatile and easy to operate machines, with the ability to process mixtures of different plastics even with impurities such as dirt, labels, metal, glass, aluminum, wood, etc; by means of a static smelting process on electric oven and then pressing it with cooling. This features allows to use almost any thermoplastic, however to obtain a feasible and resistant product it is recommended that 75% of the blend high-density polyethylene or polypropylene, materials which its use dominates in the world (79%).
The presentation of the raw materials must be granular, so it requires previous processes such as crushed in hard waste and densified in films.
It is feasible the use of: HDPE, LDPE, HMWPE, PP, ABS, EVA, PS and others. It should be mention that PET is not recommended because it crystallizes at the heat, causing it to be extremely fragile, however the PET.G works well.
The production that delivers the machine is aboard pf dimensions of 1,220mm x 2,440mm (4'x8'), and thicknesses of 8mm to 50mm. The board is work with paint and other types of materials.
Based on the nature of the process and the mixture of the raw material, the board will have an indefinite or multicolor finish, according to the raw material.

IDEAL TO TRANSFORM THE PLASTIC GARBAGE TRASH

HEATmx

SOLUTION TO WASTE PLASTIC

MACHINES FOR MANUFACTURING BOARDS FROM PLASTIC WASTE
MADE IN MEXICO

International patent pending

HEATmx60 Data Sheet

Machine to produce boards with post-consumer and post-industrial plastic waste; with dimensions of 1220 mm x 2440 mm, with a thickness of 8 mm to 50 mm.

PRODUCTION
60 kg / hr or 1 board 3/4 "thick per hour.

HEATING
By means of 1 oven. With heating by electrical resistances with electronic control and double ceramic fiber insulation. Maximum temperature of 350 ° C

PRESS
A press station with 4-cylinder hydraulic system and 4-way dividing valve, with a maximum pressure of 64 tn at 2500 psi. Power source with 3 hp motor.

REPOSE PRESS
A press station for finished boards, with 2-cylinder hydraulic system and 2-way dividing valve, with a maximum pressure of 32 tn at 2500 psi. Power source with 3 hp motor.

COOLING
Cooling incorporated into the main press by circulating cold water through the platen. It has a water cooler of 5 tons of cooling.

MOLD
2 steel molds are included, each with 16 wheels at 45 °, spring suspension, 1 removable lid.

LEVELER
Aluminum rule for the uniform arrangement of the raw material inside the mold with adjustable vertical movement.

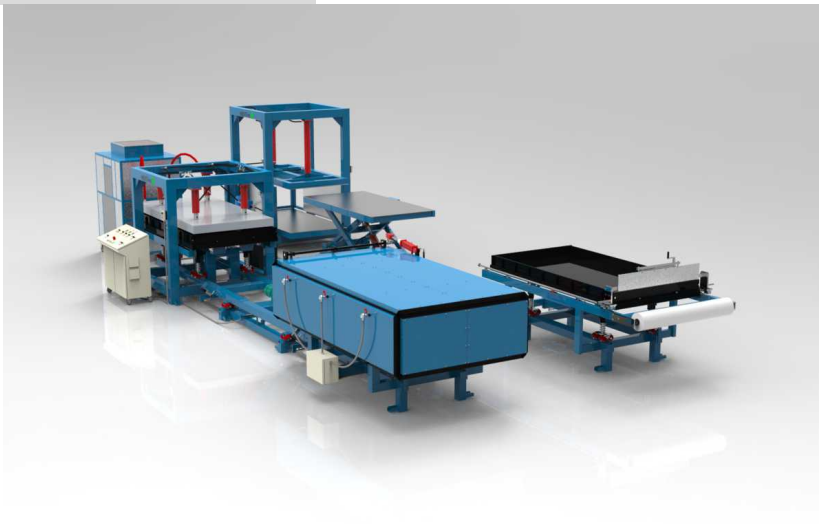
ANTI ADHERENT
That has a roll holder for polyester film, which works as anti adherent

LIFTING TABLE
It has a hydraulic lifting table as a burr cutting table and to facilitate the movement of the mold board to the repose press.

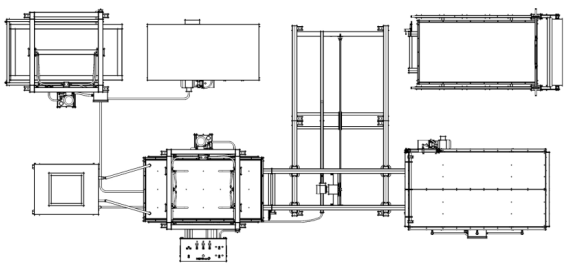
ELECTRICAL CONSUMPTION
52 kwh; 120 amps at 220 v; 60 amps in 440 v.

DIMENSIONS
Height 2530 mm
Width 5500 mm
Length 12200 mm

WEIGHT
Approximate weight of 8400 kg



HEATmx60
machine to manufacture boards
60 kg/hr



STATIC CASTING

HEATmx

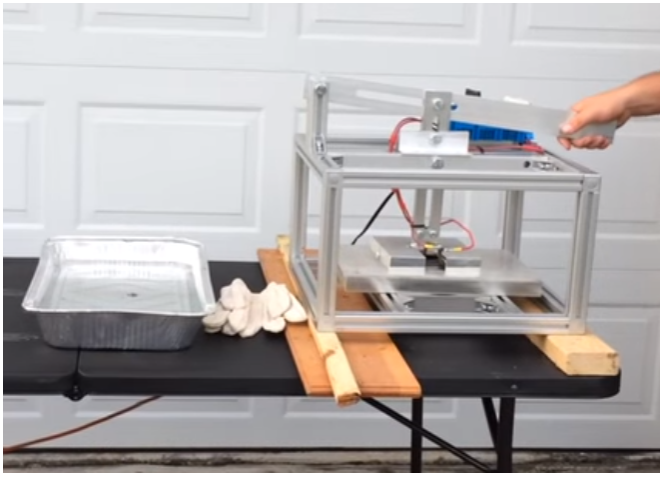
A.1.2. OPEN SOURCE/DIY SOLUTIONS

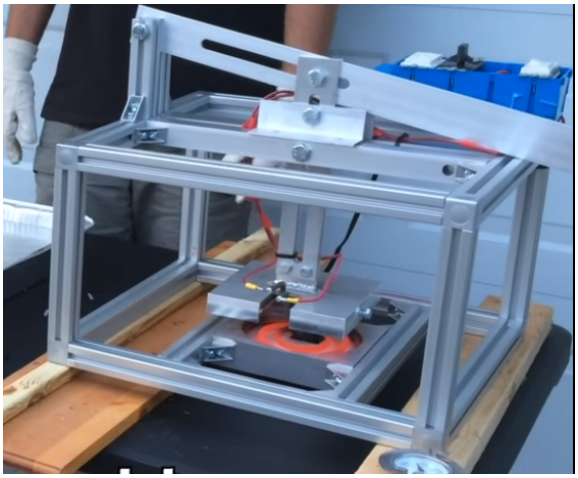
1. Build a 10-ton hydraulic press
- Makes use of a “jack-bottle”, a hydraulic pump operated by a lever to raise the clamp. Unsure of the availability of jack-bottles in Angola, but can possibility be replaced with a scissor car-jack for lower manufacturing cost.
- The hydraulic press requires an arc welder, drill press and an angle grinder as well as workshop space and materials. Fábrica de Sabão is well equipped to make the hydraulic press, with slight modifications to press over a large surface area.
- http://www.instructables.com/id/Build-a-10-Ton-Hydraulic-Press/

2. DIY 5-ton hydraulic press
- A smaller hydraulic press but has a similar working principle to example (a). It would require modification to apply force over a larger surface area.
- https://www.youtube.com/watch?v=wqtdfb1dJ5I

3. Precious Plastic open source project
- Open-source project, makes use of components and materials found in scrap-yards.
- The design is adaptable, as the construction will depend on the size of the oven used. Also, the maker can customize the design to fit their requirements.
- The size of the pressing area is limited by the size of the oven’s cavity.
- Heating is efficient as it is done within an insulated cavity.
- One possibility could be to extract the heating element from the oven and build an expanded heated cavity with the surrounding insulation.
- https://preciousplastic.com/en/videos/build/compression/

4. HDPE Compression Molding
- Square aluminum tube construction.
- Heating element seems to derive from a portable stove. This is located underneath the mold.
- The molding die consists of a female and male die. The male die is pushed downwards by the press.
- The downward vertical force is applied to the mold below by a hand operated lever.
- After molding, the die is quenched in a water bath.
- https://www.youtube.com/watch?v=PKM0OvDaz8g





A.1.3. OTHER MANUFACTURING METHODS

1. PIM (Powder Impression Molding)

- Mixing different groups of plastic and impurities results in mechanical weakness. Through PIM, strong, high quality boards are produced, solving the issue of mixed plastics and impurities.
- The panels consists of a foamed core sandwiched between two exterior panels.
- Manufacturing method (Taken from "PIM moulding of post consumer mixed plastics", page 1 Brunel University,)
- http://bura.brunel.ac.uk/bitstream/2438/7661/2/FullText.pdf
- Powder Impression Moulding (PIM) is designed to mould lightweight panels with solid skins sandwiching a foamed core and possesses great potential for incorporating low-grade and mixed plastics recyclates in powder or flake forms. A thin layer of powder materials is spread on two halves of a heated flat–bed mould and sintered to form solid skin layers and on one of the moulds, powder with blow agent for the core is added. The moulds are then closed and heated to a temperature at which a foamed core is produced and bond to the surfaces. As minimum material flow is required and the non-molten particles (e.g. impurities or contaminants) can be encapsulated by the dominant composition in the material, PIM is much more tolerant to the incorporation of mixed plastics or impurities in the feedstock than conventional extrusion and moulding techniques as means of mechanical recycling. This enables PIM to produce high performance sandwich panels that have found many applications in construction e.g. hauling boards, bathroom wet floor systems and concrete moulds and hybrid structures with embedded pipes or reinforcements.
- Cedar Environmental developed Eco-board, plastic panels to replace wooden or metal panels in construction. Current thickness: 18mm
- https://www.youtube.com/watch?v=O_XzQ7DkGfM

2. Plaswood

-Plastic Lumbar as an alternative to wooden lumbar. From inspection, it appears the Plaswood lumbar is made by extrusion.
http://www.innovation-portal.info/wp-content/uploads/Plaswood.pdf

A.2. ANALYSIS TOPICS

- Angolan Culture
- Properties of Plywood
- Available tools in Africa
- Open-source extended meaning
- Binding techniques for granulate
- Plastic processing techniques
- Plastic recycling in the industry
- DIY plastic recycling
- Maker-spaces
- Plastic processing additives
- Design guide for recycled plastic
- Plastic type properties
- Sorting techniques
- Potential user needs
- Mixed plastic processing possibilities
- Energy consumption
- Plastic melting theories
- heat conductivity
- Construction material needs
- Why a plate?
- Local facilities
- Local plastic availability]
- plastic pollution
- Garbage infrastructures
- DIY tips and tricks
- DIY machine building
- Machine building
- Machine safety
- Infrared heating
- pressure techniques
- Distributed production
- Low resource definition

A.3. EXPERT MEETING EXCERPTS

A.3.1. THE BETTER FUTURE FACTORY

Meetings with Laura Klaus:

1st meeting:
- PET is hard to process, sticky, high temperature and crystalline
- keep it easy
- keep it safe, suck off fumes, low resource areas are not about rules and safety measurements, so you have to make it safe without rules
- Without shredding would make it really easy
- Power cost is important
- processing temperature is important
- import is expensive
- moisture and room temperature are also of influence
- workdays are less effective and shorter
- recognise-ability is important for collection
- there is enough plastic to be picky

2nd meeting:
- Think about what language they speak, no technical knowledge
- Cooling takes approximately as long as melting
- Very thick plates need very long cooling, meaning more degradation caused by long heating
- The more mass the more heat, the more cooling, the more difference in temp, the more warpage
- 25kW is a lot, find out what is normal and what is available
- production cycle in between blackouts = short production time needed
- Euro Pallet size is nice standard size, fits through the door
- Adjusting temperature and thickness would be nice
- Nice flatness and low porosity is nice

Conclusions for design process
- When selecting choose the easy/simple option
- Look into processing temperatures
- A limit to process only 1 or a few plastic types can be set
- Separation of processing steps is worth looking into
- Instructions communication and questions need to be thought through and adjusted for local understanding
- The effects of increasing plate thickness should be examined
- Realistic power usage should be determined
- A limit to process only 1 or a few plastic types can be set

Conclusions for POR
- PET is too difficult to process
- Adjustable thickness would be a nice function
- The machine(s) need to be safe without instructions
- Locally available parts are preferred over import
- Minimal flatness needs to be defined
- Maximum porosity needs to be defined
- Maintenance possibilities should be included in the design
- welding all parts together should be avoided

A.3.2. FABRICA DE SABÃO

Phone calls with Koen Verpaalen, initial contact:
- Nice to do something with all of the plastic waste
- Fantastic if we could replace plywood
- nice to use in furniture
- We'll find an application for anything
- The aim of Fabrica de Sabão is: Helping the social environment with starting / strengthening their own economy, through the teaching of practical and entrepreneurial skills and providing guidance in business start-ups?
- The maker-space and the equipment in it serve to teach practical skills and produce products.
- The products that are produced in the maker-space are sold to local private individuals and companies
- The products are produced and sold with the main goal of generating income for Fábrica the Sabão
- Fabrica de Sabão wants a machine that transforms plastic waste into usable raw materials,
- In the 1st place because this produces a cheap material while the existing building materials are very expensive. In the second place to clean up the environment. Creating waste awareness is more important than cleaning up.
- Fabrica de Sabão is already processing plastic waste into products but is limited to PET (New marble)
- A plate press that processes plastic waste into plastic sheets that can be used as a building material for furniture or other products, is of great value to Fabrica de Sabão. Despite the fact that the plates can not be used directly in the existing furniture designs.
- Considering that PET bottles are already being collected for recycling to "New marble", collecting the caps is a small extra effort.
- In addition to PET bottles and the corresponding caps, liquid containers in other shapes and sizes are the most common recognisable plastic waste. (Not including plastic bags and films)
- Fabrica de sabão is interested in starting up a plastic recycling hub with, among other things, the machinery of precious plastics.
- It is realistic that Fabrica de Sabão collects large quantities of mixed plastic, part of which is sorted.
- A large part of the plastic is not easy to sort by type of plastic because there are no clear characteristics present.
- A large part of the plastic waste consists of packaging material and food packaging.
- If a plastic sheet is made whose mechanical properties are not immediately suitable for replacing wooden sheets, we will come up with some other application.
- If a plastic plate with unique qualities is available then we think up some nice products to make of it.
- It is not a problem that the plates press must be used in a well-ventilated room.
- The equipment that Fabrica de sabão has available is mainly suitable for processing sheet material.

Conclusions for design process
- It is worth looking into wether mixed plastics can be processed
- Furniture application requirements might be a nice goal
- Plastic type and residue pollution should be taken into account

Conclusions for POR
- PET is already processed in another process, making it a lower priority be be processable by the plate press
- Directly replacing 18mm plywood would be very nice, but thinner and smaller plates are still very useful

Phone call with Daniela Antonio, Maker-space manager:

Fábrica helps community members to learn manufacturing & entrepreneurial skills. next to that Fábrica has their own in-house manufacturing with their own employees. in the near future Fábrica wishes to share the facility with small entrepreneurs that started with help of Fábrica. They can then also share all of the facilities of the maker space.
The community members that are trained are mostly young and inexperienced, often this their first "job".
Manufacturing is based on CC designs but designs also come from the community members and are shared through CC. Designs can thus be adapted.
Fabrica is also working on waste awareness and because of it they are setting up their own recycling hub, collecting and sorting waste.
The intended use of the maker space in which the PPP will function is a shared facility for all companies within the Fábrica de Sabão institution.
The PPP is wanted to be an new means for processing plastic acquired through the future efforts of the waste collection and sorting facility set up by Fabrica de Sabão.

Conclusions for design process
- Fábrica de Sabão and possible other users, are expected to be willing to adjust their facility and preprocessing and collection efforts to fit the design

Conclusions for POR
- The plastic plates do not have to be a direct replacement of plywood.
- The design has to account for multiple users with minimal experience

Fabrica de sabão video call, Maker-space team:

- Fábrica de Sabão stresses that 6mm is not strong enough for furniture, they would need 12mm.
- Fábrica de Sabão will research my BOM items for availability and price

Conclusions for POR
The plate press should be (adjust)able to press plates with 12mm thickness.

Telemeeting Daniela, FS
Checking design decision, discussing material options

- Ovens are accessible and cheap
- Aluminium moulding is easily available
- Aluminium sheets are available
- Steel I-beams all sizes available
- Steel square hollow sections all sizes available
- Fasteners are expensive and not all sizes are available

Conclusions for design process
- Minimum / maximum fastener sizes should be listed to provide limited selection freedom

Conclusions for POR
- When possible expensive fasteners should be avoided

A.3.3. PRECIOUS PLASTIC

Interview Mathijs Stroober:

- Lots of power needed
- Sorting is not precise
- Unknown is not used
- Pet is not used
- Specific products are collected, thus material is known and colour is constant
- We provide the machine, others figures out what you can make with it
- Users are creative and will experiment and makes nice things

Conclusions for POR
- PET is too difficult to process

Interview Intern Jerry, Plate Press build:

- Jerry built a plate press for producing 1m x 1m x 10mm plates
- Thickness is adjustable by replacing border ring
- Classic press concept, heating on both sides, single hydraulic press of 8 tons
- Three phase 230v 16A used, 1 phase used per heating side, 1 used for central electronics
- 230v x 16A = 3680 W used per side for heating thus 7360 Watt total for heating
- Custom heating elements created by ceramic oven builder
- Zig zag heating element in middel of plate 1x1m
- Centre runs hotter
- Production of 1 plate takes 1 day
- 2hr heat of machine top and bottom touching
- 2hr heating plastic pressed tightly and increasing pressure every 15 minutes
- Whole night of cooling
- No mould
- Aluminum flatbeds
- Inefficient process
- Cost of machine €2000
- Build time 6 weeks, including redesign (problem solving) of smaller elements while building
- Thick layer of isolation
- Aluminium €600 steel construction 400€ electronics, heating & insulation 1000€

- Air gap was left between flatbed aluminium and heating elements, allowing better heat Distribution, downside is longer warm up time.
- Scaling up revealed new problems, small scale tests do not prove full scale function
- Nice thing is 1 machine for pressing plates, downside is production rate and inefficient energy consumption, advise is to separate heating (,pressing) and cooling
- Will be publicly available in half a year

Conclusions for design process
- The separation of process steps is worth looking into because of the energy efficiency
- The "classic" Plate press design is already executed, other options are more interesting to look into
- Full scale prototyping might be needed to confirm the expected functionality
- Heat distribution is something that needs to be looked in to
- Custom made heating elements are worth looking into
- More extensive energy consumption calculations might be needed

A.3.4. FLIPFLOPI

Interview Leonard Schürg:
- Flipflopi is building a ship from recycled plastic in Kenya
- They made a plank/plate press for planks of 6000 x 220 x 25 mm
- HDPE is heated in a low pressure extruder, the plastic sausage is that comes out is put into a heated mould which is pressed together with hydraulic car jacks
- Sorting is done through production techniques:
  - Clear bottles = PET
  - Blow-moulded objects, Blow = HDPE
  - Injection-moulded objects, Inject = PP
  - So a lot of type pollution occurs
- 4x 16 ton pressure is applied, which is enough according to Leonard, it could be increased, but it works for now, less pressure would also work, but it should not be decreased too much.
- 4x 16 ton pressure on 6000 x 220 mm ≈ 0.5 MPA
- Cracks should not me bigger than 1.5mm otherwise plastic creeps out of the mould
- Mixed plastic doesn't work, crack lines along the plastic boarders, PP doesn't stick to HDPE
- With High shrinkage of HDPE and rough surface of unpolished mould, the plank breaks when it is cooled down completely inside the mould, but when taken out to soon, it warps
- Their mould is made from steel rods welded together
- They also tried to mix the extruded and molten HDPE with solid HDPE flakes in the mould, which worked fine
- the mould is heated with locally available heating elements, which locals call life elements

Production:
- Always choose the easy option, local builders will do the same or try to find shortcuts

Construction materials:
- Standard profiles are available, but often not in the size you want
- Bolts and nuts are expensive and size choices are limited and differ from time to time
- hinges and that sort of articles are available in some sort if you search well, but expensive
- Sheet materials are available
- Quality of all materials differ a lot from time to time
- Import is tricky, it takes long, can be expensive and corruption at customs can cost time and money. goods can also never arrive

Conclusions for design process
- A realistic pressure to start experimenting with is 0.5 MPa
- Mixed plastics are unwise to process since the resulting material is of bad quality
- Most parts and materials are available or acquirable, but the more exotic, the more expensive

Conclusions for POR
The design should account for varying fastener sizes, profile dimensions and material quality

A.3.5. WASTE BOARDS

Visit production facility & interview Johnathan Morison:
- Recycled plastic doesn't act like normal plastic
- Practical experience is worth more than theory
- Plastics burn easily when too hot
- Plastics leave very nasty stains on the mould
- Melt plastic in oven, press with heated mould
- PP doesn't mix with or stick to HDPE, fractions lines gather along the interfaces of the different type of plastics.

Conclusions for design process
- Experimentation renders great insights often more useful than the theory, which is often wrong or nonexistent
- Separating the process steps might be a good idea
- Mixed plastics are unwise to process since the resulting material is of bad quality

A.3.6. STICHTING STUNT

Working observations & interviews with Frank Van Polanen Petel & Lodewijk Bosman:
- Account for Murphy's law
- Rules are forgotten
- Safety is very important
- Everything should work the way it is supposed
- Everything should be simple and clear
- Only 1 way should be thé way
- Doing it wrong should not be possible

Conclusions for design process
- All safety hazards should be determined and eliminated

Conclusions for POR
- The design should provide 1 clear way of working that is not multi interpretable
- Safety should be inherent and not forced through rules

A.4. COMMODITY PLASTICS PROPERTIES OVERVIEW

1	2	3	4	5	6	7
PET	**HDPE**	**PVC**	**LDPE**	**PP**	**PS**	**O**
POLYETHYLENE TEREPHTHALATE	HIGH DENSITY POLYETHYLENE	POLYVINYL CHLORIDE	LOW DENSITY POLYETHYLENE	POLYPROPYLENE	POLYSTYRENE	OTHER OR MIXED
PETE, A-PET, PETP	**PE-HD, PE**	**V**	**PE-LD**			**? UNKNOWN ?**
Good gas & moisture barrier properties High heat resistance Clear Hard Though Microwave transparent Solvent resistant	Excellent moisture barrier properties Excellent chemical resistance Hard to semi-flexible and strong Soft waxy surface Permeable to gas Pigmented bottles stress resistant	Excellent transparency Hard, rigid (flexible when plasticised) Good chemical resistance Long term stability Good weathering ability Stable electrical properties Low gas permeability	Tough and flexible Waxy surface Soft – scratches easily Good transparency Low melting point Stable electrical properties Good moisture barrier properties	Excellent chemical resistance High melting point Hard, but flexible Waxy surface Translucent Strong	Clear to opaque Glassy surface Rigid or foamed Hard Brittle High clarity Affected by fats and solvents	There are other polymers that have a wide range of uses, particularly in engineering sectors. They are identified with the number 7 and OTHER (or a triangle with numbers from 7 to 19). Also mixes and unkown plastics are collected in this group.
COSMETIC CONTANERS FOODJARS MOUTHWASH BOTTLES SINGEL USE DIRINKING BOTLES PREPARED FOOD TRAYS SALAD DRESSIGN BOTTLES	AGRICULTURAL PIPE DETERGENT BOTTLES EXTRUDED PIPE GROCERY BAGS ICECREAM TUBS MILK/JUICE JUGS SAUCE BOTTLES OIL/VINEGAR BOTTLES SHAMPOO BOTTLES SHIPPING CONTAINERS	BLISTER PACKS BLOODBAGS CABLE SHEETING CARPET BACKING FLOOR TILES GARDEN HOSE MEDICAL TUBING OUTFOOR FURNITURE PLUMBING PIPE WINDOW FRAMES WIRES INSULATION ELECTRICAL PIPING	6-PACK RINGS BREAD BAGS DRY CLEANING BAGS GARBAGE BAGS HEAVY DUTY BAGS MOLDED LAB EQUIPMENT PLASTIC FOOD WRAP RECYCLING BINS SQUEEZEABLE BOTTLES TOYS	BOTTLE CAPS CREAL LINERS COTTAGE CHEESE LINERS HINGED LUNCH BOXES KETCHUP BOTTLES MARGERINE CONTAINERS MEDICINE BOTTLES MICROWAVE OVENWARE PACKAGING TAPE POTATOCHIP BAGS RUBBERMAID CONTAINERS STRAWS	CD AND VIDEO CASES DISPOSABLE HOT DRINK CUPS DISPOSABLE COLD DRINK CUPS DISPOSABLE PLATES DRINKING GLASSES EGG CONTAINERS FOAM PACKAGING HINGED BAKERY CONTAINERS PACKING PEANUTS/NOODLES PLASTIC CUTLERY STYROFOAM YOGURT CONTAINERS	BABY BOTTLES CAR PARTS FIBREGLASS LARGE WATER BOTTLES TUPPERWARE WATER COOLER BOTTLES ABS (SOMETIMES 9) PLA PC PMMA PEEK ETC.
1 kg ≈ 50 Soda bottles (.5L)	1 kg ≈ 70 Sauce bottles (.35L)	1 kg ≈ 12.5m of electrical piping (Ø 16mm)	1 kg ≈ 200 6-pack rings	1 kg ≈ 555 Soda bottlecaps	1 kg ≈ 300 Pieces of plastic cutllery	1 kg ≈
260 C°	177 C°	182 C°	121 C°	208 C°	177 C°	MIN. MELT. TEMP.
80 C°	75 C°	60 C°	70 C°	140 C°	95 C°	SOFTEN. TEMP.
300 C°	275 C°	184 C°	318 C°	315 C°	330 C°	DECOMP. TEMP.
0,3 %	0,01 %	0,2 %	0,01 %	0,01 %	0,1 %	WATER ABSORP. 1
0,8 %	0,01 - 0,002 %	3,5 %	0,01 - 0,002 %	0,1 %	0,15 %	WATER ABSORP. 2
$70 \cdot 10^{-6-1} C^{\circ-1}$	$200 \cdot 10^{-6-1} C^{\circ-1}$	$80 \cdot 10^{-6-1} C^{\circ-1}$	$225 \cdot 10^{-6-1} C^{\circ-1}$	$150 \cdot 10^{-6-1} C^{\circ-1}$	$70 \cdot 10^{-6-1} C^{\circ-1}$	LIN. THERM. EXP.
$40\ N/MM^2$	$20 - 30N/MM^2$	$80 - 110\ N/MM^2$	$8 - 15\ N/MM^2$	$40 - 45\ N/MM^2$	$80\ N/MM^2$	FLEX. STRENGTH
$30 - 45\ N/MM^2$	$25 - 34\ N/MM^2$	$50 - 60N/MM^2$	$9 - 28\ N/MM^2$	$30 - 40\ N/MM^2$	$40 - 65\ N/MM^2$	TENSILE STRENGTH
70 %	250 - >500 %	20 - >350 %	200 - 600 %	>450 %	15 %	ELONG. AT RUPT.
BRITTLE	TOUGH	-	FLEXIBLE	TOUGH	BRITTLE	GENERAL QUALITY

Source: CES edupack level 2 and 3

A.5. SURVEY

Thank you for helping me on my quest to design an open-source plastic plate press for bottom-up recycling in low resource areas.
This questionnaire is intended to be filled out by potential users/builders/buyers of such a plate press and it is set up to find out what potential users expect and want from a plate press and what the limitations of the contexts of these potential users are.
It wil take about 15 minutes of your time.

The following questions are about your specific context, in which the plate press will have to opperate.

1 We are/I am located in ...

City, Country

2 The name of our/my operation/institution/company is

3 We/I have or can get acces to: *

(This is about finding the maximum amount of power that can be provided)

- [ ] A standard power socket, ca. 2 kilowatt
- [ ] A standard power socket, ca. 4 kilowatt
- [ ] A Three-phase power socket, ca. 10 kilowatt
- [ ] A Three-phase power socket, ca 20 kilowatt
- [ ] Other

4 My/Our power supply *

- ◯ is trustworthy, almost without blackouts
- ◯ blacks out sometimes for a short time
- ◯ blacks out somtimes for more than an hour
- ◯ blacks out often for a short time
- ◯ blacks out often for more than an hour
- ◯ only works sometimes
- ◯ Other

5 My/Our power supply is *

- ◯ expensive in terms of cost per kilowatt
- ◯ affordable in terms of cost per kilowatt
- ◯ cheap in terms of cost per kilowatt
- ◯ Other

6 This is also important to know about my power supply options:

7 The person(s) that would operate the plate press will do this *

- [ ] Full-time
- [ ] Part-time
- [ ] Sometimes
- [ ] Only a few times
- [ ] once
- [ ] Other

8 We/I also think it is important to know this about the persons that will operate the machine:

The following questions are about goals of your operation/institution/company

9 We/I want to use the plate press for *

- [ ] Experimentation
- [ ] Sample production
- [ ] Batch production
- [ ] Series production
- [ ] Other

10 Our output goal is mostly about *

- ◯ Producing qualitative plastic plates/sheets
- ◯ Processing as much plastic waste as possible
- ◯ Other

11 We/I want to produce about *

- ◯ 1 plate per day
- ◯ 5 plates per day
- ◯ 10 plates per day
- ◯ 20 plates per day
- ◯ 2 plates per week
- ◯ 5 plates per week
- ◯ 10 plates per week
- ◯ as much plates as possible with non stop production
- ◯ Other

12 We/I also think it is important to know this about our operation/institution/company:

The following questions are about the main intended plate application & expected general qualities

The Aesthetics/looks of the plate are *

◯ 0	◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	◯ 6
Unimportant						Very important

The plastic plates should provide *

◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	◯ 6	◯ 7

Constructive strength Surface area

The surface area of the plastic plates should be about as large as ... *

◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	◯ 6	◯ 7
A book						A bed

16 We/I expect these specific qualities/properties of the plastic plates:

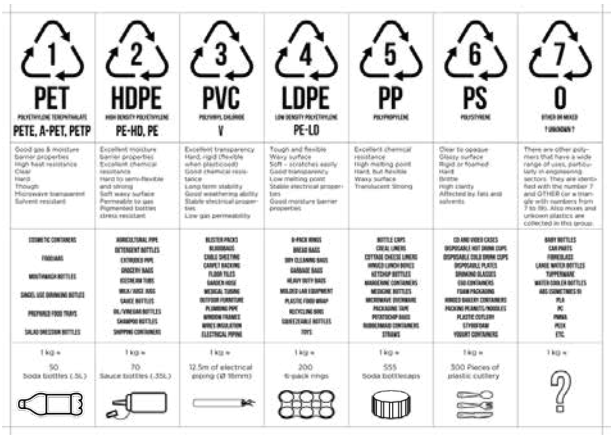
17 We/I would love be able to produce plastic plates with these qualities/properties:

18 We/I want to use the plastic plate to *

- ☐ Make furniture
- ☐ Use as input material for a laser cutter
- ☐ Use as input material for a CNC-router
- ☐ Build huts/houses
- ☐ Sell as they are
- ☐ Make boxes
- ☐ I/We'll see when I/we have them
- ☐ Other

19 We/I also think it is important to know this about what we/I will use the plates for:

The following question are about your plastic waste supply options



20 We/I can acquire plastic through *

- ☐ self organised collection
- ☐ offering payment per kg
- ☐ buying from organised collectors
- ☐ bussiness arrangement with second party

- [ ] Other

21 The acquired plastic waste is *

- [ ] sorted by plastic type
- [ ] sorted by color
- [ ] sorted by type of product
- [ ] cleaned
- [ ] shredded
- [ ] non of the above
- [ ] Other

22 We/I have or can acquire the following means to shred plastic *

- [ ] an industrial shredder
- [ ] a DIY shredder
- [ ] hand labour shredding
- [ ] it is supplied in shredded form
- [ ] non of the above
- [ ] Other

23 We/I also think it is important to know this about our/my plastic waste supply options:

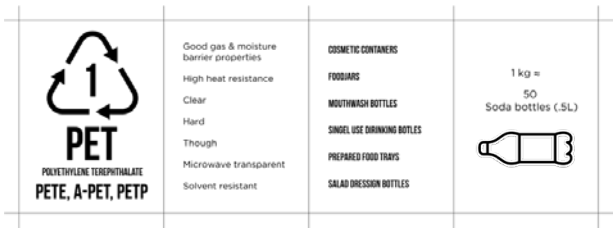
Acquiring PET is *

0 1 2 3 4 5 6 7 8 9 10

Costly/Hard Cheap/Easy

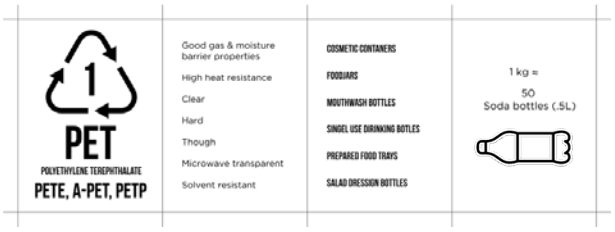
25 We/I can acquire approximately ... kg PET per day *

fill in '0' if you want to express it in kg/week in the next question

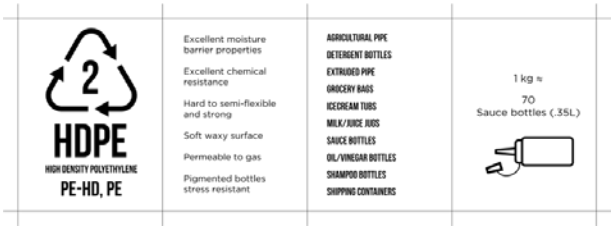


26 We/I can acquire approximately ... kg PET per week *

fill in '0' if you expressed this in kg/day in the previous question



Acquiring HDPE is *

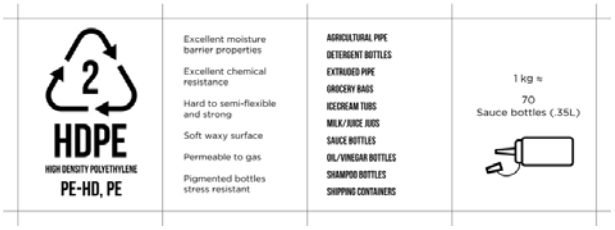


0 1 2 3 4 5 6 7 8 9 10

Costly/Hard Cheap/Easy

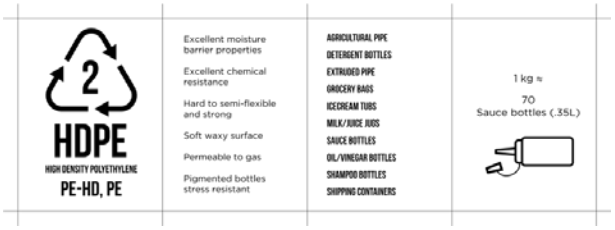
28 We/I can acquire approximately ... kg HDPE per day *

fill in '0' if you want to express it in kg/week in the next question



29 We/I can acquire approximately ... kg HDPE per week *

fill in '0' if you expressed this in kg/day in the previous question



Acquiring LDPE is *

0 1 2 3 4 5 6 7 8 9 10

Costly/Hard Cheap/Easy

31 We/I can acquire approximately ... kg LDPE per day *

fill in '0' if you want to express it in kg/week in the next question

32 We/I can acquire approximately ... kg LDPE per week *

fill in '0' if you expressed this in kg/day in the previous question

35 We/I can acquire approximately ... kg PP per week *

fill in '0' if you expressed this in kg/day in the previous question

Acquiring PS is *

Acquiring PP is *

0 1 2 3 4 5 6 7 8 9 10

Costly/Hard Cheap/Easy

34 We/I can acquire approximately ... kg PP per day *

fill in '0' if you want to express it in kg/week in the next question

0 1 2 3 4 5 6 7 8 9 10

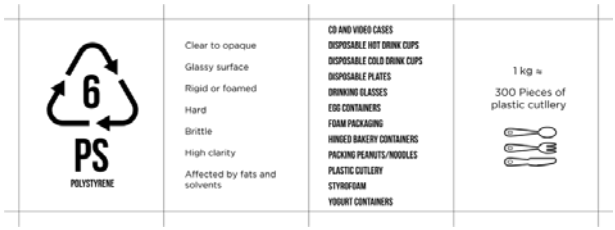
Costly/Hard Cheap/Easy

37 We/I can acquire approximately ... kg PS per day *

fill in '0' if you want to express it in kg/week in the next question

38 We/I can acquire approximately ... kg PS per week *

fill in '0' if you expressed this in kg/day in the previous question



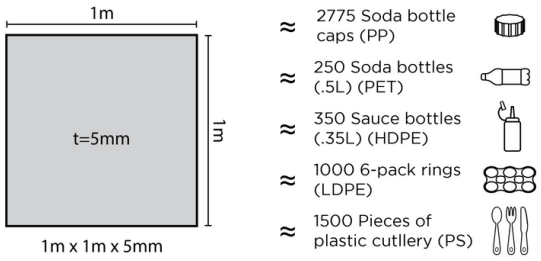
39 We/I also think it is important to know this about the plastic (waste) we can acquire:

For your infromatio: PVC (3) and ABS (9) were left out because they produce toxic fumes when melted. Other (7) is left out because it is unreliable and unpredictable.

The following questions are about the specific plate requirements that you would like

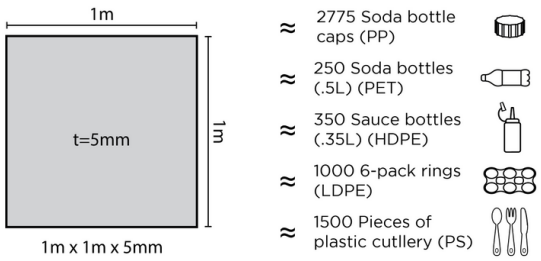
40 For the intended application(s) the best plate length would be ...cm *

keep in mind that you need a certain amount of plastic like shown in the illustration



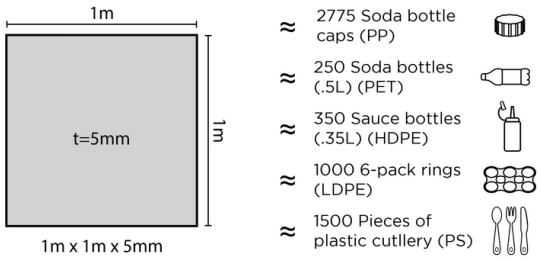
41 For the intended application(s) the best plate width would be ...cm *

keep in mind that you need a certain amount of plastic like shown in the illustration



42 For the intended application(s) the best plate thickness would be ...mm *

keep in mind that you need a certain amount of plastic like shown in the illustration



43 For the intended application(s) the plate thickness may not deviate more than *

- ◯ 0.5 mm
- ◯ 0.75 mm
- ◯ 1 mm
- ◯ 1.5 mm
- ◯ 2 mm
- ◯ Other

44 For the intended application(s) the plate surface can best be *

- ◯ Smooth

- ◯ Textured
- ◯ doesn't matter
- ◯ Other

45 For the intended application(s) the plate's color pattern *

- ◯ may be random
- ◯ must be influenceable when producing the plate

46 For the intended application(s) the plate can best *

- ◯ be flat on all sides
- ◯ have a ribbed backside
- ◯ have a ribbed back and frontside
- ◯ be any way
- ◯ Other

47 For the intended application(s) the plate's porosity level can best be *

- ◯ As close as possible to 100% solid
- ◯ Around 50%
- ◯ Around 75%
- ◯ be any way
- ◯ Other

48 These requirements are also/extra important:

49 We/I also think it is important to know this about the specific plate requirements:

Almost done, just 2 more question about money and then 4 about contact and follow-up

50 If an open-source build plan for a plastic plate press able to press plates that are right for my application was available, I would build or let build one. *

- ◯ Yes
- ◯ No

- ◯ Maybe
- ◯ Other

51 Such a plate press should not cost me more than ...$ *

Now you are really almost done, just 4 more question about contact and follow-up.

52 I'd like to be informed about new deveopments in this project *

◯ Yes ◯ No

53 You may contact me for possible follow-up questions *

◯ Yes ◯ No

54 My name is:

55 You may contact me on this email address

Thanks for completing my survey!

Please share this survey with other potential users/buyers/builders of an open-source plastic plate press for bottom-up recycling in low resource areas.

Feel free to contact me on m.bachrach@gmail.com

Submit

Never submit passwords! - Report abuse

A.6. SURVEY RESULTS

We/I have or can get acces to:

16 out of 16 people answered this question

1	A standard power socket, ca. 4 kilowatt	7 / **44%**
2	A standard power socket, ca. 2 kilowatt	5 / **31%**
3	A Three-phase power socket, ca 20 kilowatt	3 / **19%**
4	A Three-phase power socket, ca. 10 kilowatt	3 / **19%**
5	Other	2 / **13%**

My/Our power supply

16 out of 16 people answered this question

1	blacks out sometimes for a short time	6 / **38%**
2	is trustworthy, almost without blackouts	6 / **38%**
3	blacks out somtimes for more than an hour	4 / **25%**
4	blacks out often for a short time	0 / **0%**
5	blacks out often for more than an hour	0 / **0%**
6	only works sometimes	0 / **0%**

My/Our power supply is

16 out of 16 people answered this question

1	affordable in terms of cost per kilowatt	8 / **50%**
2	expensive in terms of cost per kilowatt	4 / **25%**
3	Other	2 / **13%**
4	cheap in terms of cost per kilowatt	2 / **13%**

The person(s) that would operate the plate press will do this

16 out of 16 people answered this question

1	Part-time	10 / **63%**
2	Sometimes	5 / **31%**
3	Full-time	4 / **25%**
4	Only a few times	1 / **6%**
5	once	0 / **0%**

We/I want to use the plate press for

16 out of 16 people answered this question

1	Batch production	12 / **75%**
2	Experimentation	7 / **44%**
3	Sample production	6 / **38%**
4	Series production	6 / **38%**

Our output goal is mostly about

16 out of 16 people answered this question

1	Producing qualitative plastic plates/sheets	11 / **69%**
2	Processing as much plastic waste as possible	4 / **25%**
3	Other	1 / **6%**

We/I want to produce about

16 out of 16 people answered this question

1	10 plates per day	6 / **38%**
2	5 plates per day	4 / **25%**
3	1 plate per day	2 / **13%**
4	20 plates per day	2 / **13%**
5	5 plates per week	1 / **6%**
6	as much plates as possible with non stop production	1 / **6%**
7	10 plates per week	0 / **0%**
8	2 plates per week	0 / **0%**

The Aesthetics/looks of the plate are

16 out of 16 people answered this question

Average: 4.69

0	1	2	3	4	5	6

Unimportant — Very important

6		7 / **44%**
5		3 / **19%**
2		2 / **13%**
3		2 / **13%**
4		2 / **13%**

The plastic plates should provide

16 out of 16 people answered this question

Average: 4.19

1	2	3	4	5	6	7

Constructive strength — Surface area

4		6 / **38%**
5		4 / **25%**
3		2 / **13%**
7		2 / **13%**
1		1 / **6%**
2		1 / **6%**

The surface area of the plastic plates should be about as large as ...

16 out of 16 people answered this question

Average: 4.25

1	2	3	4	5	6	7

A book — A bed

3		5 / **31%**
4		4 / **25%**
5		3 / **19%**
7		3 / **19%**
1		1 / **6%**

We/I want to use the plastic plate to

16 out of 16 people answered this question

1	Make furniture	12 / **75%**
2	Sell as they are	9 / **56%**
3	Build huts/houses	7 / **44%**
4	Use as input material for a CNC-router	7 / **44%**
5	Make boxes	6 / **38%**
6	Use as input material for a laser cutter	6 / **38%**
7	I/We'll see when I/we have them	4 / **25%**
8	Other	2 / **13%**

We/I can acquire plastic through

16 out of 16 people answered this question

1	self organised collection	13 / **81%**
2	offering payment per kg	7 / **44%**
3	buying from organised collectors	6 / **38%**
4	bussiness arrangement with second party	2 / **13%**
5	Other	1 / **6%**

The acquired plastic waste is

16 out of 16 people answered this question

1	sorted by plastic type	14 / **88%**
2	cleaned	11 / **69%**

3	shredded	9 / **56%**
4	sorted by color	6 / **38%**
5	sorted by type of product	3 / **19%**
6	non of the above	2 / **13%**

We/I have or can acquire the following means to shred plastic

16 out of 16 people answered this question

1	a DIY shredder	12 / **75%**
2	an industrial shredder	5 / **31%**
3	hand labour shredding	2 / **13%**
4	it is supplied in shredded form	1 / **6%**
5	non of the above	0 / **0%**

Acquiring PET is

16 out of 16 people answered this question

Average: 8.75

Costly/Hard — Cheap/Easy

10		10 / **63%**
9		2 / **13%**
3		1 / **6%**
5		1 / **6%**
6		1 / **6%**
8		1 / **6%**

Acquiring HDPE is

16 out of 16 people answered this question

Average: 5.81

Costly/Hard — Cheap/Easy

3		3 / **19%**
8		3 / **19%**
1		2 / **13%**
5		2 / **13%**
6		2 / **13%**
10		2 / **13%**
7		1 / **6%**
9		1 / **6%**

Acquiring LDPE is

16 out of 16 people answered this question

Average: 5.94

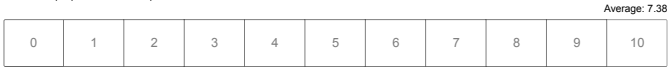
Costly/Hard — Cheap/Easy

2		3 / **19%**
5		3 / **19%**
8		3 / **19%**
4		2 / **13%**
10		2 / **13%**
6		1 / **6%**
7		1 / **6%**
9		1 / **6%**

Acquiring PP is

16 out of 16 people answered this question

Average: 7.38



Costly/Hard — Cheap/Easy

10		6 / **38%**
8		3 / **19%**
5		2 / **13%**
7		2 / **13%**
1		1 / **6%**
3		1 / **6%**
6		1 / **6%**

Acquiring PS is

16 out of 16 people answered this question

Average: 4.00

Costly/Hard — Cheap/Easy

5		4 / **25%**
0		2 / **13%**
1		2 / **13%**
3		2 / **13%**
6		2 / **13%**
2		1 / **6%**
4		1 / **6%**
8		1 / **6%**
10		1 / **6%**

For the intended application(s) the plate thickness may not deviate more than

16 out of 16 people answered this question

1	1 mm	7 / **44%**
2	2 mm	3 / **19%**
3	0.5 mm	2 / **13%**
4	Other	2 / **13%**
5	0.75 mm	1 / **6%**
6	1.5 mm	1 / **6%**

For the intended application(s) the plate surface can best be

16 out of 16 people answered this question

1	Smooth	13 / **81%**
2	doesn't matter	3 / **19%**
3	Textured	0 / **0%**

For the intended application(s) the plate's color pattern

16 out of 16 people answered this question

1	must be influenceable when producing the plate	9 / **56%**
2	may be random	7 / **44%**

For the intended application(s) the plate can best

16 out of 16 people answered this question

1	be flat on all sides	12 / **75%**
2	have a ribbed backside	2 / **13%**
3	Other	1 / **6%**
4	be any way	1 / **6%**
5	have a ribbed back and frontside	0 / **0%**

For the intended application(s) the plate's porosity level can best be

16 out of 16 people answered this question

1	As close as possible to 100% solid	11 / **69%**
2	Around 75%	4 / **25%**
3	Around 50%	1 / **6%**

4	be any way	0 / **0%**

If an open-source build plan for a plastic plate press able to press plates that are right for my application was available, I would build or let build one.

16 out of 16 people answered this question

1	Yes	14 / **88%**
2	Maybe	2 / **13%**
3	No	0 / **0%**

I'd like to be informed about new deveopments in this project

16 out of 16 people answered this question

1	Yes	16 / **100%**

You may contact me for possible follow-up questions

16 out of 16 people answered this question

1	Yes	16 / **100%**

A.7. EXPERIMENTATION DOCUMENTATION

A.7.1. TESTS 1.1 - 2

Test nr	1.1	1.2	1.3	1.4	2
Label nr	**0.1**	**0.2**	**0.3**	**0.4**	**1**
Test	Tryout	Tryout	Tryout	Tryout	Defined form can be filled
Denominator	**Paninin grill**	**Paninin grill**	**Paninin grill**	**Paninin grill**	**Alu Mould**
Heating apparatus	Panini grill	Panini grill	Panini grill	Panini grill	Panini grill
Mould	Grills original Flat bed	Grills original Flat bed	Grills original Flat bed	Grills original Flat bed	Aluminum lasercut mould
Mould thickness setting	**6mm**	**6mm**	**6mm**	**6mm**	**5mm**
Pressure	25kg	25kg	25kg	25kg	25kg
Material	**PP**	**HDPE**	**HDPE**	**HDPE**	**HDPE**
Plastic shape	Whole prototype parts	Whole bottle caps	Re-molten previous test	Whole bottle caps	Whole bottle caps
Input material weight (g)	-	-	-	-	220
Material distribution	Evenly	Evenly	Evenly	Evenly	Evenly
PTFE spray	No	No	No	No	Yes
Baking paper sheet	Yes	No	No	No	No
Melting time	-	-	-	-	30m
Melting temperature	200-250	200-250	200-250	200-250	200-250
Cooling setup	In panini grill	In panini grill	In panini grill	In panini grill	Outside grill inside mould
Cooling pressure	25kg	-	25kg	25kg	25kg
Cooling time	2h	2h	2h	2h	2h
Cooling temperature	12º C	12º C	12º C	12º C	8º C
Vent holes layer height	-	-	-	-	-
Handling	Folded when molten and pressed again 2x	Folded when molten and pressed again 1x	Re-molten previous test, Folded when molten and pressed again 1x	Folded when molten and pressed again 2x	
Process observations	Plastic pieces where hollow and trapped a lot of air, baking paper sticks to plastic	When cooled without pressure, warpage and rippling occurred	When cooled with pressure, warpage and rippling was eliminated	Bigger caps trapped more air, pollution burned	Bigger caps trapped more air, pollution burned
Mould opening observations	-	-	-	-	Mould opened easily
Trapped air	Medium sized bubbles medium amount	a few small bubbles	a few small bubbles	a few small bubbles	Medium sized bubbles medium amount

A.7.2. TESTS 3 - 4.4

Test nr	**3**	**4.1**	**4.2**	**4.3**	**4.4**
Label nr	**2**	**3.1.1**	**3.1.2**	**3.1.3**	**3.1.4**
Test	Try PET	Shredded = less air	PP processes like HDPE	PS processes like HDPE & PP	Longer melting time = better spread of PS
Denominator	**Alu Mould**	**Alu Mould**	**Alu Mould**	**Alu Mould**	**Alu Mould**
Heating apparatus	Panini grill	Panini grill	Panini grill	Panini grill	Panini grill
Mould	Aluminum lasercut mould	Aluminum lasercut mould	Aluminum lasercut mould	Aluminum lasercut mould	Aluminum lasercut mould
Mould thickness setting	**5mm**	**5mm**	**5mm**	**5mm**	**5mm**
Pressure	25kg	25kg	25kg	25kg	25kg
Material	**PET**	**HDPE**	**PP**	**PS**	**PS**
Plastic shape	Cut pieces PET bottle, 30x30	Shredded	Shredded	Shredded	Shredded
Input material weight (g)	310	240	220	240	240
Material distribution	Evenly	Mount in middle	Mount in middle	Mount in middle	Evenly
PTFE spray	Yes	Yes	Yes	Yes	Yes
Baking paper sheet	No	No	No	No	No
Melting time	1h 20m	20m	20m	20m	40m
Melting temperature	200-250	200-250	200-250	200-250	200-250
Cooling setup	Outside grill inside mould	Outside grill inside mould	Outside grill inside mould	Outside grill inside mould	Outside grill inside mould
Cooling pressure	25kg	25kg	25kg	25kg	25kg
Cooling time	12h	1h	1h	1h	1h
Cooling temperature	8º C	4º C	8º C	4º C	8º C
Vent holes layer height	-	-	-	-	-
Handling		Normal	Normal	Normal	Normal
Resulting thickness	-	5-6	4.9-5.1	5,3	5,3
Resulting weight of cleaned plate		214.3	188.6	235	233.8
Process observations	No melting, occurred. Only a few pieces stuck together and a few turned opaque. Some stuck to the mould, very hard to remove	Mould could not completely close, thickness therefore not even and slightly above 5mm-6mm. Melting process is way faster than with unshredded material.	PP flows more quickly than HDPE and more PP droops through the seams	Mould did not completely close, plastic didn't reach corners	Fleshing gripped mould inside and got it stuck
Mould opening observations	Pieces that stuck to the mould stuck really well and could not be pealed of only with tools the pieces were able to be scraped of and still then it was hard to remove everything	A bit of prying opened the mould	Fleshing gripped mould inside and got it stuck	Fleshing gripped mould inside and got it stuck	Fleshing gripped mould inside and got it stuck

Test nr	3	4.1	4.2	4.3	4.4
Result evaluation	No plate was formed	Pattern on top shows slight signs of flow, increasing towards corners, Pattern on the bottom shows more flow , from centre outwards.	Pattern on top shows slight signs of flow, increasing towards corners, Pattern on the bottom shows more flow , from centre outwards.	Pattern on top shows slight signs of flow, increasing towards corners, Pattern on the bottom shows more flow , from centre outwards.	Pattern on top shows slight signs of flow, increasing towards corners, Pattern on the bottom shows more flow , from centre outwards.
Trapped air	-	Very little	a few tiny air bubbles visible and 1 big one	Very little	Very little
Surface quality	-	Good, plastic pollution noticeable	Non melting elements incapsulated gives problems at surface. Plastic polution from other types don't blend or stick, you can peel them off easily	Eventual (air) dimples	Eventual (air) dimples
Flatness	-	Good	Good	Good	Good
Raised edges	-	Slightly	Slightly	Very slightly	Very slightly
Shrinkage	-	3-4 mm on longest side	6-7 mm on longest side	2-3 mm on longest side	2-3 mm on longest side
warpage	-	None		None	None
Theory development	Panini iron cannot heat above 250 C PET needs +260 C,	Bottom heat more quickly, and has more surface contact at beginning, thus flow is more at bottom than at the top	PP has a higher flow rate? Lower viscosity at melting temperature than HDPE?	Low flow rate caused plastic not to spread fast enough, therefore mould did not close and corners were not filled	Longer melting time allowed plastic to spread better. But plastic was already divided better at start.

A.7.3. TESTS 5.1 - 6.2

Test nr	5.1	5.2	5.3	6.1	6.2
Label nr	**3.2.1**	**3.2.2**	**3.2.3**	**3.3.1**	**3.3.2**
Test	Thick plates are also possible	Thick plates are also possible with HDPE	Thick plates are also possible with PS		
Denominator	**Alu Mould**	**Alu Mould + vents**	**Alu Mould + vents**	**Alu Mould + vents**	**Alu Mould + vents**
Heating apparatus	Panini grill	Panini grill	Panini grill	Panini grill	Panini grill
Mould	Aluminum lasercut mould	Aluminum lasercut mould	Aluminum lasercut mould	Aluminum lasercut mould	Aluminum lasercut mould
Mould thickness setting	**20mm**	**20mm**	**20mm**	**10mm + 2mm spacers**	**10mm + 2mm spacers**
Pressure	25kg	25kg	25kg	25kg	25kg
Material	**PP**	**HDPE**	**PS**	**HDPE**	**PP**
Plastic shape	Shredded	Shredded	Shredded	Shredded	Shredded
Input material weight (g)	830	850	850	440	410
Material distribution	Evenly	Evenly	Evenly	Evenly	Evenly
PTFE spray	Yes	Yes	Yes	Yes	Yes
Baking paper sheet	No	No	No	No	No
Melting time	1h	1h	1h	40m	40m
Melting temperature	200-250	200-250	200-250	200-250	200-250
Cooling setup	Outside grill inside mould	Outside grill inside mould	Outside grill inside mould	Outside grill inside mould	Outside grill inside mould
Cooling pressure	25kg	25kg	25kg	25kg	25kg
Cooling time	12h	12h	12h	4h	4h
Cooling temperature	4º C	4º C	4º C	-4º C	-4º C
Vent holes layer height	-	20-25	15-20	10-15	10-15
Handling	Normal	Normal	Normal	2mm spacers between mould closing edges	2mm spacers between mould closing edges
Resulting thickness	20,5 - 26,5	20-25	18.7 - 20.0	10.3 - 13	10 - 11.5
Resulting weight of cleaned plate	807,6	828,5	847,5	407,9	393,4
Process notes	The top part of the mould was wiggled and pressed in different corners when the plastic was assumed to be fluid. This was an attempt to even out the plastic and to drive out air bubbles.	The mould would not close to the right thickness, and could not be pressed down further. 3 holes were drilled in the 5th mould layer (25mm hight) to allow excess material and air to flow out, this worked only a little bit and the mould would still not completely close.6mm spacers were inserted in the gap to ensure a level output.	The failed 5mm PS plate was put in this process. Together with the granulate there was an insufficient amount of PS to put in the 960g that was needed. The mould was sanded to remove scratches and sticking plastic pieces before the process.	The mould would not close thus the melting time was increased, hoping that the excess material and air would come out through the vents. Eventually plastic came out through the top opening, suggesting that the pressure forced enough flow and that excess material was the cause for not closing	The material seeped out through all cracks and the mould could completely close suggesting that the process was successful.

Test nr	5.1	5.2	5.3	6.1	6.2
Process observations	Mould could not completely close, thickness therefore not even and above 20 mm, result is very crooked.	Mould could not completely close, thickness therefore not even and above 20 mm. The plastic drooping out of the holes seemed to have a very high viscosity and flowed out very slowly.	The mould closed completely		The plastic seeped through all cracks, more fluid than HDPE
Mould opening observations	Mould had to be pried open layer by layer	Even though a easy accessible gap was left open, the mould could not be pried open and had to be screwed apart. The fleshing seems grip the mould stuck.	The mould would not open, not even with disassembly. Only with a chisel and hammer the bottom layer of the mould could be peeled off. Sanding was not a good idea.	Mould had to be disassembled but flat side came loose easily	
Result evaluation	Result looks very nice and solid, but crooked and after cutting through it, large air bubbles showed up	Result looks very nice and solid, but has very large sink marks and after cutting through it, large air bubbles showed up.	Result looks even and flat. Surfaces have a few interruptions, dimples, air gaps.	Result looks even and flat. Surfaces have no interruptions	Result looks even and flat. Surfaces have a few interruptions, air gaps.
Trapped air	Large air bubbles uneven distributed	Large air-bubbles gather just below top surface.	Sporadic small air bubbles, overall good solidity	Big air pockets are revealed when cut open	Sporadic vey small air bubbles, overall good solidity
Surface quality	Smooth and flat, no dimples or holes	Smooth and continuous, but not flat	Looks flat, but Slightly thinner (1.3mm) towards middle. Surface discontinuations, small and medium sized air gaps.	Nice, smooth, continuous surface without interruptions	Nice, smooth, continuous surface with just a few very small superficial air gaps
Flatness	Good	Edges are straight, middle has large height differences	Edges are straight, middle is slightly thinner	Edges are straight, middle is slightly thinner	Edges are straight, middle is slightly thinner
Raised edges	Slightly, more than the 5mm version	Easily noticeable raised edges or lowered middle	Very slightly	Visibly	Slightly
Shrinkage	3-4 mm on longest side	6-7 mm on longest side and sink marks in middle up to 5mm	2-3 mm on longest side	6-7 mm on longest side	3-4 mm on longest side
warpage	None		Edges are straight, middle is slightly thinner	Edges are straight, middle is slightly thinner (1-2 mm)	Edges are straight, middle is slightly thinner (1-1.5 mm)
Theory development	The surfaces of the plastic volume melt first and incapsulate the air, the viscosity of the plastic keeps the bubbles from moving a lot. The surfaces stay continuous due to plastic sticking to the hot mould and surface drag.	Higher viscosity of HDPE makes it harder for air bubbles to move, therefore more air is incapsulated.	the lower flow rate of PS causes the particles to take longer to merge leaving air flow paths open and thus air is able to leave the plastic and the mould.		Lower viscosity allows more flow and allows bubbles to move to the vents and leave the mould

A.7.4. TESTS 7 - 9.2

Test nr	7	8.1	8.2	9.1
Label nr	**4.1**	**4.2.1**	**4.2.2**	**5.1**
Test				
Denominator	**Mould + vents + handling**	**Mould + vents + handling**	**Mould + vents + handling**	**Alu mould + rolling**
Heating apparatus	Panini grill	Panini grill	Panini grill	Panini grill
Mould	Aluminum lasercut mould	Aluminum lasercut mould	Aluminum lasercut mould	Aluminum lasercut mould
Mould thickness setting	**20mm**	**10mm**	**10mm**	**-**
Pressure	25kg	25kg	25kg	-
Material	**HDPE**	**HDPE**	**HDPE**	**HDPE**
Plastic shape	Shredded	Shredded	Shredded	Shredded
Input material weight (g)	800	450	450	450
Material distribution	Even	Even	Even	Even
PTFE spray	Yes	Yes	Yes	Yes
Baking paper sheet	No	No	No	No
Melting time	1h 20m	1h 40m	40m	40m
Melting temperature	200-250	200-250	200-250	200-250
Cooling setup	Outside grill inside mould	Outside grill inside mould	Outside grill inside mould	Outside grill, inside mould, no lid
Cooling pressure	25kg	25kg	25kg	-
Cooling time	4h	4h	4h	12h
Cooling temperature	-4º C	-4º C	-4º C	6
Vent holes layer height	15-20	5-10	5-10	-
Handling	Melting from top & bottom without top half of the mould, when molten, the mould was closed and “pressurised” with a cold top mould part.	Melting from bottom without top half of the mould. Top would not melt then top was also heated for 20 minutes, then top part of mould was placed and heated and pressed.	Melting from both sides with closed mould. Pressed 25kg during melting process. Afterwards pressurised cooling with glue clamps	Melting from both sides with open mould. Pressed after cooling by rolling over with a cyclinder
Resulting thickness	22	8.55 - 10.1	8.3 - 10	3 - 18
Resulting weight of cleaned plate	783,4	369,3	378,2	450
Process notes	The open mould was heated from both sides.	Melting from bottom without top half of the mould. Top would not melt then top was also heated for 20 minutes, then top part of mould was placed and heated and pressed. The mould would not close and thus glue clamps were used to exert pressure.	The mould would not close and thus glue clamps were used to exert pressure.	After applying rolling pressure, the plastic was quite flat and straight. Major deformations occurred while cooling
Process observations	Although not put under pressure, also the top layer of the granulate was molten before the middle.	Heating from bottom side with open topside did not melt till top layer of granulate. With glue clamp pressure, the mould was bending outwards and plastic came drooping out of every seam.	With glue clamp pressure, the mould was bending outwards and plastic came drooping out of every seam.	The Outer surface of the plastic solidified to the coach of the aluminum roller. This created solidified rippling effects
Mould opening observations	The mould had to be disassembled to get the plate out.	Mould had to be disassembled but came loose nicely.	Mould had to be disassembled but came loose nicely.	the mould was not closed of for cooling thus the result was open to the view, it came loose very easily from the bottom mould half

Test nr	7	8.1	8.2	9.1
Result evaluation	The result looked and felt solid except for the top surface which was ugly and no continuous. Air was trapped at the surface.	Result looks good, the top side feels a bit grainy, it might have needed some more melting time.	Result looks good, the bottom side feels a bit grainy.	the result is very bad, although the surface is very shiny, it has no consistency at all.
Trapped air	Also air was trapped in the middle of the plaque	Only a few small air bubbles	Only a few small air bubbles	Although the result is horrible, the amount of trapped air is less than earlier tests without pressure
Surface quality	the bottom surface was continuous and smooth, with some sinks of 1-2mm the top surface was rubbish	Bottom surface is nice and smooth, top surface is somewhat grainy.	Top surface is nice and smooth, bottom surface is somewhat grainy.	Shiny but ripped and very random
Flatness	the overall flatness is quite OK but top surface has huge discountinuation and the bottom surface has visible sinks	Overall good flatness but the middle is thinner than edges	Overall good flatness on top side, but the middle is thinner than edges drawing sink from the bottom side.	No flatness
Raised edges	Clearly visible raised edges 1-2 mm	Slightly	Slightly	Raised edges
Shrinkage	6-7 mm on longest side and sink marks in middle up to 2mm	6-7 mm on longest side	6-7 mm on longest side	6-7 mm on longest side
warpage	Edges are straight, middle is slightly thinner (1-2 mm)	Edges are straight, middle is slightly thinner (1-1.6 mm)	Edges are straight, middle is slightly thinner (1-1.7 mm)	the middle is raised, bulking upwards
Theory development	Two sided heating trapped air in the middle. Sinks in the middle are caused by uneven cooling & shrinkage a	The pressure helped to push all excess material out of the mould creating flow thus also pushing air out. Air might also have been compressed into smaller bubbles and stay trapped in under pressure. Melting from with open top and heat from bottom created a pool of molten plastic in which melting granulate sunk in, leaving the air above the pool.	The pressure helped to push all excess material out of the mould creating flow thus also pushing air out. Air might also have been compressed into smaller bubbles and stay trapped in under pressure. Melting from with open top and heat from bottom created a pool of molten plastic in which melting granulate sunk in, leaving the air above the pool.	Cooling to the air is not a good idea, rolling does seem to remove air
Course		Isolate air removal trick	Isolate air removal trick	

A.8. CREATIVE SESSION - IDEATION

Session plan:

5 min.
Energiser

2 min.
Agenda

2 min.
Explaining goals

5 min.
Purge brainstorm

3 min.
H2 Selection

21 min.
H2 brain writing

5 min.
Selection criteria brainstorm

10 min.
Concept forming in teams

5 min.
Present the best

58 min.
Done

A.9. PROOF OF CONCEPTS TEST DOCUMENTATION

Test nr	9.2	9.3	10.1	10.2
Label nr	**5.2**	**5.3**	**6.1**	**6.2**
Test				
Denominator	**Steel mould + oven + roller**	**Steel mould + oven + roller**	**Steel mould + oven + roller**	
Heating apparatus	Oven	Oven	Oven	Oven
Mould	Folded sheet metal mould with removable height walls	Folded sheet metal mould with removable height walls	Folded sheet metal mould with removable height walls	Folded sheet metal mould
Mould thickness setting	**12mm**	**12mm**	**12mm**	**12mm**
Pressure	Fixed roller	Fixed roller	Handpress	Handpress
Material	**HDPE**	**HDPE**	**HDPE**	**HDPE**
Plastic shape	Shredded	Shredded	Shredded	Shredded
Input material weight (g)	650	650	670	700
Material distribution	Even	Even	Even	Even
PTFE spray	Yes	Yes	Yes	Yes
Baking paper sheet	No	No	No	No
Melting time	1h	1h	1h	1h
Melting temperature	230	230	230	230
Cooling setup	inside mould under pressure of steel block	inside mould under pressure of steel block	inside mould under pressure of steel block	inside mould under pressure of hand press
Cooling pressure	40kg	40kg	?	?
Cooling time	2h	2h	2h	1h
Cooling temperature	20	20	20	20
Vent holes layer height	-	-	-	-
Handling	Melting in mould without lid, when molten lid was put on and heated. Then mould was taken out and carried to roll press. Boarder was removed and lid put back on and then it was rolled to 12mm	Melting in mould without lid, when molten lid was put on and heated. Then mould was taken out and carried to roll press. Boarder was removed and lid put back on and then it was rolled to 12mm	Melting in oven without lid. When molten add lid and heat. Take out and cary to press, remove lid and walls, place back lid, put in press and press.	Melting in oven with lid. When molten, take out and cary to press, place pressing block, put in press and press.
Resulting thickness	5 - 16	9 - 14.5	12.9 - 14.1	12.8 - 13.1
Resulting weight of cleaned plate	551,7	547,8	669,3	696,1
Process notes	Removing mould parts was a hassle and cooled down parts did not stick to the plastic, which made it un smooth also the plastic surface immediately solidified when open to air .	Removing mould parts was a hassle and cooled down parts did not stick to the plastic, which made it un smooth also the plastic surface immediately solidified when open to air. To improve the result a stiff board was put under the mould to ensure the rollers would not bend the mould.	Removing the lid and the walls was a hassle and was very troublesome. It took too much time and cooling down the lid resulted in bad surface quality. Als caused by a lack of time, not all of the plastic was molten.	With the lid on the plastic was out of sight but by looking gat the lid hight the melt stage could be deducted.
Process observations	When rolling the plastic just moved away from the pressure, not building up pressure	When rolling the plastic just moved away from the pressure, not building up pressure	melting without lid seemed to take longer than with lid	melting with lid seemed to speed up the melting process
Mould opening observations	Fresh sheet metal had a nice smooth surface and thus plastic plate got released quite easily	Fresh sheet metal had a nice smooth surface and thus plastic plate got released quite easily	Fresh sheet metal had a nice smooth surface and thus plastic plate got released quite easily	Fresh sheet metal had a nice smooth surface and thus plastic plate got released quite easily

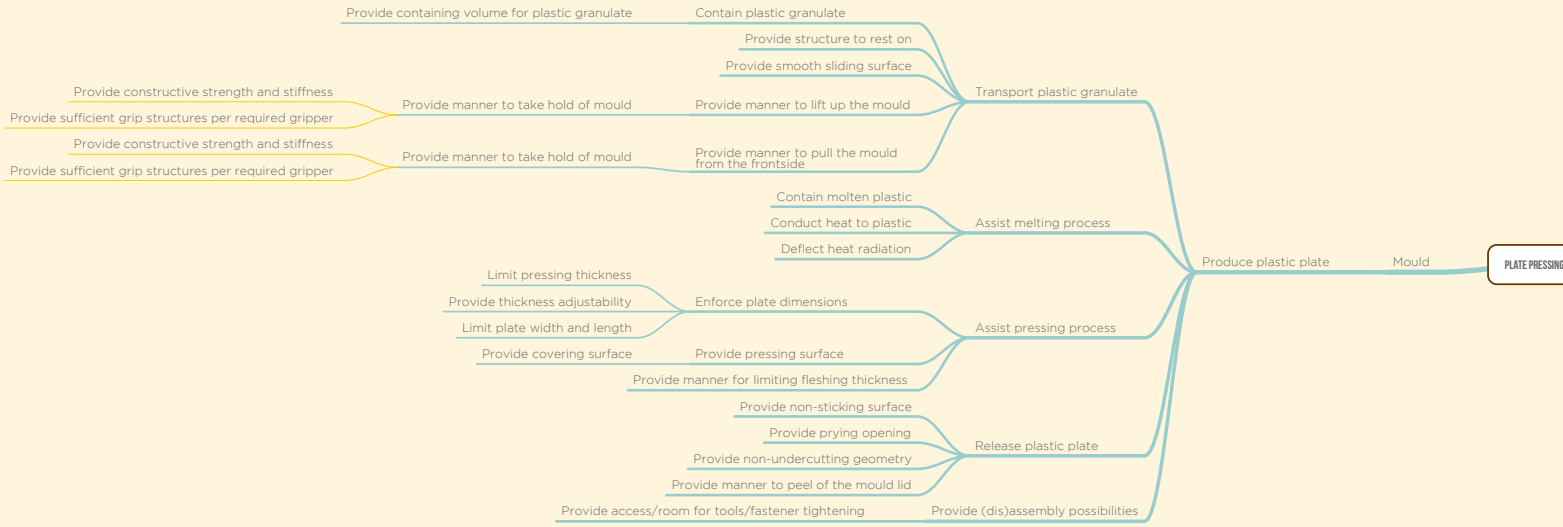
Test nr	9.2	9.3	10.1	10.2
Result evaluation	The result is not so good, although all of the air is removed. But the surface quality is very bad and the thickness varies a lot	The result is not so good, although all of the air is removed. But the surface quality is very bad and the thickness varies a lot. But it is better than the first try	Although the result was not nice, the process seemed promising	Very nice
Trapped air	No trapped air can be found	No trapped air can be found	Only a few tiny air bubbles got trapped, especially where the were unmolten granulate pieces	Very few very small air pockets
Surface quality	Bad, a lot of ripples and dimples	Bad, a lot of ripples and dimples	Bottom surface is very nice, top surface very bad, due to fliesvorming and unmolten granulate	very nice surface equality bottom better than top, top has small dimples
Flatness	Bottom surface has a smooth continuous surface but is bent upwards	Bottom surface has a smooth continuous surface but is bent upwards	Flatness is ok, but mould bend is visible and cooling was not optimal for avoiding warpage	Very good flatness
Raised edges	Not to much	Not to much	Not so much	Not so much
Shrinkage	not measured	not measured	not measured	not measured
warpage	Corners are warped upwards	Corners are warped upwards	Visible warpage	Visible warpage
Theory development	Removing the lid cools it down and when put back it cools the plastic, the surface needs to be ‘molten’ when pressed	when pressing takes too much time, dlarge temperature differences cause bad spread and surface quality, causing ripples	Taken out to hot and bent mould	Taken out to hot
Course		Rolling with simple materials is not easy		

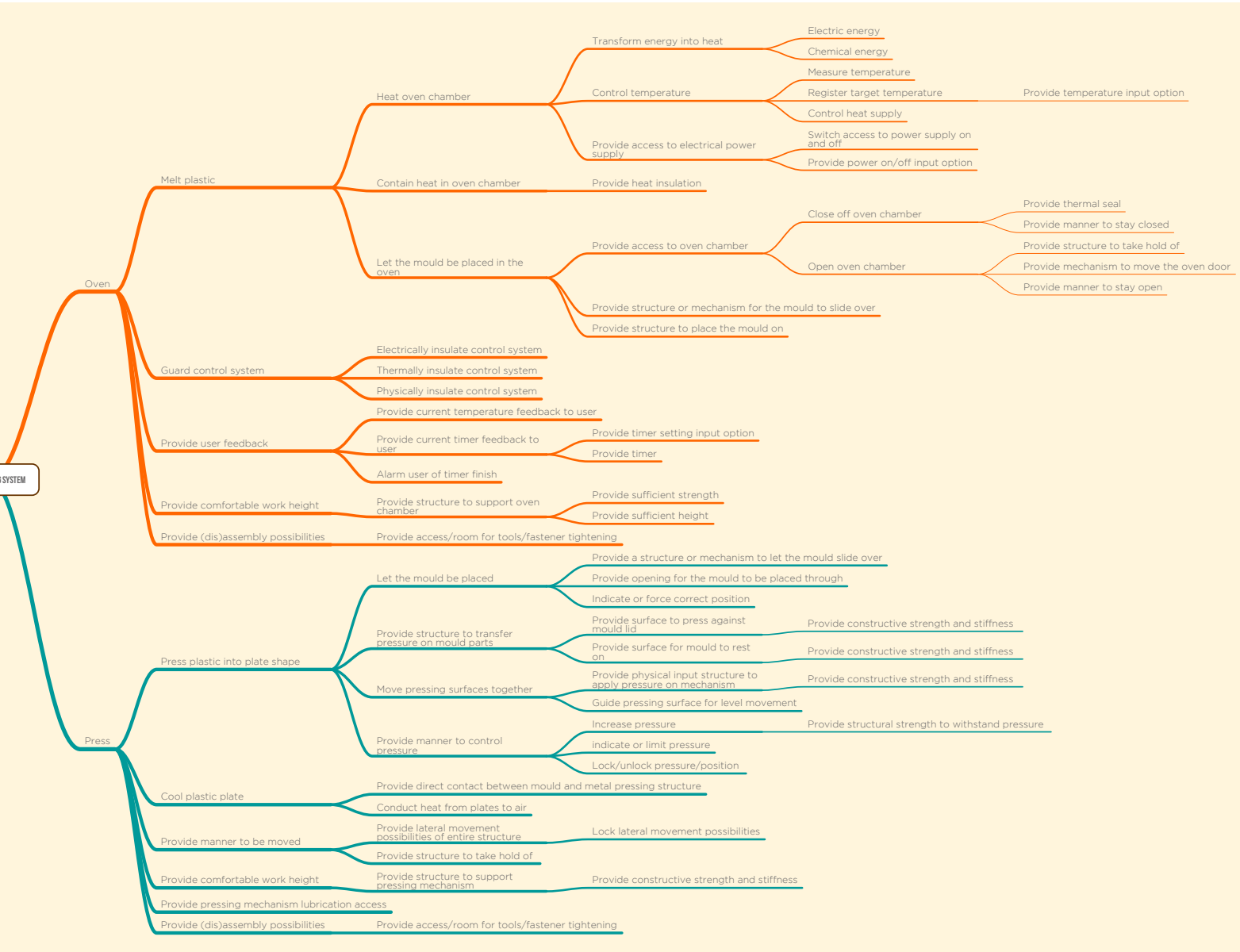
A.10. PROCESS TREE

level0	level1	level2	level3	level4	level5
Process tree	Produce	Gather the required materials	Know which materials are required		
			Know where to find the required materials		
			Be able to find the required materials		
			Transport the required materials		
		Find the required production machinery and tools	Know which production machinery and tools are needed		
			Know where to find the required machinery and tools		
			Be able to find the required machinery and tools		
		Process the materials	Know what transformation the materials need to undergo		
			Transform or let transform the materials		
		Assemble the parts	Know how the parts fit together		
			Be able to fit the parts together		
		Check the result	Know what to check		
			Know when it is right or wrong		
	Transport	Move the products/parts			
		Fit the product/parts through the door			
		Lift the product/parts			
		Set the product/parts down			
		Secure the product/parts			
	Assemble the main parts	Know how the parts fit together			
		Fit parts together			
		Secure fasteners			
	Use	Prepare the mould	Acquire the required plastic input	Know the requirements for the plastic input	
				Preprocess the plastic input	Sort
					Clean
					Shred
				Transport input material to mould	
			Retrieve the mould	Pick up the mould	
				Transport the mould to the preparation station	
				Set the mould down	
			Input the plastic	Portion the right amount	
				Transport the plastic	Contain the plastic
			Distribute the plastic		
			Cover the plastic		
		Melt the plastic	Preheat the oven	Turn on the oven	
				Know the right temperature	
				Set the oven to the right temperature	
				Know the right heating time	
				Set timer to the right time	
				Wait	
			Insert the mould into the oven	Transport the mould to the oven	
				Open the oven door	Take hold of oven door
					Pull oven door open
				Slide the mould inside the oven	
				Close the oven door	
			Set timer	Know the right heating time	
				Set timer to the right time	
			Let the oven heat up the mould and the	Wait	
				Know when time has past	Be alarmed
			Retrieve the mould from the oven	Protect hands agains heat	
				Open the oven door	
				Take hold of the mould	
				Pull the mould out	
				Close the oven door	
		Press the plastic plate	Transport the mould to the press	Protect hands agains heat	
				Move the mould to the press	
			Insert mould into the press	Move the pressing surfaces apart	
				Protect hands agains heat	
				Slide mould onto pressing surface	
			Position the mould	Know what the right position is	
				Take hold of the mould	
				Move the mould to the right position	
			Press the plate	Move the pressing surfaces on to the mould lid	
				Increase the pressure	
				Know when the pressure is right	
				Stop increasing the pressure	
				Lock the pressure/position	
			Leave the plate to cool	(Turn on cooling device)	
				Wait	
			Retrieve the plate and mould	Unlock the pressure/position	
				Move the pressing surfaces apart	
				Take hold of the mould	
				Pull the mould out	
		(Cool the plastic plate)	Transport mould to the Cooling station		
			Insert mould into Cooling station	Move the pressing surfaces apart	
				Slide mould onto Stack of plates	
				Move the pressing surfaces back to pressing position	
			Leave the plate to cool		
			Retrieve the moulds and plates		
		Retrieve the plastic plate	Open mould	Take hold of the mould lid	
				Peel the mould lid of the plastic plate	
				Remove the mould lid	
			Retrieve plate from the mould	Take hold of plastic plate edge	
				Peel the plastic plate of the mould	
				Remove the plastic plate	
			Set the plastic plate down		
			Remove fleshing		
			Store plastic plate		
		Clean the mould	Disassemble mould		
			Scrape off plastic residue		
			Re-polish damaged spots		
			Fit back together		
		Store the mould	Transport mould		
			Stack moulds		
	Maintain	Lubricate	Know when to lubricate		
			Know what lubrication substance to use		
			Retrieve lubrication substance		
			Know what parts to lubricate		
			Know where to lubricate		
			Input/apply lubrication substance		
			Know when it is ok		
		Clean	Know when to clean		
			Know what to clean		
			Know how to clean		
			Reach al cleaning areas		
			Remove cleaning substance and debris		
	Repair	Know when to repair			
		Replace parts	Know what to replace		
			Gather the required tools		
			Disassemble	Locate fasteners	
				Loosen fasteners	
				Remove fasteners	
				Remove part(s)	
			Reassemble	Place fasteners	
				Tighten fasteners	

P.T.I. Nr.	Functions	System part	Requirement
1.1.1.0.0	Provide a BOM	Instruction manual bundle	-
1.1.2.0.0	Provide sourcing suggestions with BOM	Instruction manual bundle	-
1.1.3.0.0	>	All	Include only widely available materials
1.1.4.0.0	-	Outside Project Scope (OPS)	-
1.2.1.0.0	Provide list of required machinery & tools	Instruction manual bundle	-
1.2.2.0.0	Provide sourcing suggestions with BOM	Instruction manual bundle	-
1.2.3.0.0	>	All	Include only widely available machinery & tools
1.3.1.0.0	Provide production instructions	Instruction manual bundle	-
1.3.2.0.0	>	All	All parts should be produceable
1.4.1.0.0	Provide assembly instructions	Instruction manual bundle	-
1.4.2.0.0	Provide structure for connections	All	-
1.5.1.0.0	Include construction varification instructions	Instruction manual bundle	-
1.5.2.0.0	Include construction varification instructions	Instruction manual bundle	-
2.1.2.0.0	>	All	All production parts and subassemblies should be movable
2.2.2.0.0	-	O.P.S	-
2.3.2.0.0	-	O.P.S	-
2.4.2.0.0	-	O.P.S	-
2.5.2.0.0	-	O.P.S	-
3.1.2.0.0	Provide assembly instructions	Instruction manual bundle	-
3.2.2.0.0	Provide structure for connections	All	-
3.3.2.0.0	Provide room for tools for securing fasteners of (sub-)assemblies	All	-
4.1.1.1.0	Provide user instruction manual	Instruction manual bundle	-
4.1.1.2.1	-	O.P.S	-
4.1.1.2.2	-	O.P.S	-
4.1.1.2.3	-	O.P.S	-
4.1.1.3.0	-	O.P.S	-
4.1.2.1.0	Provide structure to take hold of mould	Mould	-
4.1.2.2.0	Provide right grip/weight ratio	Mould	-
4.1.2.3.0	Provide structure to be set down on	Mould	-
4.1.3.1.0	-	O.P.S	-
4.1.3.2.1	-	O.P.S	-
4.1.4.2.0	Provide plastic distribution manner	mould/extra tool	-
4.1.5.2.0	Provide mould cover	mould	-
4.2.1.1.0	Provide power-on input option	Oven	-
4.2.1.2.0	Include temperature settings to user instruction manual	Instruction manual bundle	-
4.2.1.3.0	Provide temperature control input option	Oven	-
4.2.1.4.0	Include heating time settings to user instruction manual	Instruction manual bundle	-
4.2.1.5.0	Provide timer control input option	Oven	-
4.2.1.6.0	-		-
4.2.2.1.0	Provide transportation	Oven	-
4.2.2.2.1	Provide structure to take hold of oven door	Oven	-
4.2.2.2.2	Provide moving possibility for oven door to open/close	Oven	-
4.2.2.3.0	Provide smooth sliding structure or mechanism in oven	Oven	-
4.2.2.4.0	Provide manner for oven door to stay closed	Oven	-
4.2.3.1.0	Include heating time settings to user instruction manual	Instruction manual bundle	-
4.2.3.2.0	Provide timer control input option	Oven	-
4.2.4.1.0	-	O.P.S	-
4.2.4.2.1	Provide alarming method	Oven	-
4.2.5.1.0	Include thermal gloves in user instructions	Instruction manual bundle	-
4.2.5.2.0	Provide manner for oven door to stay open	oven	-
4.2.5.3.0	Provide structure to take hold of mould on front side	mould	-
4.2.5.4.0	Provide smooth sliding structure or mechanism in oven	oven	-
4.2.5.5.0	Provide manner for oven door to stay closed	oven	-
4.3.1.1.0	Include thermal gloves in user instructions	Instruction manual bundle	-
4.3.1.2.0	Provide manner for the mould to be transported	Mould transport table	-
4.3.2.1.0	Provide manner for the pressing surfaces to be moved apart	Press	-
4.3.2.2.0	Include thermal gloves in user instructions	Instruction manual bundle	-
4.3.2.3.0	Provide smooth sliding structure or mechanism on press	Press	-
4.3.3.1.0	Providemould positioning indications or limitations	Press	-
4.3.3.2.0	Provide structure to take hold of mould	mould	-
4.3.3.3.0	Provide smooth sliding structure or mechanism on press	Press	-
4.3.4.1.0	Provide manner for the pressing surfaces to be moved together	Press	-
4.3.4.2.0	Provide manner to increase the pressure on the pressing surfaces	Press	-
4.3.4.3.0	Provide pressure limit or indication	Press	-
4.3.4.4.0	Provide manner to stop the pressure increasments	Press	-
4.3.4.5.0	Provide manner to lock the pressure and position	Press	-
4.3.5.1.0	(Provide cooling device)	Press	-
4.3.5.2.0	-	O.P.S	-
4.3.6.1.0	Provide manner to unlock the pressure and position	Press	-
4.3.6.2.0	Provide manner for the pressing surfaces to be moved apart	Press	-
4.3.6.3.0	Provide structure to take hold of mould	Mould	-
4.3.6.4.0	Provide smooth sliding structure or mechanism on press	Press	-
4.4.1.0.0	Provide manner for the mould to be transported	Press	-
4.4.2.1.0	Provide manner for the pressing surfaces to be moved apart	Cooling station	-
4.4.2.2.0	Provide smooth sliding structure or mechanism on mould transport table	Mould transport table	Moulds should be stackable
4.4.2.3.0	Provide manner for the pressing surfaces to be moved together	Cooling station	-
4.4.3.0.0	-	O.P.S	-
4.4.4.0.0	# Reversed order of inserting moulds #	Cooling station	-
4.5.1.1.0	Provide structure to take hold of mould lid	mould	-
4.5.1.2.0	Provide non-sticking surface quality	mould	-
4.5.1.3.0	-	O.P.S	-
4.5.2.1.0	Provide manner to take hold of plate edge	Mould/extra tools/instructions	-
4.5.2.2.0	-	O.P.S	-
4.5.2.3.0	-	O.P.S	-
4.5.3.0.0	-	O.P.S	-
4.5.4.0.0	Provide process atribute(s) that limits fleshing thickness	Mould/Press/Plate	Fleshing must be able to be cut off with a sharp knife max 1mm
4.5.5.0.0	>	Plate	Plastic plate output should be stackable after fleshing removal
4.6.1.0.0	Provide manner to take apart the seperate parts of the mould	mould	-
4.6.2.0.0	-	O.P.S	-
4.6.3.0.0	-	O.P.S	-
4.6.4.0.0	Provide manner to fit seperate parts of the mould back together	mould	-
4.7.1.0.0	Provide structure to take hold of mould	mould	-
4.7.2.0.0	Provide clearance to stack moulds	mould	-
5.1.1.0.0	Include lubrication instructions in usermanual	Instruction manual bundle	-
5.1.2.0.0	Include lubrication instructions in usermanual	Instruction manual bundle	-
5.1.3.0.0	-	O.P.S	-
5.1.4.0.0	Include lubrication instructions in usermanual	Instruction manual bundle	-
5.1.5.0.0	Include lubrication instructions in usermanual	Instruction manual bundle	-
5.1.6.0.0	Provide opening for lubrication input	press	-
5.1.7.0.0	Include lubrication instructions in usermanual	Instruction manual bundle	-
5.2.1.0.0	Include cleaning instructions in usermanual	Instruction manual bundle	-
5.2.2.0.0	Include cleaning instructions in usermanual	Instruction manual bundle	-
5.2.3.0.0	Include cleaning instructions in usermanual	Instruction manual bundle	-
5.2.4.0.0	Provide open structure	all	-
5.2.5.0.0	provide opening to remove sleaning substances and debris	all	-
6.1.1.0.0	-	O.P.S	-
6.2.1.0.0	Include failure/ repair table in instructions	Instruction manual bundle	-
6.2.2.0.0	-	O.P.S	-
6.2.3.1.0	Provide manner to disassemble parts	all	-
6.2.3.2.0	Provide manner to disassemble parts	all	-
6.2.3.3.0	Provide manner to disassemble parts	all	-
6.2.3.4.0	Provide manner to disassemble parts	all	-
6.2.4.1.0	Provide manner to resassemble parts	all	-
6.2.4.2.0	Provide manner to resassemble parts	all	-

A.11. FUNCTION ANALYSIS




SYSTEM
Oven
Melt plastic
Heat oven chamber
Transform energy into heat
Electric energy
Chemical energy
Control temperature
Measure temperature
Register target temperature
Provide temperature input option
Control heat supply
Provide access to electrical power supply
Switch access to power supply on and off
Provide power on/off input option
Contain heat in oven chamber
Provide heat insulation
Let the mould be placed in the oven
Provide access to oven chamber
Close off oven chamber
Provide thermal seal
Provide manner to stay closed
Open oven chamber
Provide structure to take hold of
Provide mechanism to move the oven door
Provide manner to stay open
Provide structure or mechanism for the mould to slide over
Provide structure to place the mould on
Guard control system
Electrically insulate control system
Thermally insulate control system
Physically insulate control system
Provide user feedback
Provide current temperature feedback to user
Provide current timer feedback to user
Provide timer setting input option
Provide timer
Alarm user of timer finish
Provide comfortable work height
Provide structure to support oven chamber
Provide sufficient strength
Provide sufficient height
Provide (dis)assembly possibilities
Provide access/room for tools/fastener tightening
Press
Press plastic into plate shape
Let the mould be placed
Provide a structure or mechanism to let the mould slide over
Provide opening for the mould to be placed through
Indicate or force correct position
Provide structure to transfer pressure on mould parts
Provide surface to press against mould lid
Provide constructive strength and stiffness
Provide surface for mould to rest on
Provide constructive strength and stiffness
Move pressing surfaces together
Provide physical input structure to apply pressure on mechanism
Provide constructive strength and stiffness
Guide pressing surface for level movement
Provide manner to control pressure
Increase pressure
Provide structural strength to withstand pressure
indicate or limit pressure
Lock/unlock pressure/position
Cool plastic plate
Provide direct contact between mould and metal pressing structure
Conduct heat from plates to air
Provide manner to be moved
Provide lateral movement possibilities of entire structure
Lock lateral movement possibilities
Provide structure to take hold of
Provide comfortable work height
Provide structure to support pressing mechanism
Provide constructive strength and stiffness
Provide pressing mechanism lubrication access
Provide (dis)assembly possibilities
Provide access/room for tools/fastener tightening

A.12. PRESSING FORCE CALCULATION

With a force measuring device, the pulling force exerted on the spindle handle during the pressing process was measured. This pulling force was measured to reach a maximum of 500 N and was exerted on the handle, 350mm removed from the spindles axle.

```
> restart
```

Bookpress measurements

```
> Lb := 0.5
```

$$Lb := 0.5 \quad (1)$$

```
> Bb := 0.5
```

$$Bb := 0.5 \quad (2)$$

```
> Ab := Lb·Bb
```

$$Ab := 0.25 \quad (3)$$

```
> rb := 0.35
```

$$rb := 0.35 \quad (4)$$

Bookpress parameters

```
> Finb := 500
```

$$Finb := 500 \quad (5)$$

```
> Tb := Finb·rb
```

$$Tb := 175.00 \quad (6)$$

Platepress measurements

```
> Lp := 1.22
```

$$Lp := 1.22 \quad (7)$$

```
> Bp := 1.22
```

$$Bp := 1.22 \quad (8)$$

```
> Ap := Lp·Bp
```

$$Ap := 1.4884 \quad (9)$$

```
> rp := 1.2
```

$$rp := 1.2 \quad (10)$$

Platepress parameters

```
> Finp := 500
```

$$Finp := 500 \quad (11)$$

```
> n := 2
```

$$n := 2 \quad (12)$$

```
> Tp := n· Finp·rp
```

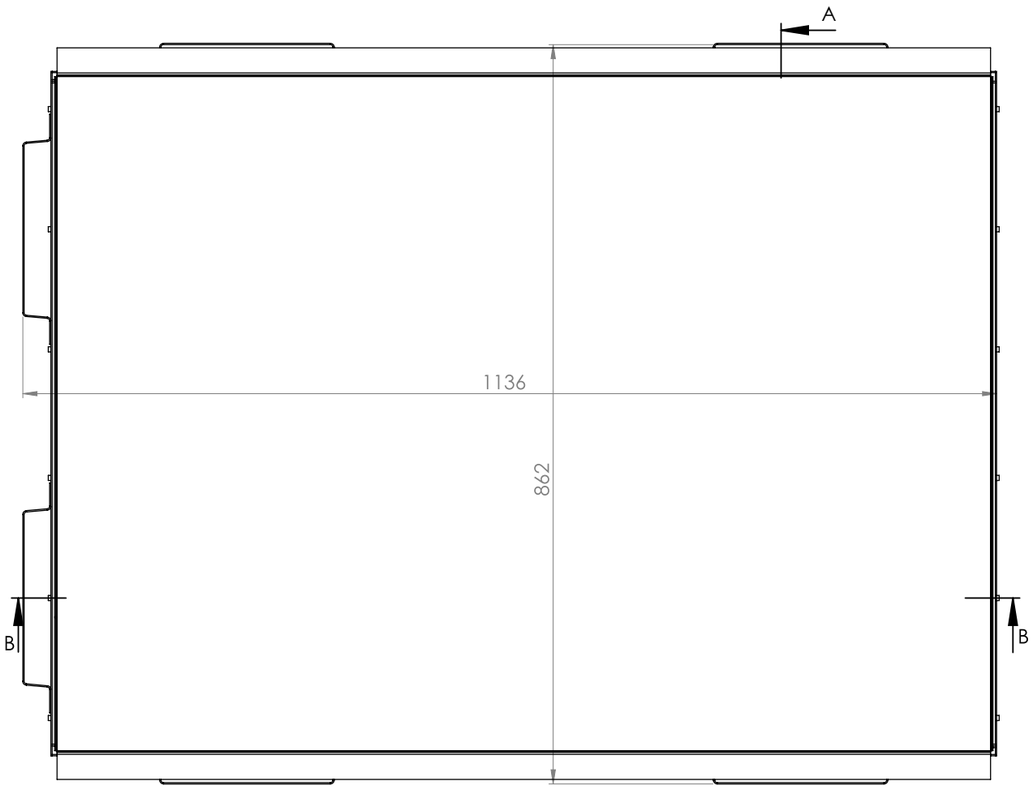
$$Tp := 1200.0 \quad (13)$$

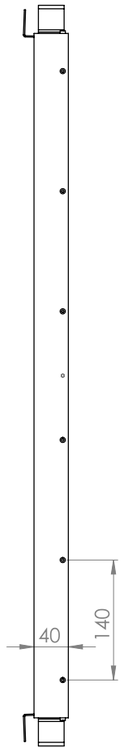
Spindle measurements

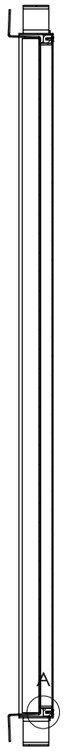
```
> Douter := 0.0375
```

$$Douter := 0.0375 \quad (14)$$

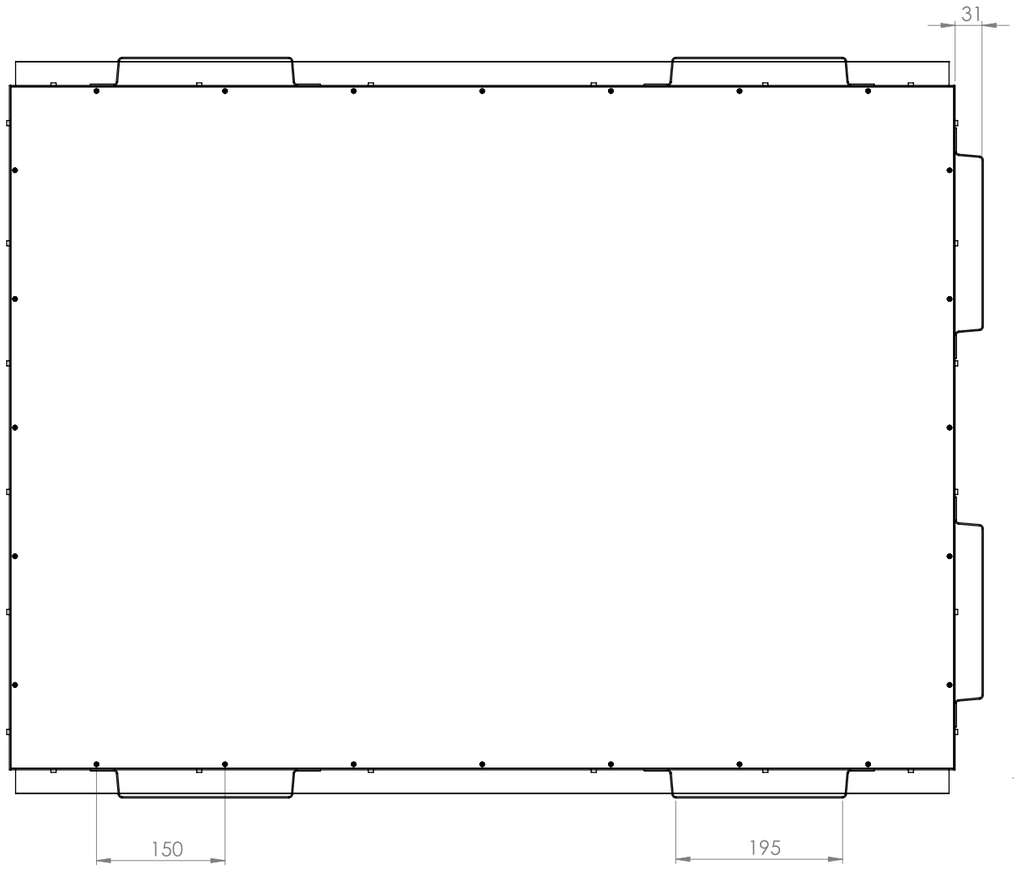
A.13. MOULD PROTOTYPE 1, ASSEMBLY DRAWING

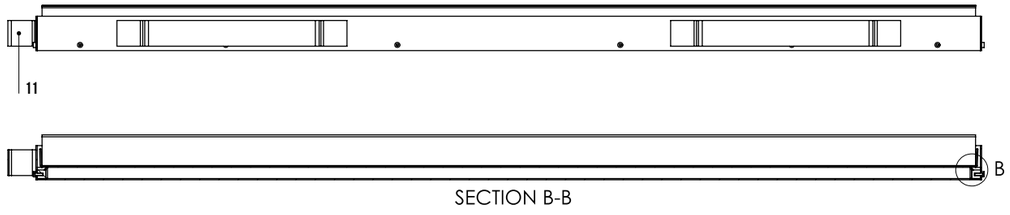




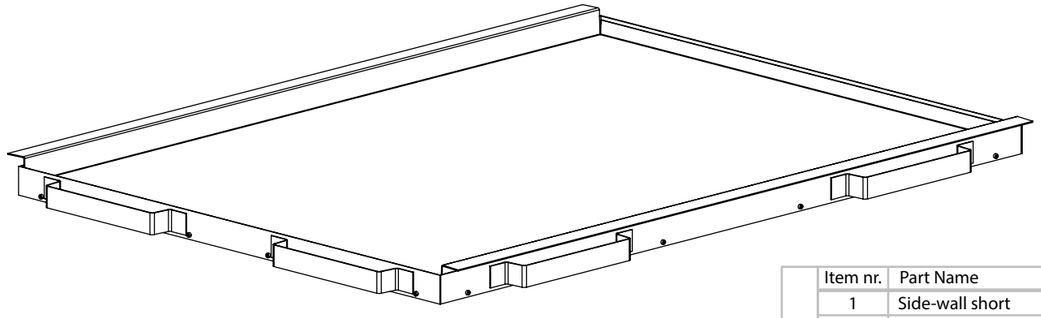


SECTION A-A

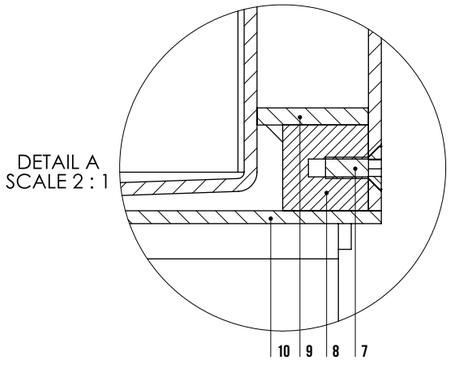




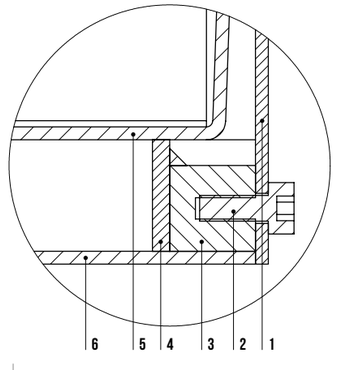
SECTION B-B



BOM	Item nr.	Part Name	Amount
	1	Side-wall short	2
	2	M3 - cylindrical head	24
	3	Frame bar long	2
	4	Cut-off-edge short	2
	5	Lid	1
	6	Baseplate	1
	7	M3 - Countersunk head	24
	8	Frame bar short	2
	9	Cut-off-edge long	2
	10	Side-wall long	2
	11	Handle	6



DETAIL A
SCALE 2 : 1



DETAIL B
SCALE 2 : 1

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:

DEBURR AND BREAK SHARP EDGES

TITLE: Mould Prototype 1

MATERIAL: Steel

DWG NO. 1

A3

SHEET 1 OF 1

WEIGHT: 24748 gr

Scale 1:10

DO NOT SCALE DRAWING

A.14. BOTTLE JACKS

Bottle jacks are devices that can be placed underneath a heavy object that needs lifting and can then be operated to lift up the object by hydraulic pressure. The jacks come with a rod that can be used to move an oil pump up and down which pumps oil from the reservoir/ bottle to the cylinder chamber underneath the ram. When the cylinder chamber is filled with oil, the ram moves up and with it the object that rests on the ram end. The lifting power is defined by the maximum pressure that can be put on the oil in the cylinder chamber and the area size of the ram bottom. A ram of 4cm diameter has a bottom area size of Pi * 0,02^2 = 0,00125664. That multiplied by 700 bar which is a common maximum pressure of bottle jacks, results in a maximum output force of 88 kN or 8.8 Tonnes.
These bottle jacks come in different sizes and strengths, mostly the force ratings are expressed in Tons, which is not the same as tonnes, 1 ton ≈ 0.9072 tonne. Bottle jack strengths commonly use increments of multiplications of 5 or 8 tons. Next to the force selection, the size has two options in general, regular or extended. The regular size jacks typically have a stroke of about 10-20 cm and the extended 'long ram jacks' a stroke of 30-50 cm. Of the extended type, fewer force options are available, mostly 1, 3, 5, 8, 10 and 16 tons.

Some bottle jacks are fitted with an air pump that can quickly pump the oil and thus move the cylinder without the need for the hand pump. The air pump works on pneumatic air pressure that can be supplied by a compressor for example. Figure XX features a bottleneck with such an air pump.

Figure XX shows a range of cylinders next to each other including a long ram jack and a bottle jack with an air pump.

Image by http://www.kwipped.com/rentals/material-handling/bottle-jacks/503
& https://www.surpluscenter.com/Hydraulics/10-000-PSI-Power-Team-Components/Jacks/8-Ton-19-25-Stroke-Flat-Base-Valley-Long-Ram-Jack-9-8721-F.axd
& https://www.northerntool.com/shop/tools/product_200641747_200641747

A.15. SLIDING OR SETTING CALCULATION

(1): $$\sum F_y = 0 : F_{P2} + F_{By} + F_{Dy} = 0$$

(2): $$\sum F_x = 0 : F_{Dx} - F_{Bx} = 0 : F_{Dx} = F_{Bx}$$

(3): $$\sum M_D = 0 : F_{Bx} \cdot a + F_{P2} \cdot d + F_{By} \cdot b = 0$$

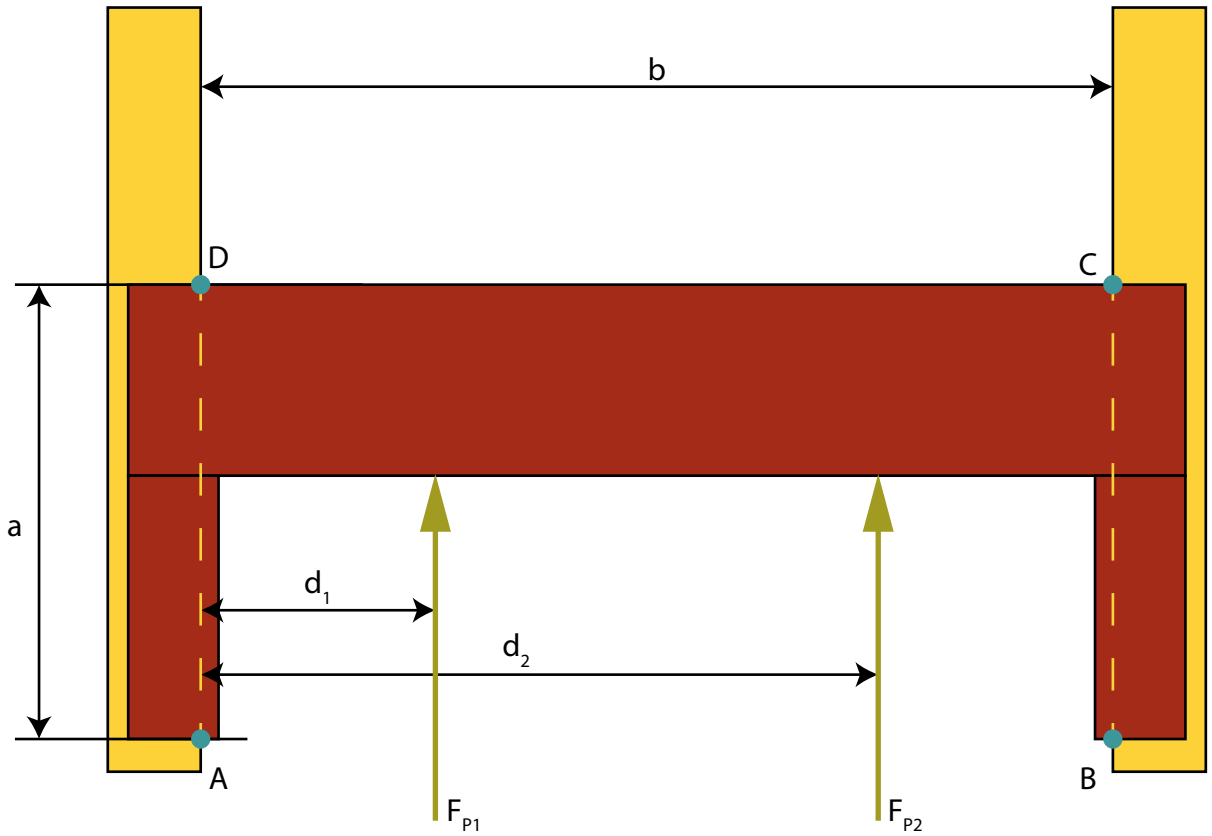
(4): $$F_{By} = k \cdot F_{Bx} : F_{Bx} = \frac{F_{By}}{k}$$

(5): $$F_{Dy} = k \cdot F_{Dx} : F_{Dx} = \frac{F_{Dy}}{k}$$

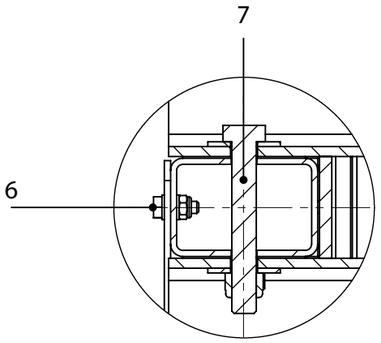
(6): (2)(4)(5) : $$F_{Dy} = F_{By}$$

(7): (1)(6) : $$F_{P2} = -2F_{By}$$

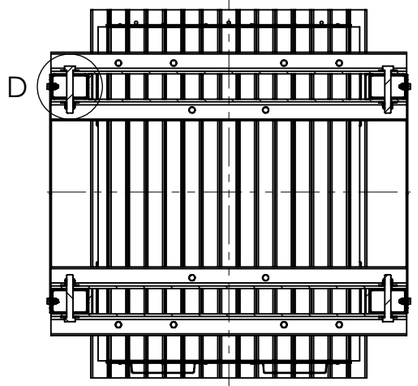
(8): (3)(4)(7) : $$a = k(2d - b)$$



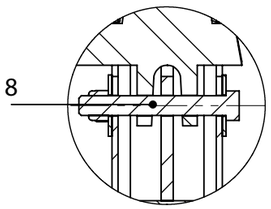
A.16. PRESS PROTOTYPE ASSEMBLY DRAWING



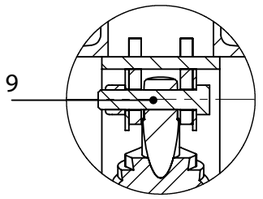
DETAIL D
SCALE 1 : 5



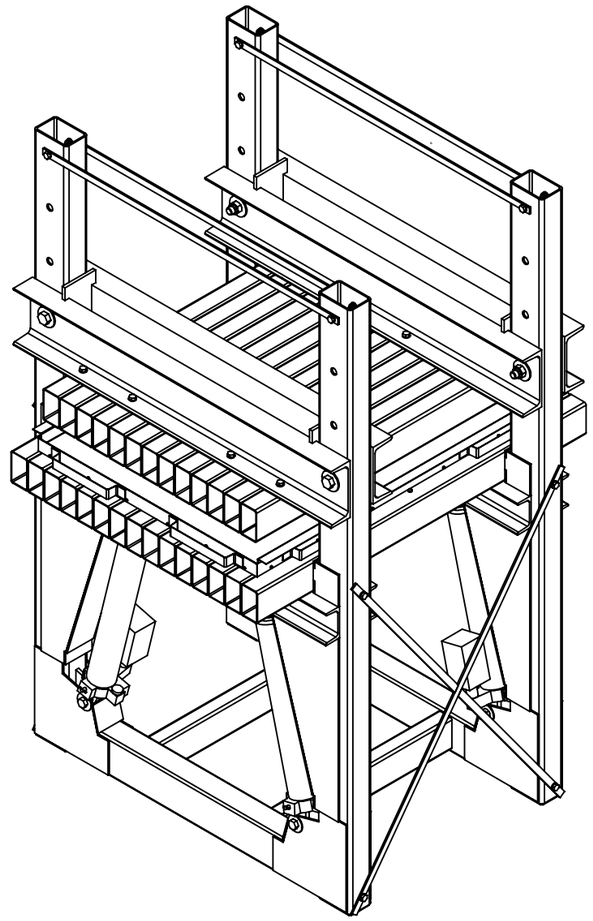
SECTION A-A

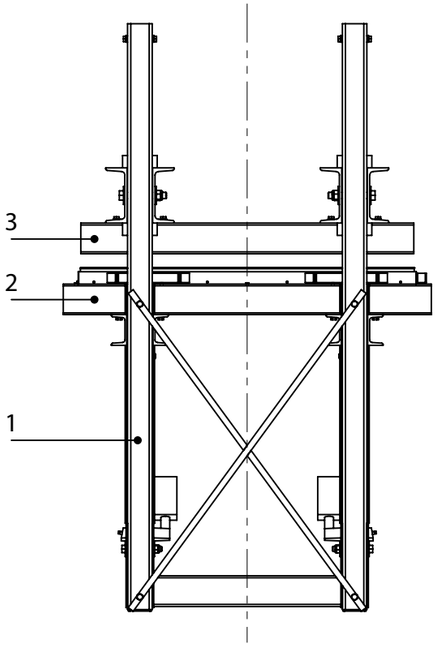


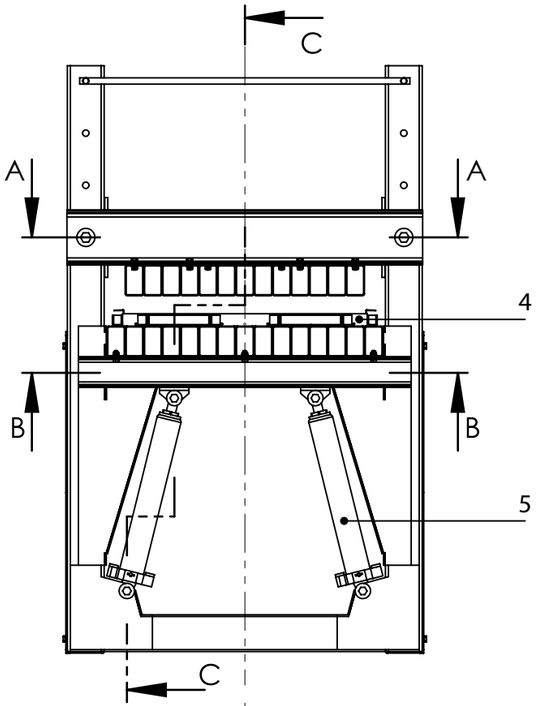
DETAIL F
SCALE 1 : 5

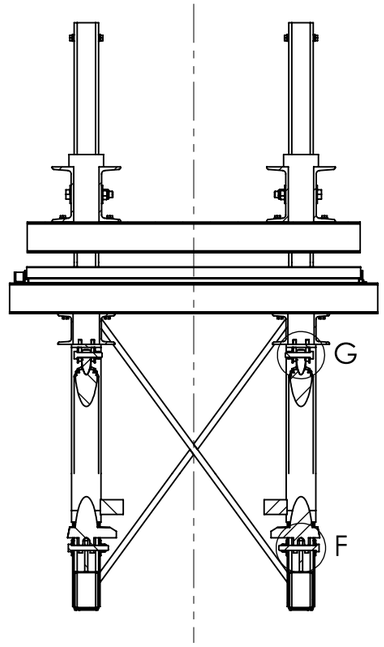


DETAIL G
SCALE 1 : 5

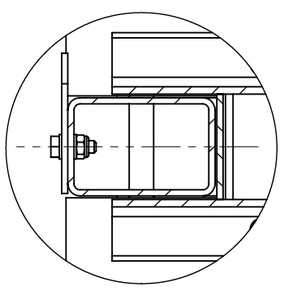




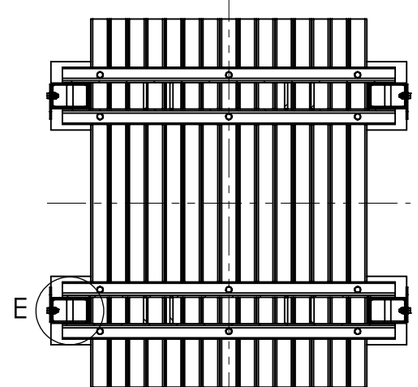




SECTION C-C



DETAIL E
SCALE 1 : 5



SECTION B-B

BOM	Item nr.	Part Name	QTY.
	1	Press Frame - sub-assembly	1
	2	Press bed - sub-assembly	1
	3	Press roof - sub-assembly	1
	4	Mould	1
	5	Hydraulic jack	4
	6	M10 bolt 30 + Rings + Nylon nut	40
	7	M20 bolt 140 + Rings + Nylon nut	4
	8	M16 bolt 120 + Rings + Nylon nut	4
	9	M16 bolt 80 + Rings + Nylon nut	4

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:

DEBURR AND BREAK SHARP EDGES

TITLE: Press Prototype 1

MATERIAL: Steel

DWG NO. 1

A3

SHEET 1 OF 1

WEIGHT: 343692 gr

Scale 1:20

DO NOT SCALE DRAWING

A.17. PROTOTYPE MATERIALS LIST

Section	Type	Specification	Change size?	length	width	Amount
Steel beams	UPN/UNP	180	- No / + Yes	1160	-	4
	UPN/UNP	100	- No / + Yes	1085	-	4
Steel tubes	Rectangular section	80x120x5	- 1 size / + Yes, Keep T5	190	-	4
	Rectangular section	80x120x3	- 1 size / + Yes, Keep T3	920	-	2
	Rectangular section	60x100x3	- 1 size / + 1 size, Keep T3	1200	-	15
	Rectangular section	60x100x3	- 1 size / + 1 size, Keep T3	1086	-	13
	Rectangular section	60x100x3	- 1 size / + 1 size, Keep T3	620	-	2
Steel rod	hotrolled	10x20	No	1060	-	2
	hotrolled	10x20	No	800	-	2
Steel plate	Hot rolled	5mm	No	600	300	4
	Hot rolled	5mm	No	275	275	8
	Hot rolled	5mm	No	115	75	4
	Hot rolled	5mm	No	600	96	4
	Hot rolled	10mm	No	100	70	8
	Hot rolled	10mm	No	100	90	8
	Hot rolled	10mm	No	100	100	4
	Hot rolled	10mm	No	260	115	4
	Hot rolled	10mm	No	120	120	4
Sheet steel	Cold rolled	3mm	No	1100	60	2
	Cold rolled	3mm	No	800	60	2
	Cold rolled	2mm	No	1100	800	1
	Cold rolled	2mm	No	400	13	10
	Cold rolled	2mm	No	300	105	6
	Cold rolled	1.5mm	No	1150	950	1
Fasteners	Bolts	M3 CS	No	5	-	52
	Bolts	M6	M5 - M8	20	-	28
	Bolts	M6	M5 - M8	100	-	4
	Bolts	M10	M8 - M12	30	-	20
	Bolts	M16	No	80	-	4
	Bolts	M16	No	120	-	4
	Bolts	M20	No	140	-	4
	Nuts	M10	fit to bolts	-	-	16

Section	Type	Specification	Change size?	length	width	Amount
	Nylon Lock Nuts	M16	No	-	-	8
	Nuts	M16	No	-	-	8
Fasteners	Nylon Lock Nuts	M20	No	-	-	4
	Wing nuts	M6	fit to bolts	-	-	4
	Body rings	M6	fit to bolts	-	-	28
	Body rings	M10	fit to bolts	-	-	36
	Body rings	M16	No	-	-	16
	Body rings	M20	No	-	-	8
Wheels	fixed castor	250kg	Stronger is ok	-	-	2
	Caster wheel	250kg	Stronger is ok	-	-	2
Pneumatics	4 way Splitter	10 bar	Stronger is ok			1
	Connectors	10 bar	Fitting the splitter & cylinder hose			5
	Air pistol	10 bar	Stronger is ok			1
	PTFE Tape roll	-	-	-	-	1
Hydraulics	8 ton long Air bottle jack	Hydraulic/ pneumatic	Plain Bottle jacks without air pump are a cheaper option	-	-	4

A.18. PRODUCTION TOOL LIST

Section	Tool	Specification	Amount
Power tools	Welding machine	Suitable for min. 5mm plate thickness	1
	Angle Grinder		1
	Column drill		1
	Electric drill		1
Safety equipment	Welding mask/helmet		1
	Welding gloves		1
	Safety goggles		1
	Hearing protection		1
	Workshop gloves		1
Hand tools	Sledgehammer	small handle 1kg	1
	Locking pliers		2
	Adjustable wrench	Large enough for biggest bolt	1
	Wrench	all sizes fitting the bolts	1
	Allen key	If applicable fit to bolts	1
	Screwdriver	If applicable fit to bolts	1
	Steel brush		1
Measuring and alignment tools	Ruler		1
	Tape measure		1
	Right angle		1
	Scriber		1
	Center point		1
	Glue clamps	min. 200mm	6
	Ratchet band	4m	3
Drill accessories	Taps	M3, M6, (or fitted to your adaptations)	1
	Drills	2.5mm, 3mm, 5mm, 7mm, 12mm (or fitted to your adaptations)	1
	Hole saw for metal	17mm, 22mm (or fitted to your adaptations)	1
	Countersink	for 3mm holes	1
Consumeables	Deburring disc		2
	Sanding disc coarse		2
	cutting disc		2
	Welding electrodes	3.2mm minimum	150
	Cutting oil		1

A.19. COST ESTIMATION BASED ON PROTOTYPE

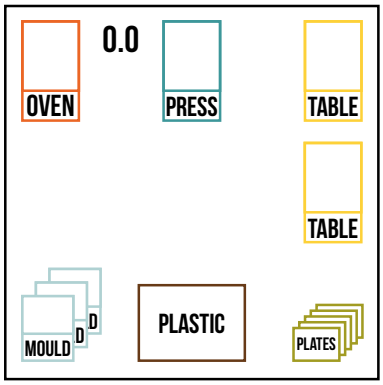
Section	Type	Spec.	length (mm)	width (mm)	QTY.	Unit	Unit price (€)	Item Price (€)	Total	P/M	src.
Steel beams	UPN/UNP	180	1160	-	4	m	€ 25,36	€ 29,42	€ 117,67	P	L
	UPN/UNP	100	1085	-	4	m	€ 12,41	€ 13,46	€ 53,86	P	L
Steel tubes	Rectangular section	80x120x5	1900	-	4	m	€ 33,46	€ 63,57	€ 254,30	P	L
	Rectangular section	80x120x3	920	-	2	m	€ 22,10	€ 20,33	€ 40,66	P	L
	Rectangular section	60x100x3	1200	-	15	m	€ 16,24	€ 19,49	€ 292,32	P	L
	Rectangular section	60x100x3	1086	-	13	m	€ 16,24	€ 17,64	€ 229,28	P	L
	Rectangular section	60x100x3	620	-	2	m	€ 16,24	€ 10,07	€ 20,14	P	L
Steel rod	hotrolled	10x20	1060	-	2	m	€ 2,70	€ 2,86	€ 5,72	Me	L
	hotrolled	10x20	800	-	2	m	€ 2,70	€ 2,16	€ 4,32	Me	L
Steel plate	Hot rolled	5mm	600	300	4	m^2	€ 103,25	€ 18,59	€ 74,34	P	L
	Hot rolled	5mm	275	275	8	m^2	€ 103,25	€ 7,81	€ 62,47	P	L
	Hot rolled	5mm	115	75	4	m^2	€ 103,25	€ 0,89	€ 3,56	P	L
	Hot rolled	5mm	600	96	4	m^2	€ 103,25	€ 5,95	€ 23,79	P	L
	Hot rolled	10mm	100	70	8	m^2	€ 206,02	€ 1,44	€ 11,54	P	L
	Hot rolled	10mm	100	90	8	m^2	€ 206,02	€ 1,85	€ 14,83	P	L
	Hot rolled	10mm	100	100	4	m^2	€ 206,02	€ 2,06	€ 8,24	P	L
	Hot rolled	10mm	260	115	4	m^2	€ 206,02	€ 6,16	€ 24,64	P	L
	Hot rolled	10mm	120	120	4	m^2	€ 206,02	€ 2,97	€ 11,87	P	L
Sheet steel	Cold rolled	3mm	1100	60	2	m^2	€ 62,00	€ 4,09	€ 8,18	Me	L
	Cold rolled	3mm	800	60	2	m^2	€ 62,00	€ 2,98	€ 5,95	Me	L
	Cold rolled	2mm	1100	800	1	m^2	€ 51,03	€ 44,91	€ 44,91	Me	L
	Cold rolled	2mm	400	13	10	m^2	€ 51,03	€ 0,27	€ 2,65	Me	L
	Cold rolled	2mm	300	105	6	m^2	€ 51,03	€ 1,61	€ 9,64	Me	L
	Cold rolled	1.5mm	1150	950	1	m^2	€ 38,28	€ 41,82	€ 41,82	Me	L
Fasteners	Bolts	M3 CS	5	-	52	#	-	€ 0,05	€ 2,34	Me	S
	Bolts	M6	20	-	28	#	-	€ 0,10	€ 2,80	P	S
	Bolts	M10	30	-	20	#	-	€ 0,30	€ 6,00	P	S
	Bolts	M16	80	-	4	#	-	€ 1,61	€ 6,44	P	S
	Bolts	M16	120	-	4	#	-	€ 2,29	€ 9,16	P	S
	Bolts	M20	140	-	4	#	-	€ 2,48	€ 9,92	P	S
	Nuts	M10	-	-	16	#	-	€ 0,11	€ 1,76	P	S
	Nylon Lock Nuts	M16	-	-	8	#	-	€ 0,42	€ 3,36	P	S
	Nylon Lock Nuts	M20	-	-	4	#	-	€ 0,82	€ 3,28	P	S
	Wing nuts	M6	-	-	4	#	-	€ 0,11	€ 0,44	P	S
	Body rings	M6	-	-	28	#	-	€ 0,08	€ 2,24	P	S
	Body rings	M10	-	-	36	#	-	€ 0,11	€ 3,96	P	S
	Body rings	M16	-	-	16	#	-	€ 0,15	€ 2,40	P	S
	Body rings	M20	-	-	8	#	-	€ 0,31	€ 2,48	P	S
Pneumatics	4 way Splitter	10 bar	-	-	1	#	-	€ 30,00	€ 30,00	P	W
	Connectors	10 bar	-	-	5	#	-	€ 3,95	€ 19,75	P	G
	Air pistol	10 bar	-	-	1	#	-	€ 9,95	€ 9,95	P	G

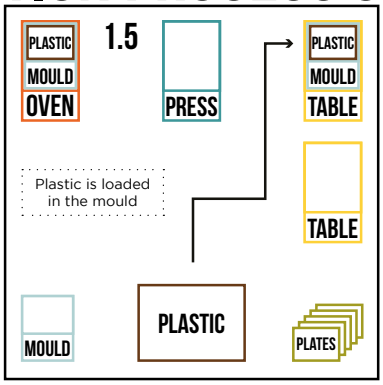
Section	Type	Spec.	length (mm)	width (mm)	QTY.	Unit	Unit price (€)	Item Price (€)	Total	P/M	src.
	PTFE Tape roll	-	-	-	1	#	-	€ 1,75	€ 1,75	P	G
Hydraulics	Long ram jack	8-ton + air	-	-	4	#	-	€ 75,00	€ 300,00	P	B
Special tools	Taps	M3	-	-	1	#	-	€ 6,76	€ 6,76	M1	M
	Taps	M6	-	-	1	#	-	€ 8,70	€ 8,70	P	M
	Drills	2,5mm	-	-	1	#	-	€ 5,93	€ 5,93	M1	M
	Drills	3mm	-	-	1	#	-	€ 3,51	€ 3,51	M1	M
	Drills	5mm	-	-	1	#	-	€ 4,72	€ 4,72	P	M
	Drills	7mm	-	-	1	#	-	€ 9,56	€ 9,56	P	M
	Drills	12mm	-	-	1	#	-	€ 14,40	€ 14,40	P	M
	Hole saw for metal	17mm	-	-	1	#	-	€ 6,95	€ 6,95	P	Z
	Hole saw for metal	22mm	-	-	1	#	-	€ 6,95	€ 6,95	P	Z
	Countersink	6mm	-	-	1	#	-	€ 8,95	€ 8,95	M1	M
Consumables	Deburring disc	steel	-	-	2	#	-	€ 2,79	€ 5,58	P	G
	Sanding disc coarse	g 60	-	-	2	#	-	€ 1,64	€ 3,28	P	G
	Sanding disc midle	g 120	-	-	2	#	-	€ 1,64	€ 3,28	Me	G
	Sanding disc fine	g 350+	-	-	5	#	-	€ 1,64	€ 8,19	Me	G
	Cutting disc	steel 1mm	-	-	20	#	-	€ 1,34	€ 26,80	P	G
	Welding electrodes	3.2mm	-	-	150	#	-	€ 0,18	€ 26,82	P	G
	Mig Wire	-	-	-	2	kg	-	€ 2,00	€ 4,00	Me	H
Labour	Design adaptations		-	-	5	hr	€ 3,00	€ 15,00	€ 15,00	M1	FS
	Sourcing	Mould	-	-	5	hr	€ 3,00	€ 15,00	€ 15,00	M1	FS
	Material prep.	Mould	-	-	10	hr	€ 3,00	€ 30,00	€ 30,00	Me	FS
	Assembly	Mould	-	-	16	hr	€ 3,00	€ 48,00	€ 48,00	Me	FS
	Design adaptations	Press	-	-	15	hr	€ 3,00	€ 45,00	€ 45,00	P	FS
	Sourcing	Press	-	-	15	hr	€ 3,00	€ 45,00	€ 45,00	P	FS
	Material prep.	Press	-	-	40	hr	€ 3,00	€ 120,00	€ 120,00	P	FS
	Assembly	Press	-	-	40	hr	€ 3,00	€ 120,00	€ 120,00	P	FS
Mould once					1				€ 55,15	M1	
Mould each					3				€ 219,01	Me	
Press					1				€ 2102,95	P	
Oven					1				€ 750,00	O	
Total									€ 3565,13		

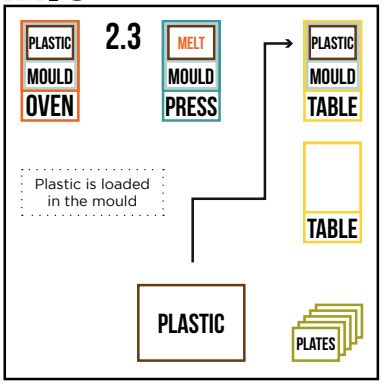
Unit or item price Sources (src):

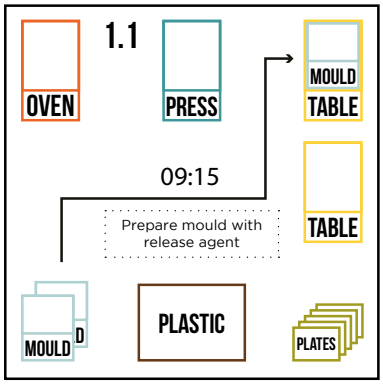
B: barntools.nl
G: gamma.nl
H: hbm-machines.com
L: limtrade.nl
M: bouwmaat.nl
S: smoldersbv.nl
W: westfalia.eu
Z: gatzagen.com
FS: Discussed with Fábrica de Sabão

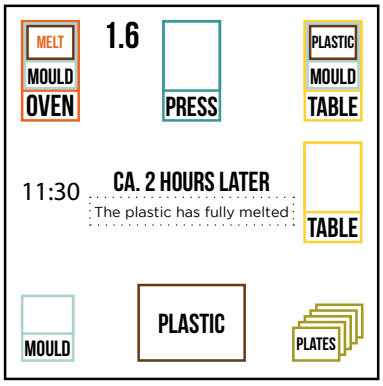
A.20. SERIES PRODUCTION PROCESS SCENARIO

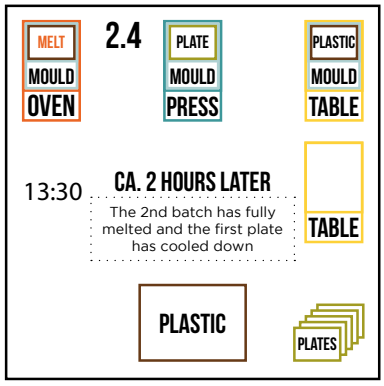


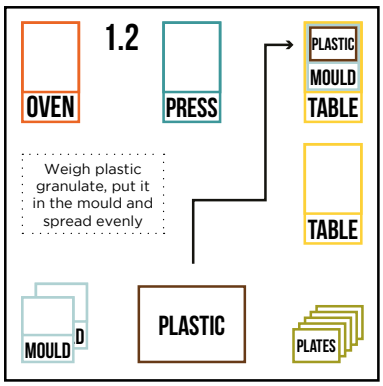


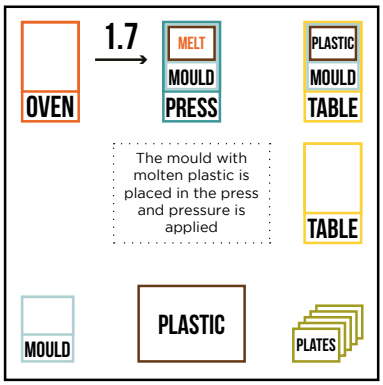


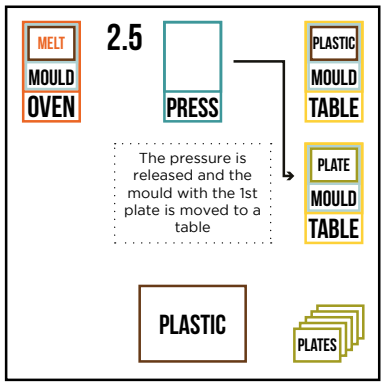


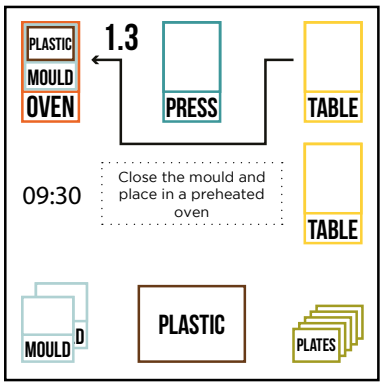


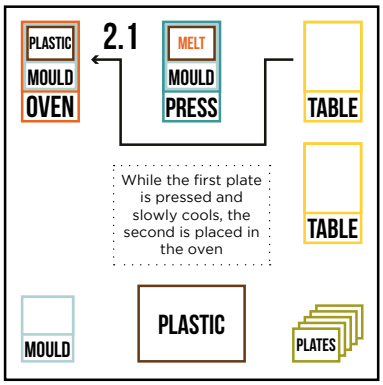


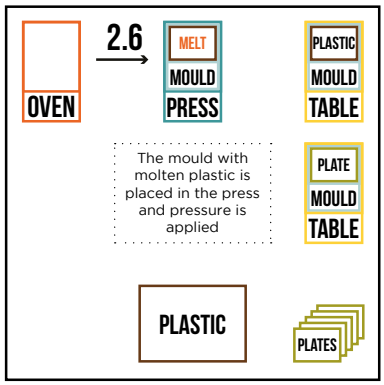


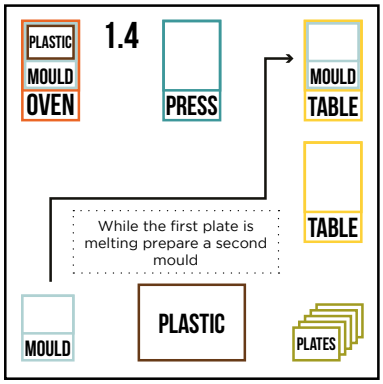


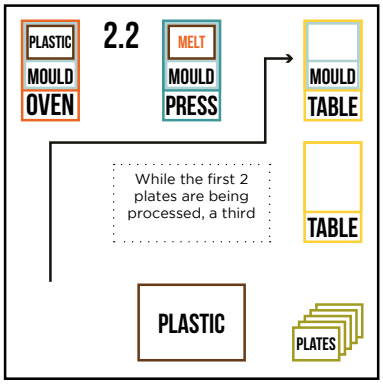


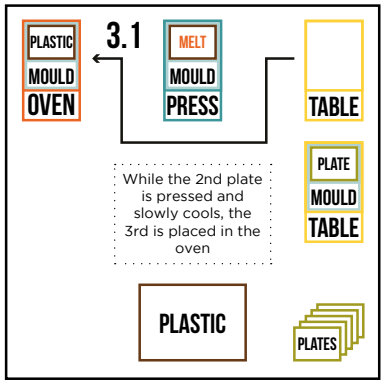


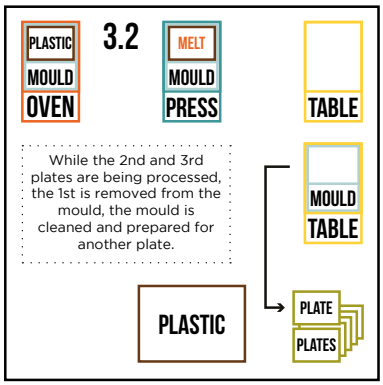


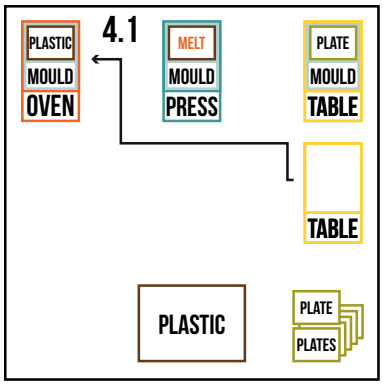


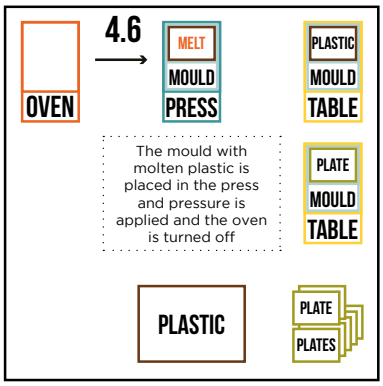


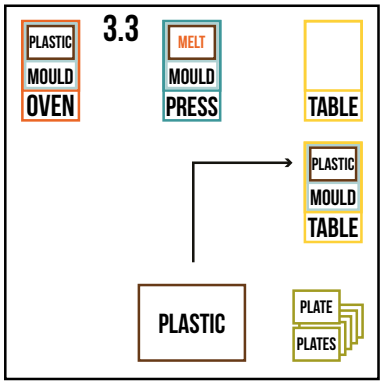


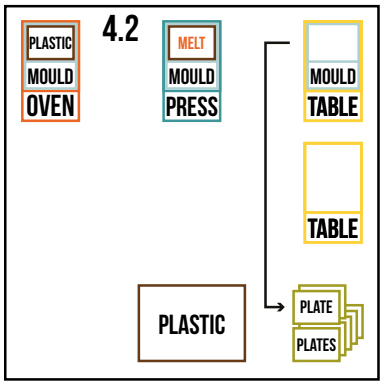


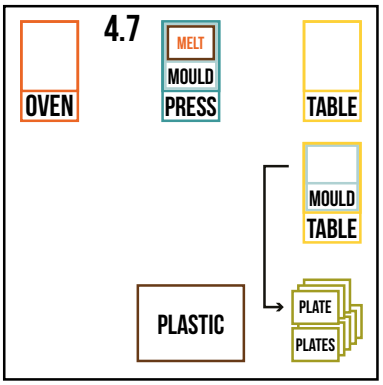

PLASTIC MOULD OVEN
3.2
MELT MOULD PRESS
TABLE
While the 2nd and 3rd plates are being processed, the 1st is removed from the mould, the mould is cleaned and prepared for another plate.
MOULD TABLE
PLASTIC
PLATE PLATES

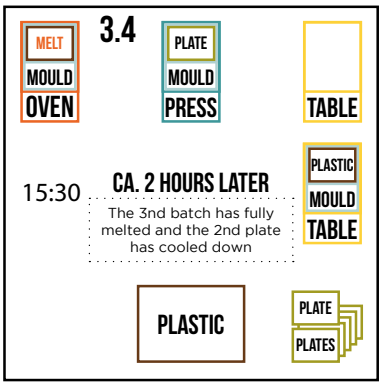

PLASTIC MOULD OVEN
4.1
MELT MOULD PRESS
PLATE MOULD TABLE
TABLE
PLASTIC
PLATE PLATES

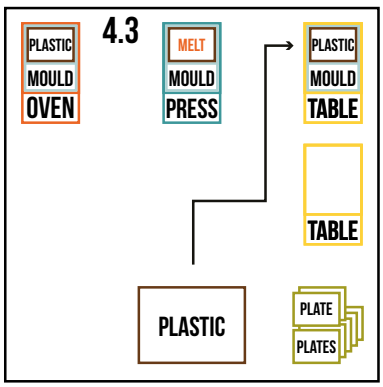

OVEN
4.6
MELT MOULD PRESS
PLASTIC MOULD TABLE
The mould with molten plastic is placed in the press and pressure is applied and the oven is turned off
PLATE MOULD TABLE
PLASTIC
PLATE PLATES

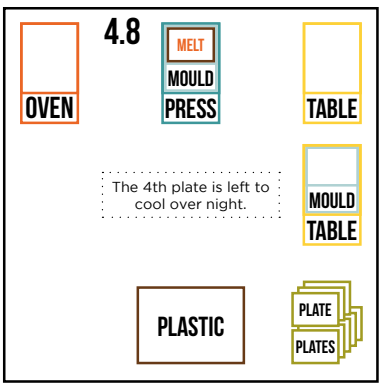

PLASTIC MOULD OVEN
3.3
MELT MOULD PRESS
TABLE
PLASTIC MOULD TABLE
PLASTIC
PLATE PLATES

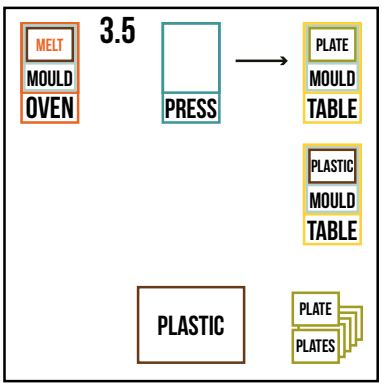

PLASTIC MOULD OVEN
4.2
MELT MOULD PRESS
MOULD TABLE
TABLE
PLASTIC
PLATE PLATES

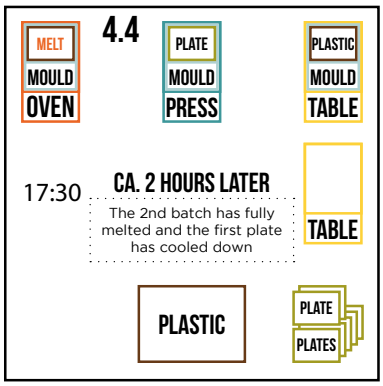

OVEN
4.7
MELT MOULD PRESS
TABLE
MOULD TABLE
PLASTIC
PLATE PLATES

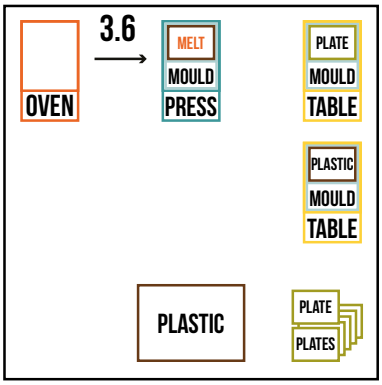

MELT MOULD OVEN
3.4
PLATE MOULD PRESS
TABLE
15:30
CA. 2 HOURS LATER
The 3nd batch has fully melted and the 2nd plate has cooled down
PLASTIC MOULD TABLE
PLASTIC
PLATE PLATES

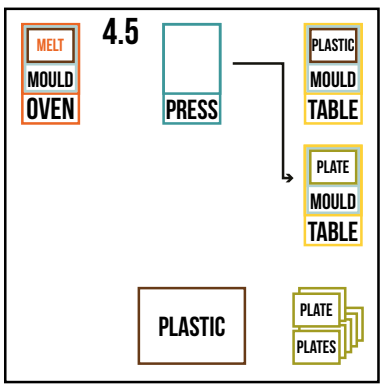

PLASTIC MOULD OVEN
4.3
MELT MOULD PRESS
PLASTIC MOULD TABLE
TABLE
PLASTIC
PLATE PLATES


OVEN
4.8
MELT MOULD PRESS
TABLE
The 4th plate is left to cool over night.
MOULD TABLE
PLASTIC
PLATE PLATES


MELT MOULD OVEN
3.5
PRESS
PLATE MOULD TABLE
PLASTIC MOULD TABLE
PLASTIC
PLATE PLATES

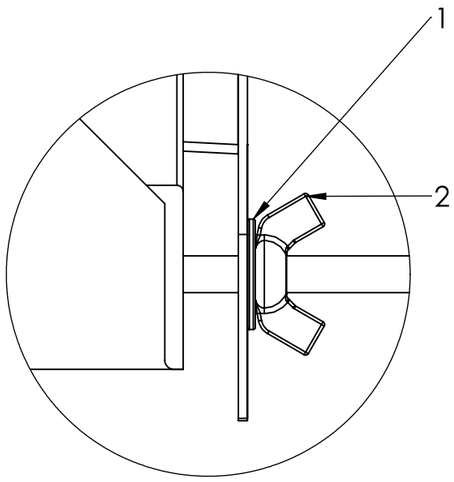

MELT MOULD OVEN
4.4
PLATE MOULD PRESS
PLASTIC MOULD TABLE
17:30
CA. 2 HOURS LATER
The 2nd batch has fully melted and the first plate has cooled down
TABLE
PLASTIC
PLATE PLATES


OVEN
3.6
MELT MOULD PRESS
PLATE MOULD TABLE
PLASTIC MOULD TABLE
PLASTIC
PLATE PLATES

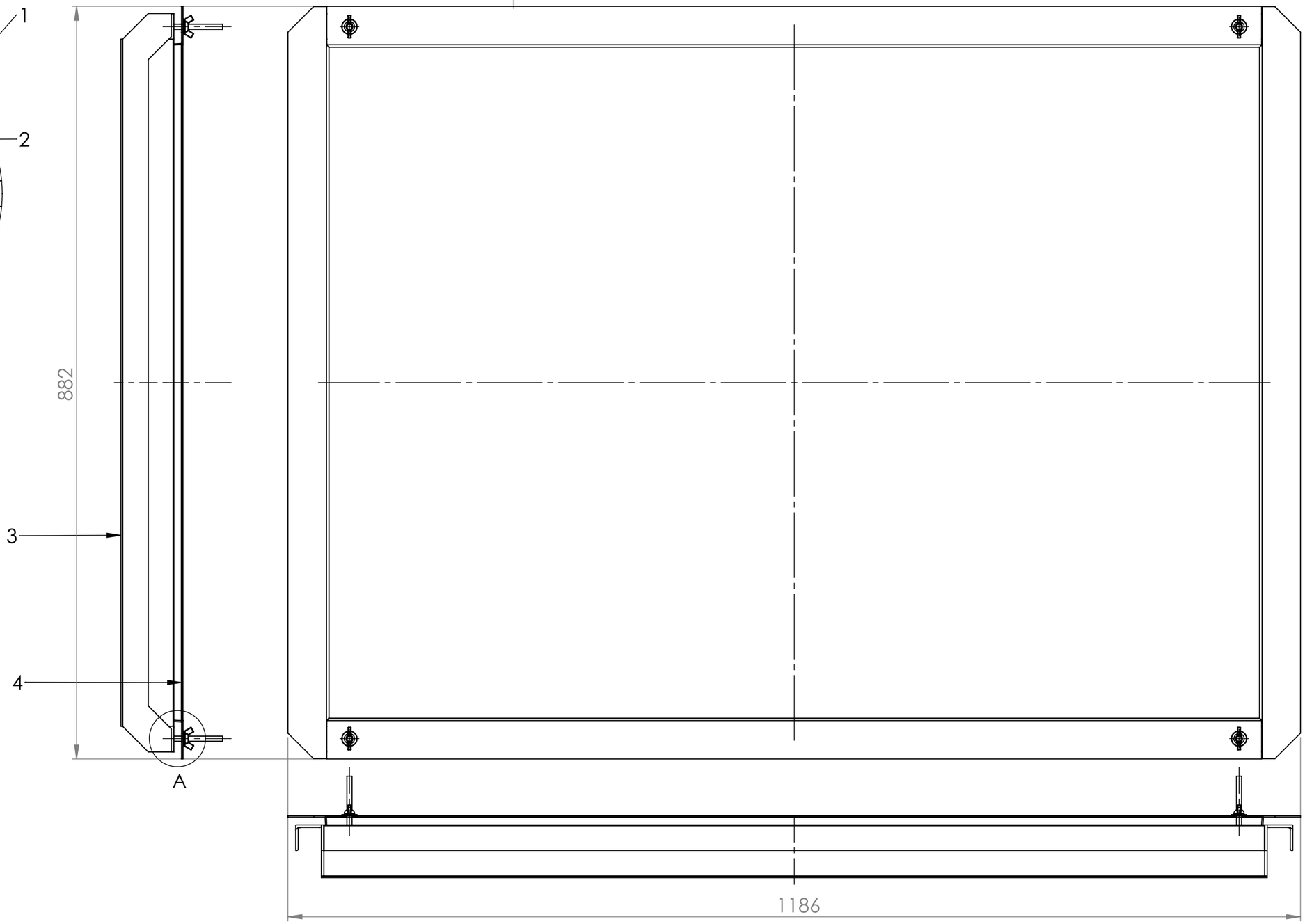

MELT MOULD OVEN
4.5
PRESS
PLASTIC MOULD TABLE
PLATE MOULD TABLE
PLASTIC
PLATE PLATES

A.21. TECHNICAL DRAWING SET: MOULD

A.21.1. MOULDS ASSEMBLY



DETAIL A
SCALE 1 : 1



ITEM NO.	PART NAME	DRAWING NUMBER	QTY.
1	M6 Body ring	-	4
2	M6 Wing nut	-	4
3	Mould-Tub_Assembly	1.1	1
4	Mould-Lid_Weld Assembly	1.2	1

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title: Mould_Assembly

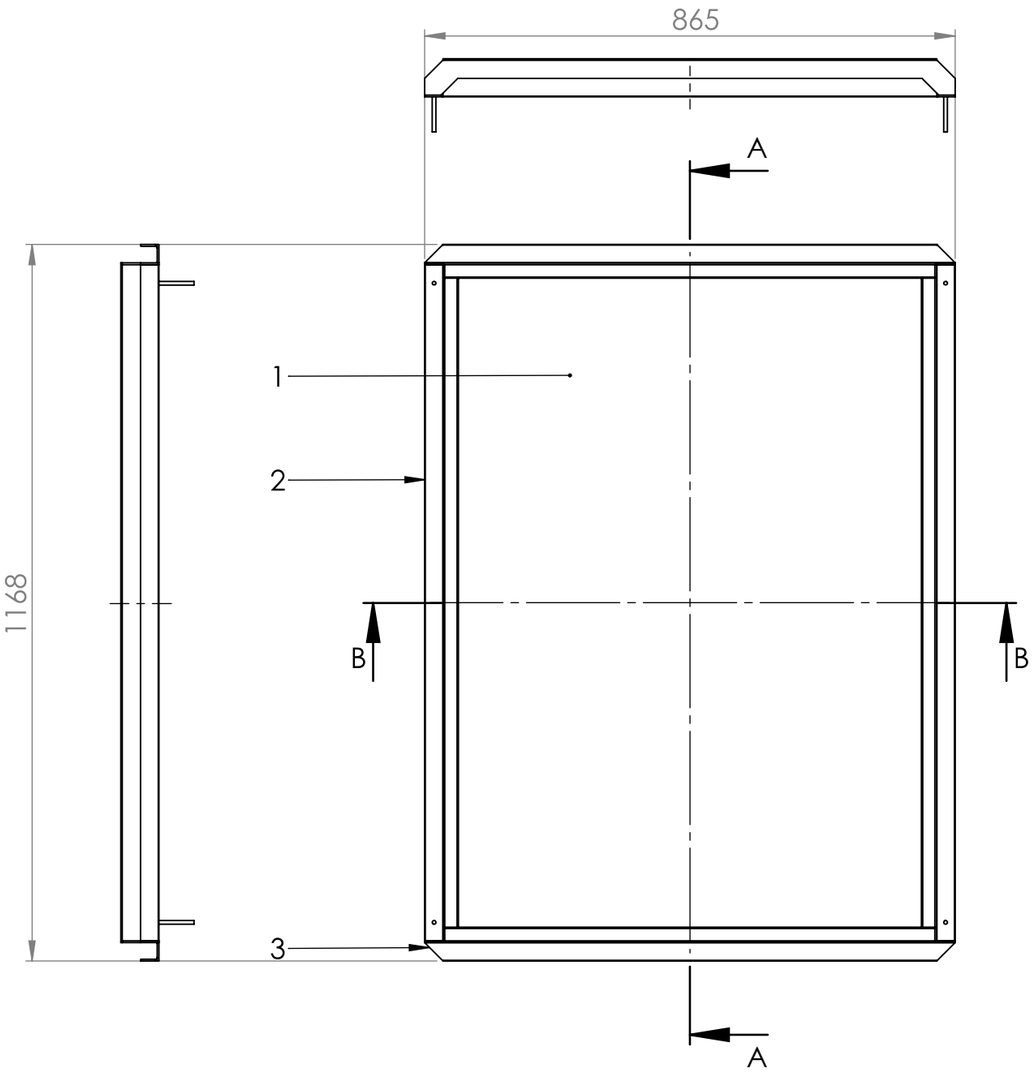
Project name: A Plastic Plate Press for Low resource settings

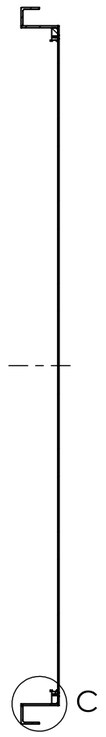
Drawing no. 1

A3

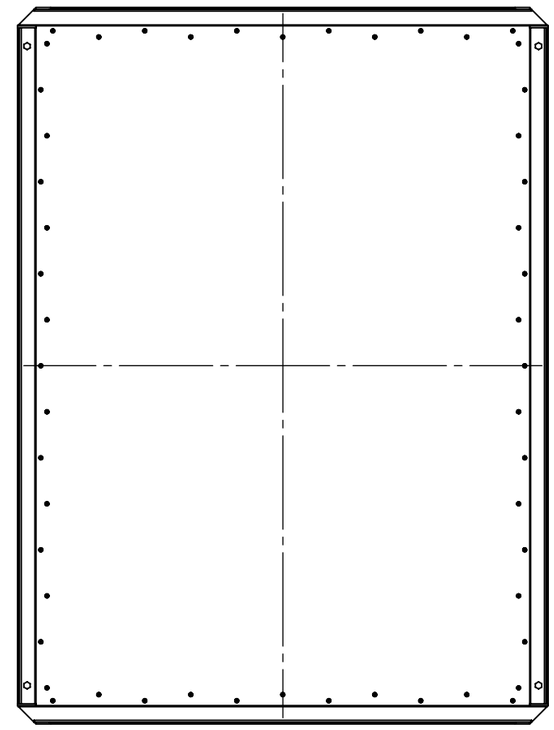
Scale: 1:5 | DO NOT SCALE DRAWING | Sheet 1 of 1

A.21.2. MOULDS-TUB ASSEMBLY

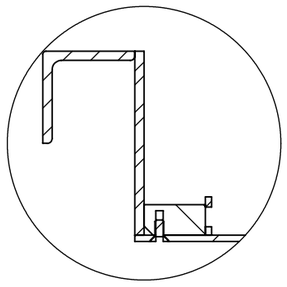




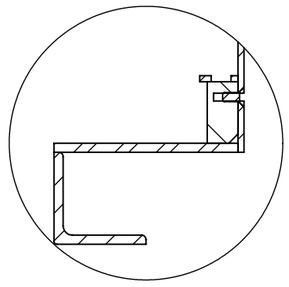
SECTION A-A



SECTION B-B



DETAIL D
SCALE 1 : 2



DETAIL C
SCALE 1 : 2

ITEM NO.	PART NAME	DRAWING NUMBER	QTY.
1	Mould-Tub_Base-Plate	1.1.1	1
2	Mould-Tub_Frame-longside_Weld-Assembly	1.1.2	2
3	Mould-Tub_Frame-shortside_Weld-Assembly	1.1.3	2
4	M3 Bolt Countersunk head	-	52

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title:

Mould-Tub_Assembly

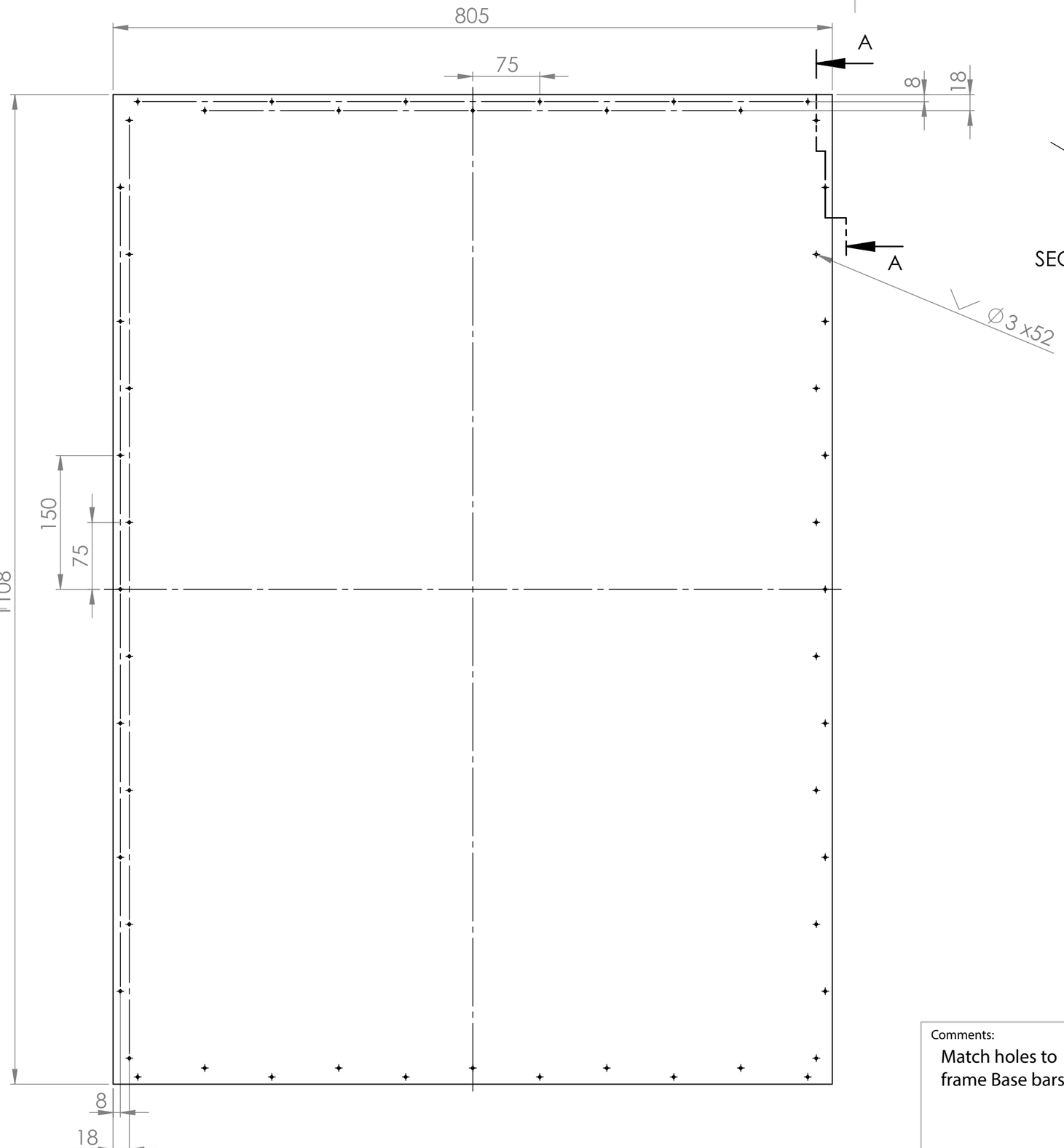
Project name: A Plastic Plate Press for Low resource settings

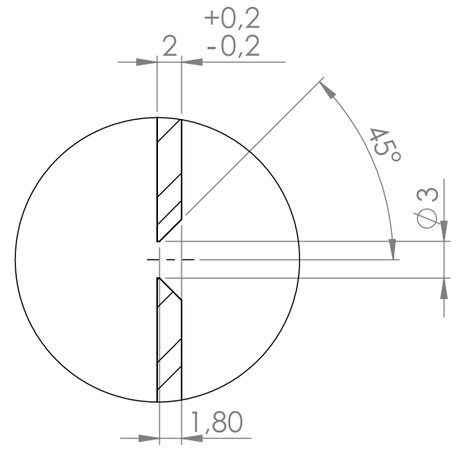
Drawing no. 1.1

A3

Scale: 1:10 | DO NOT SCALE DRAWING | Sheet 1 of 1

A.21.3. MOULDS-TUB BASE-PLATE

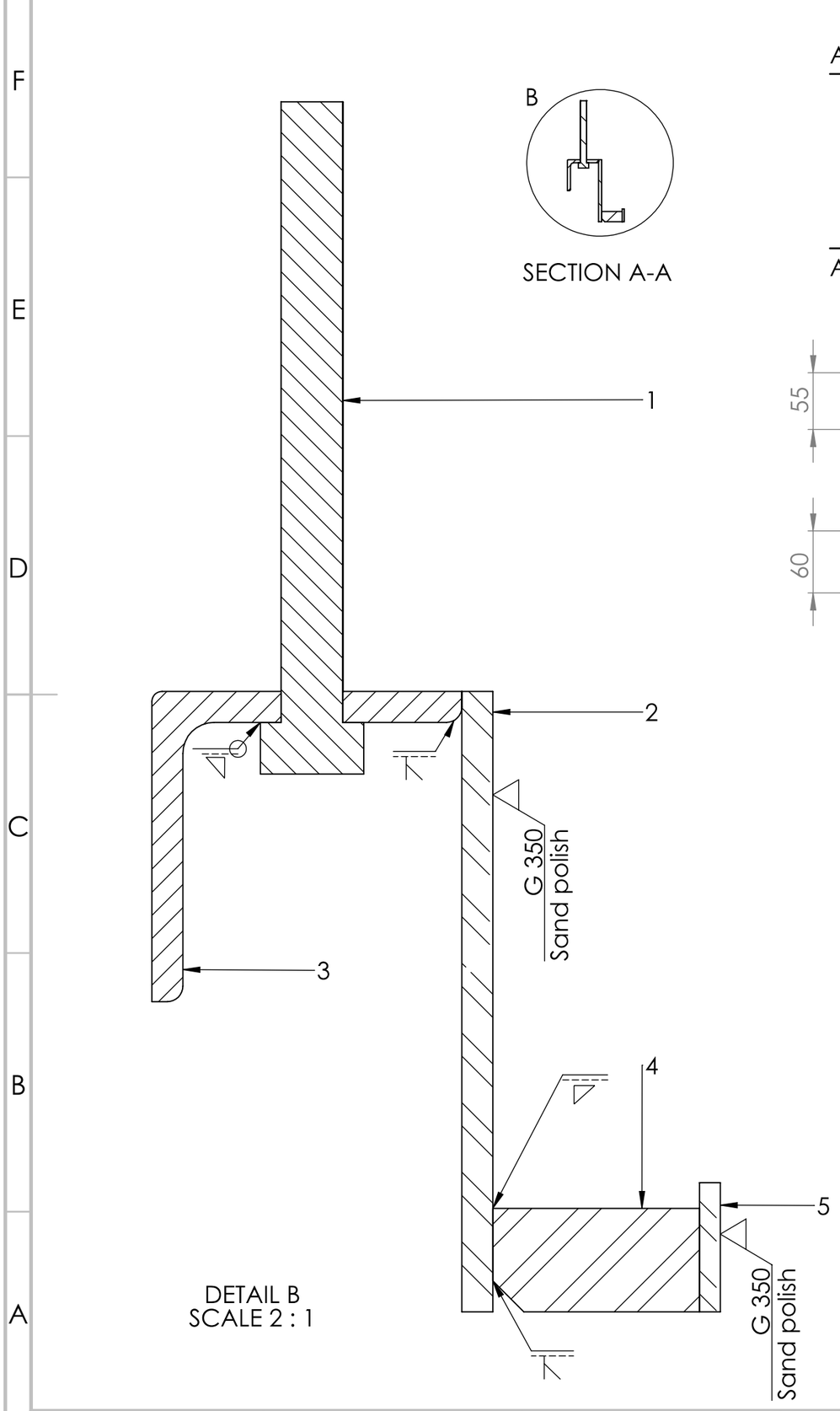


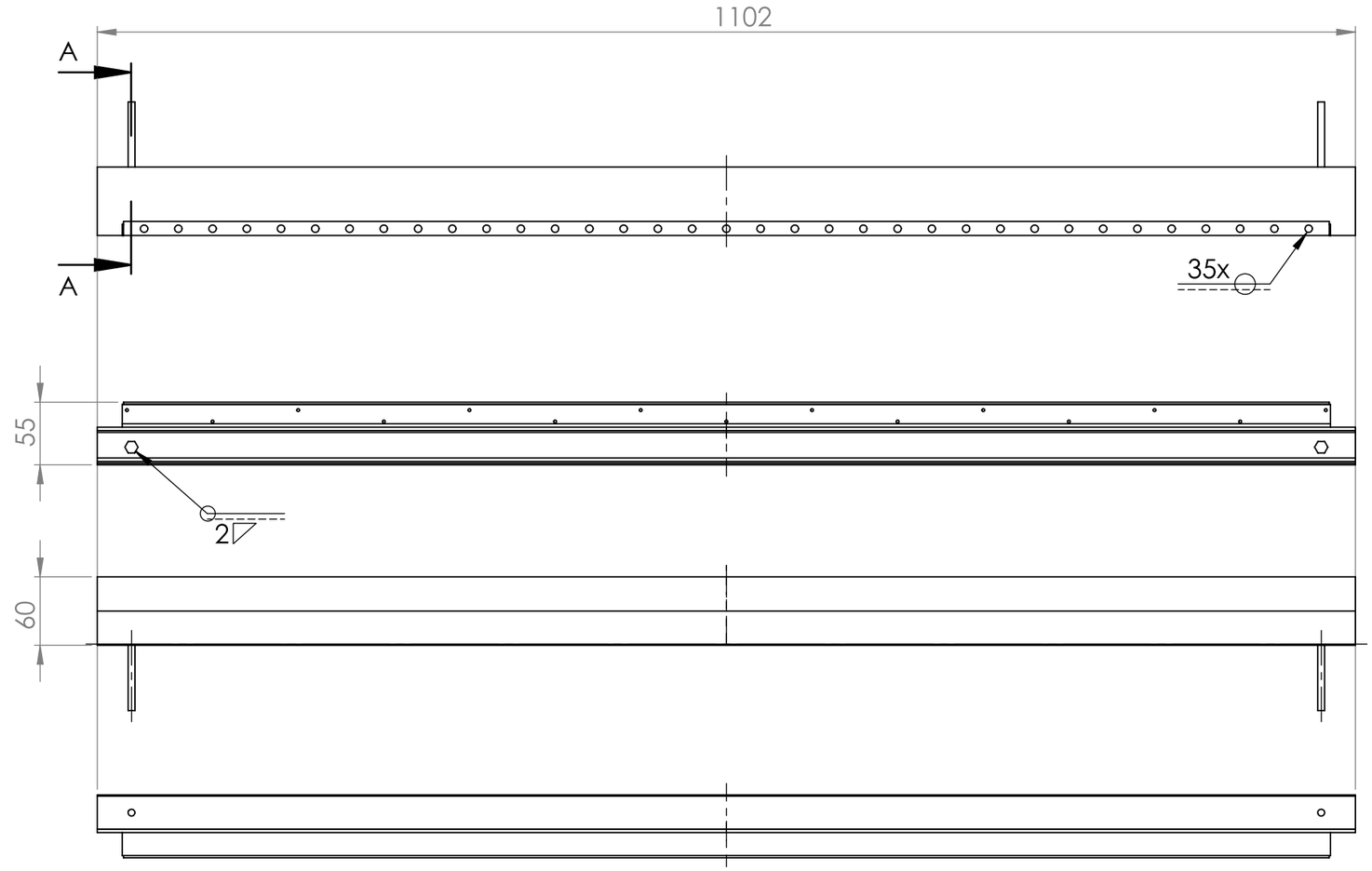


DETAIL B
SCALE 2 : 1
All 52 holes

Comments: Match holes to frame Base bars	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Tub_Base-Plate	
		Project name: A Plastic Plate Press for Low resource settings	
	Deburr and break sharp edges	Drawing no. 1.1.1	A3
Material: Steel	Finish: Untreated (No rust)	Scale: 1:5 DO NOT SCALE DRAWING	Sheet 1 of 1

A.21.4. MOULDS-TUB FRAME-LONGSIDE WELD ASSEMBLY





Item No.	PART NAME	Drawing No.	QTY.
1	M6 x 60 Bolt	-	2
2	Mould-Tub-Frame_Wall-Longside	1.1.2.2	1
3	Mould-Tub-Frame_Grip-Longside	1.1.2.1	1
4	Mould-Tub-Frame_Base-Bar-Longside	1.1.2.4	1
5	Mould-Tub-Frame_Cut-off-edge-Longside	1.1.2.3	1

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

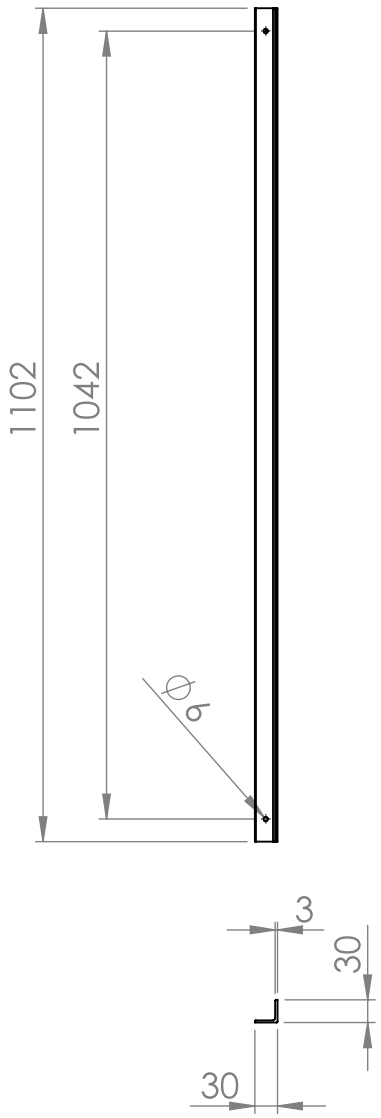
Title: Mould-Tub_Frame-longside_Weld-Assembly

Project name: A Plastic Plate Press for Low resource settings

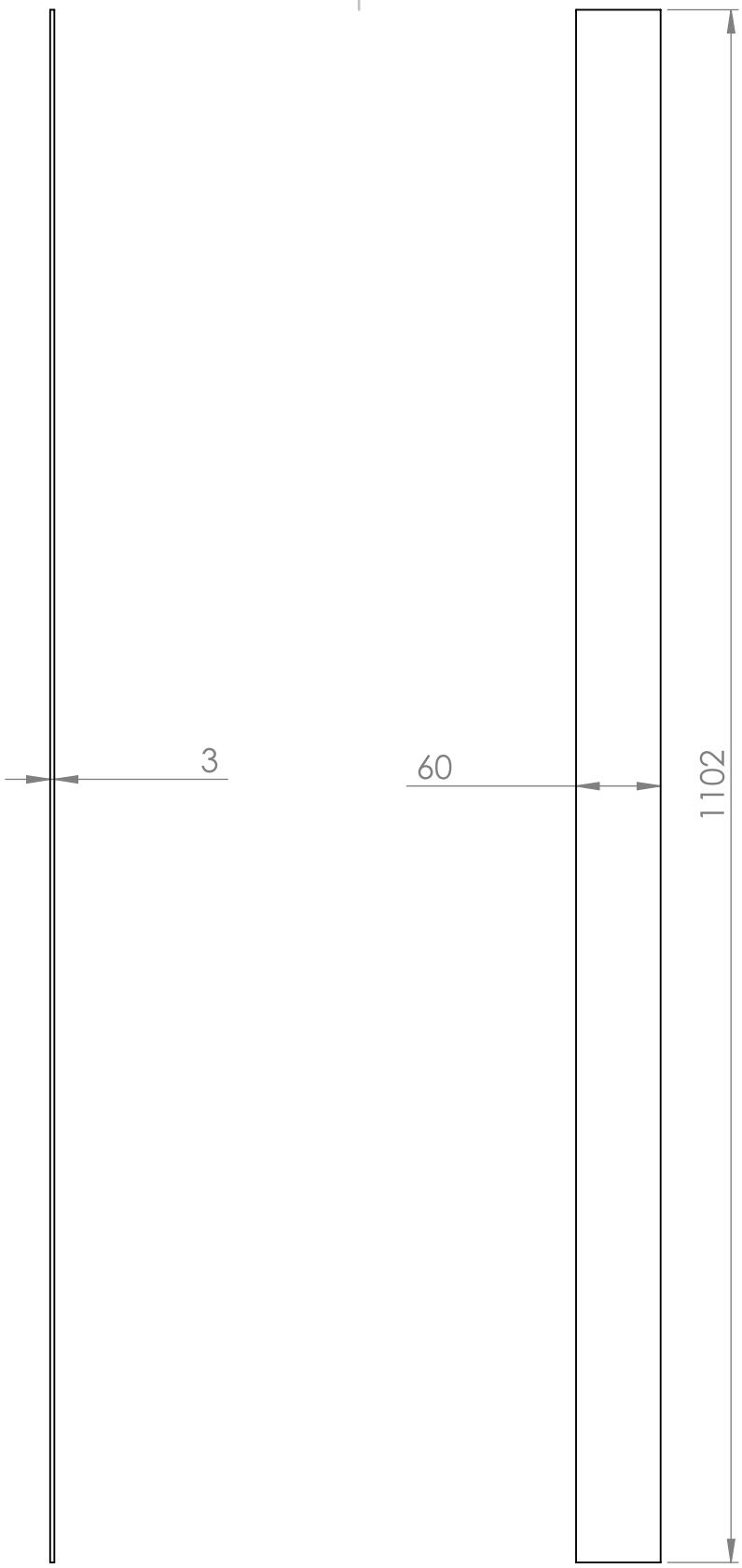
Drawing no. 1.1.2

A3

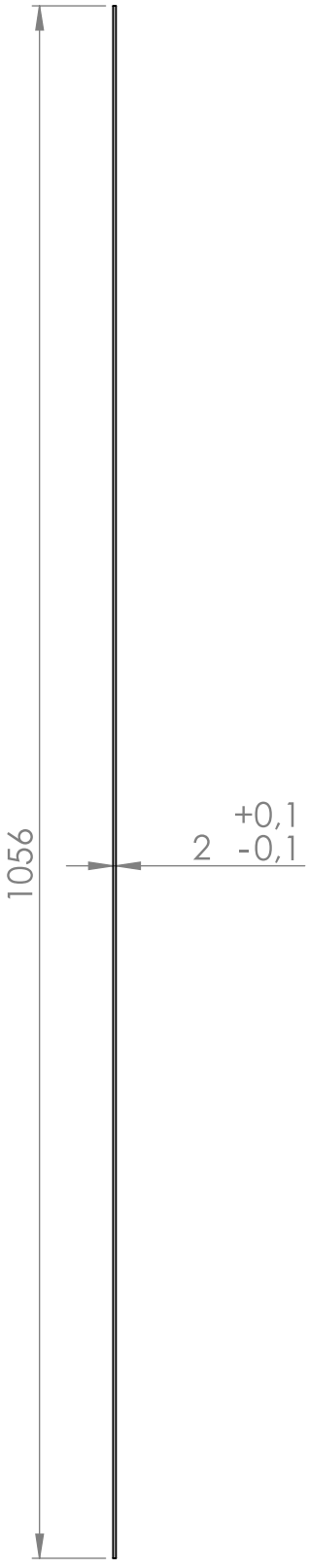
Scale: 1:5 | DO NOT SCALE DRAWING | Sheet 1 of 1

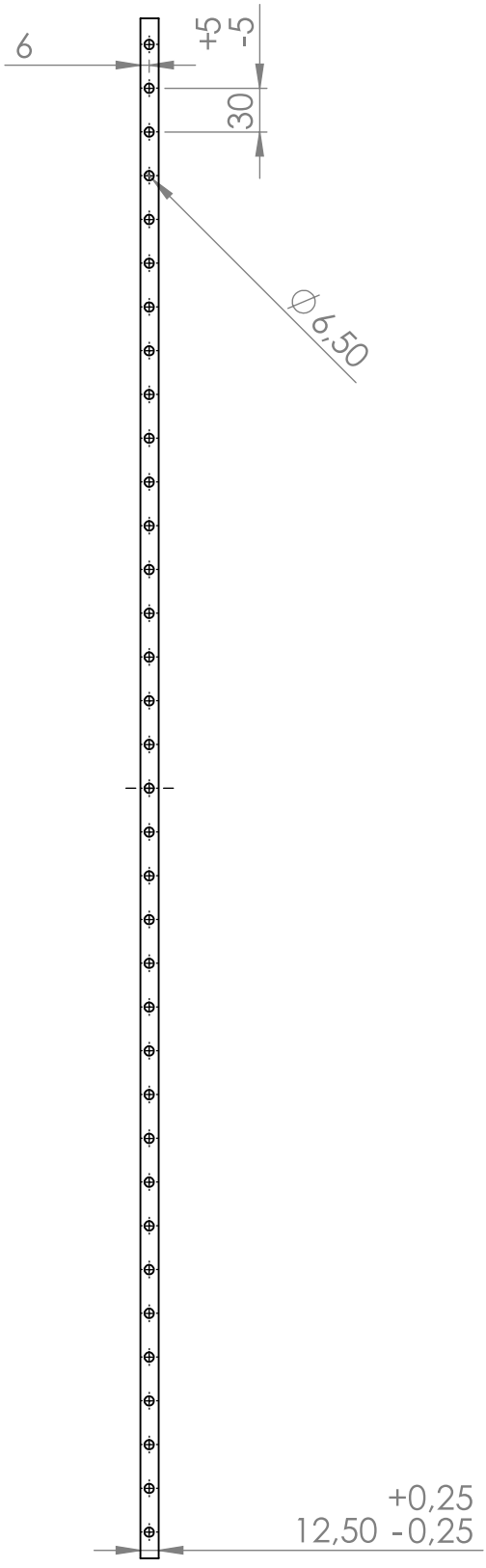


Comments: Based on Angled section 30x30x3	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Tub-Frame_Grip-Longside	
		Project name:	A Plastic Plate Press for Low resource settings
	Deburr and break sharp edges	Drawing no. 1.1.2.1	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:10	DO NOT SCALE DRAWING Sheet 1 of 1

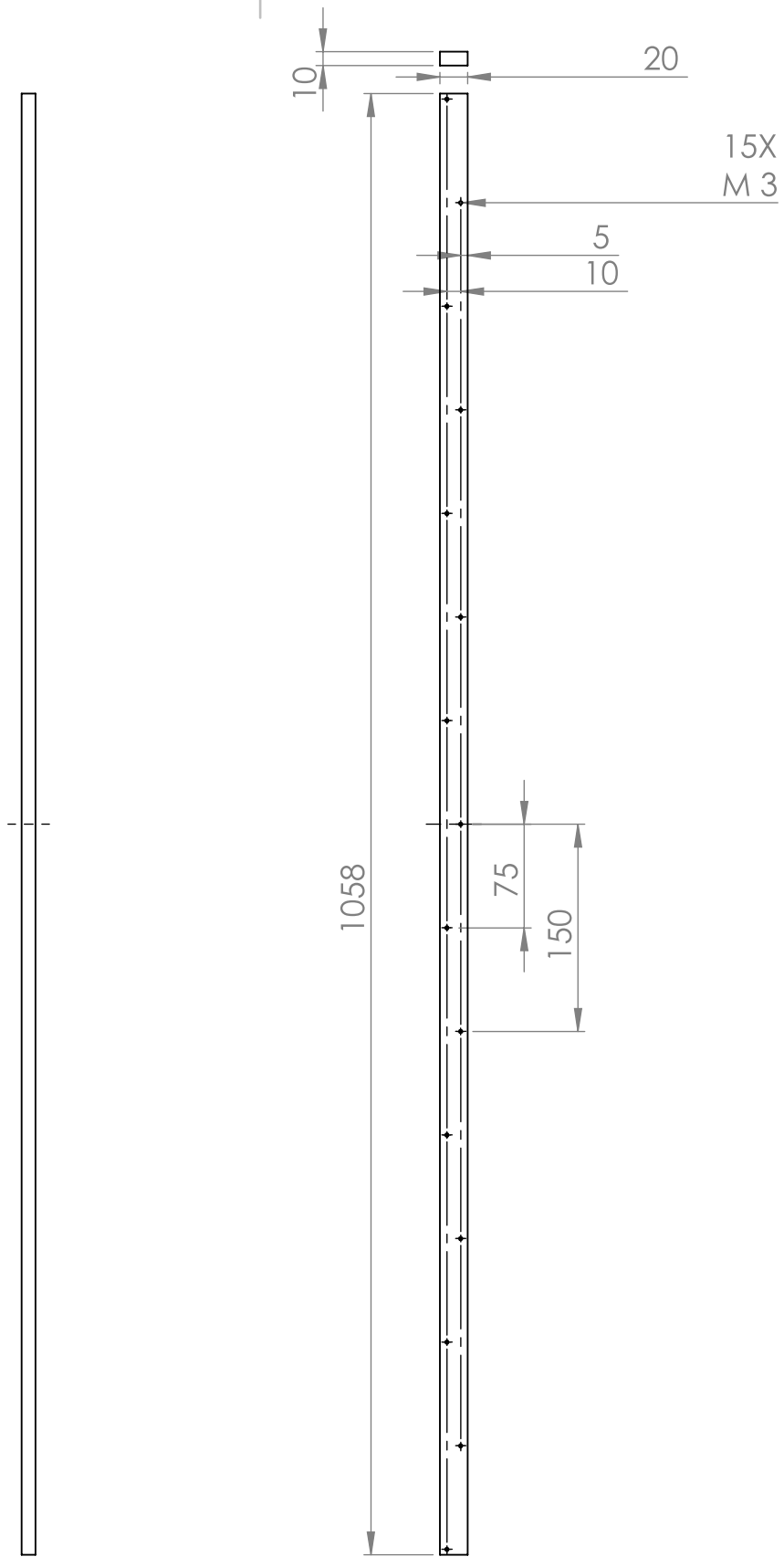


Comments:	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Tub-Frame_Wall-longside	
		Project name: A Plastic Plate Press for Low resource settings	
	Deburr and break sharp edges	Drawing no. 1.1.2.2	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:5	DO NOT SCALE DRAWING / Sheet 1 of 1



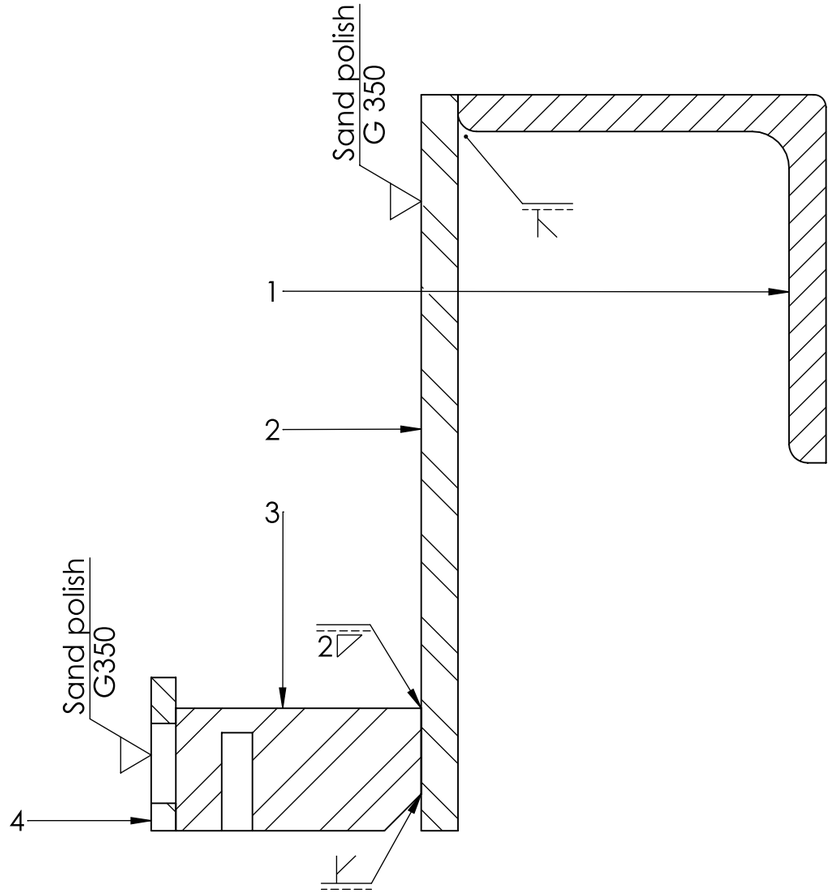


Comments: Strip can also be cut in pieces for ease of production	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Tub-Frame_Cut-off-edge-longside	
		Project name: A Plastic Plate Press for Low resource settings	
	Deburr and break sharp edges	Drawing no. 1.1.2.3	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:5	DO NOT SCALE DRAWING / Sheet 1 of 1

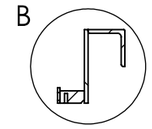


Comments: Based on Steel section 10x20 Match holes to baseplate	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Tub-Frame_Base-Bar-longside	
		Project name:	A Plastic Plate Press for Low resource settings
	Deburr and break sharp edges	Drawing no. 1.1.2.4	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:5	DO NOT SCALE DRAWING Sheet 1 of 1

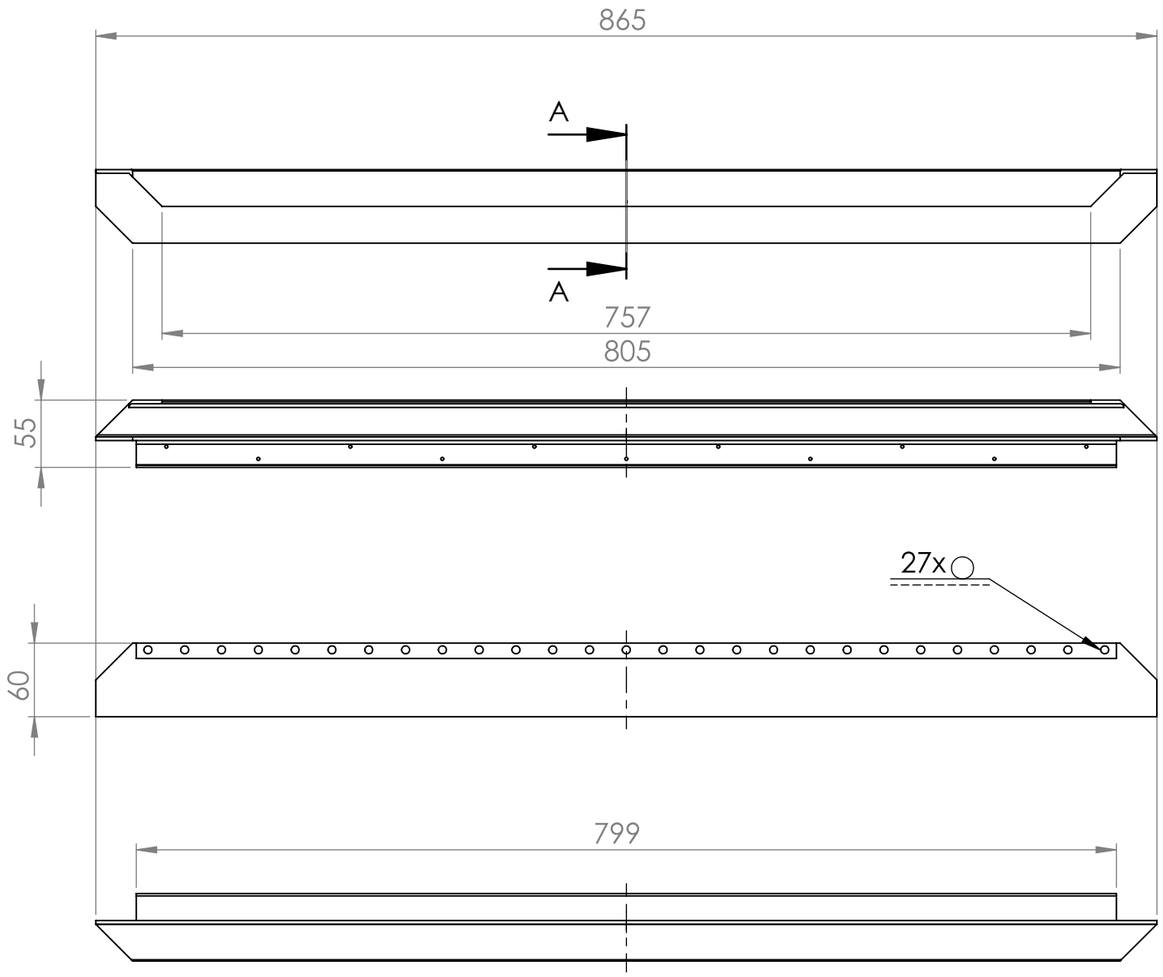
A.21.9. MOULDS-TUB FRAME-SHORTSIDE WELD ASSEMBLY



DETAIL B
SCALE 2 : 1



SECTION A-A



Item No.	PART NAME	Drawing No.	QTY.
1	Mould-Tub-Frame_Grip-Longside	1.1.3.1	1
2	Mould-Tub-Frame_Wall-Longside	1.1.3.2	1
3	Mould-Tub-Frame_Base-Bar-Longside	1.1.3.4	1
4	Mould-Tub-Frame_Cut-off-edge-Longside	1.1.3.4	1

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

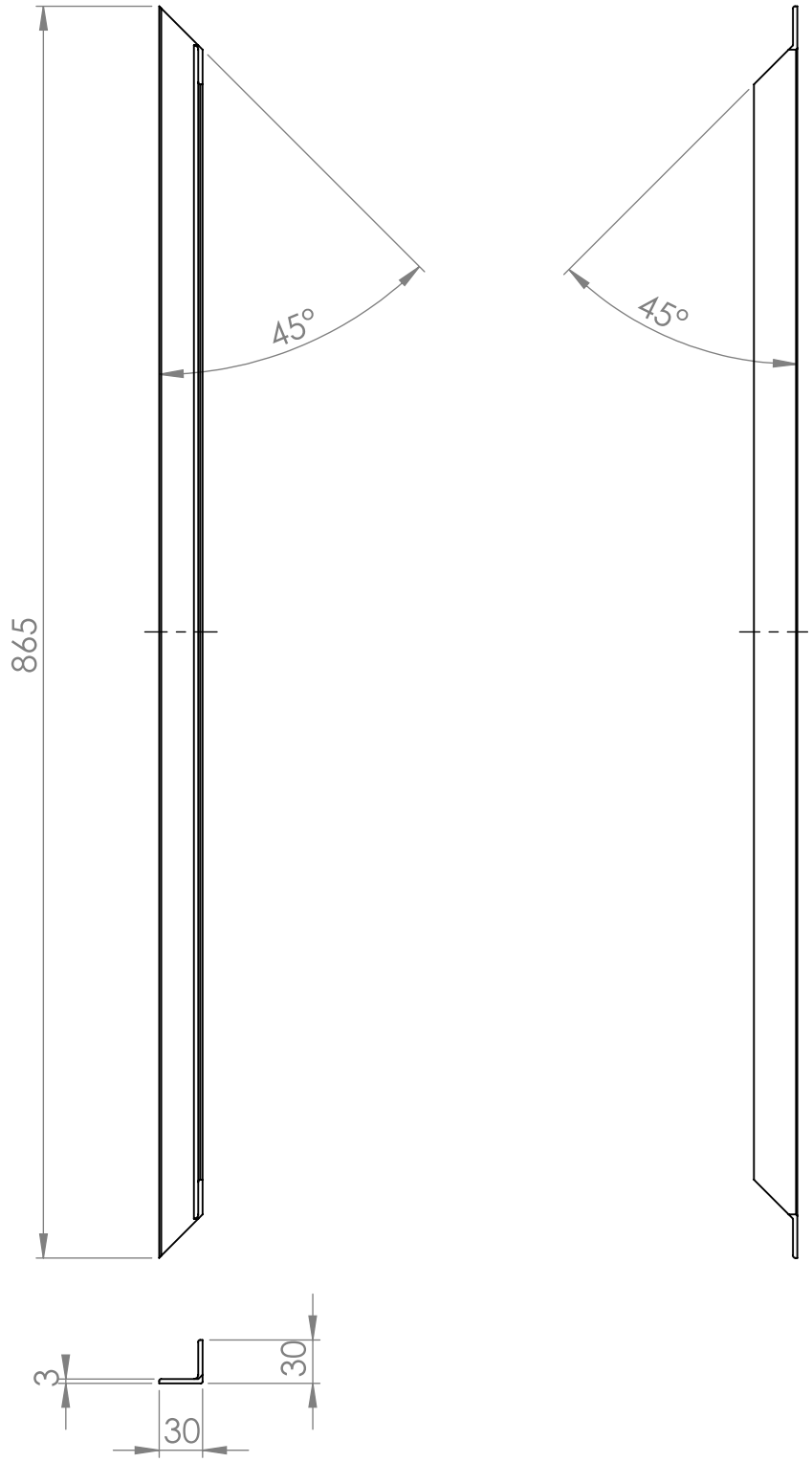
Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title: Mould-Tub_Frame-shortside_Weld-Assembly

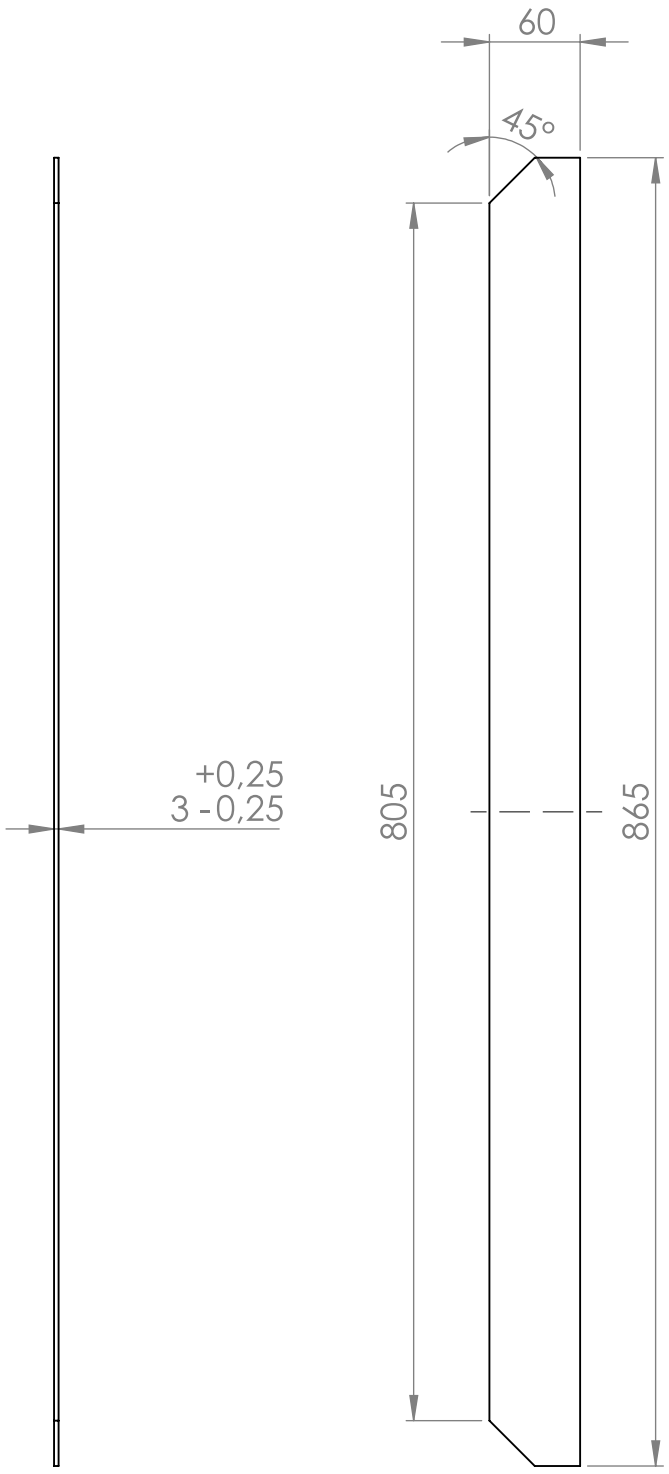
Project name: A Plastic Plate Press for Low resource settings

Drawing no. 1.1.3 | A3

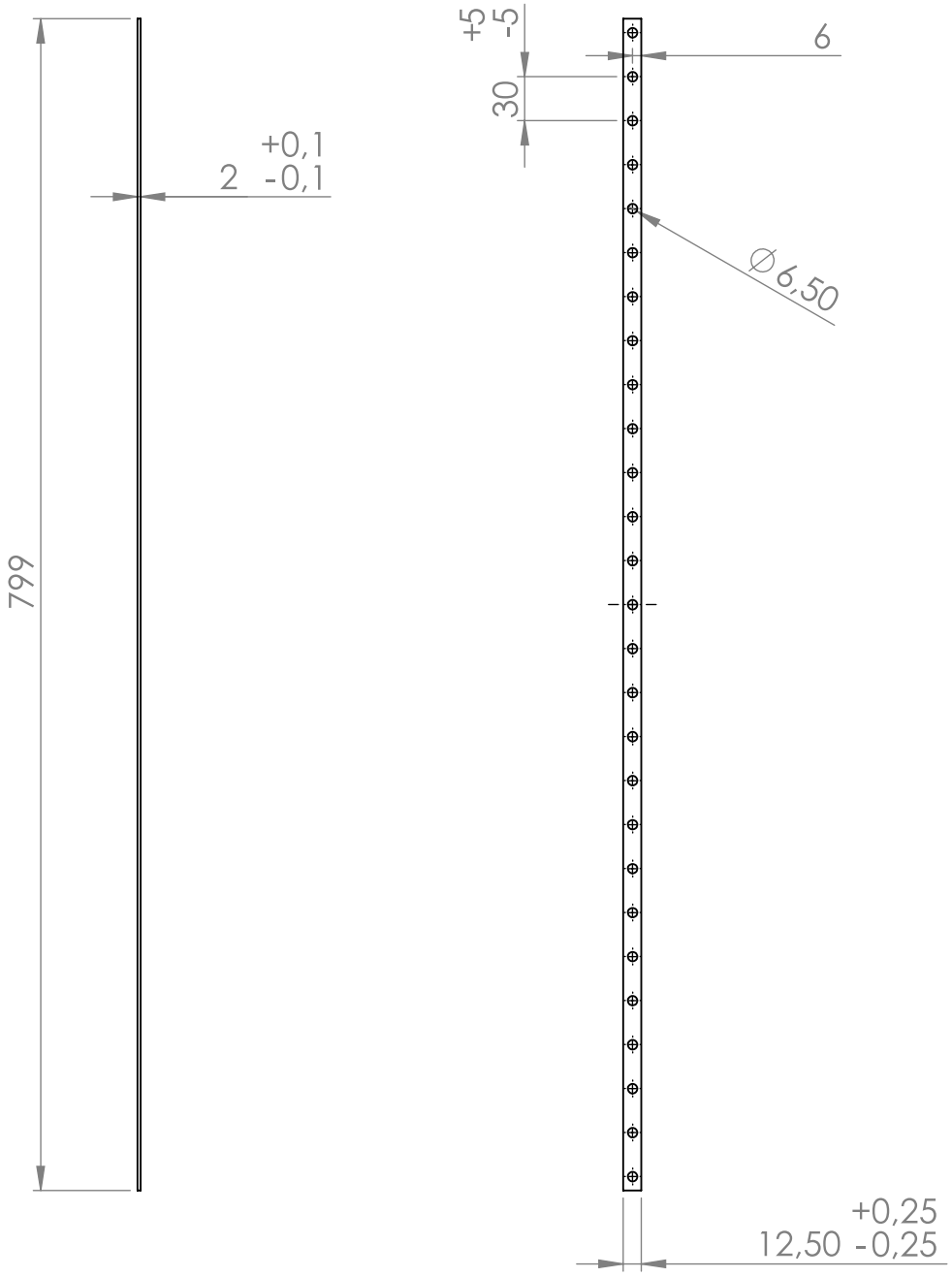
Scale: 1:5 | DO NOT SCALE DRAWING | Sheet 1 of 1



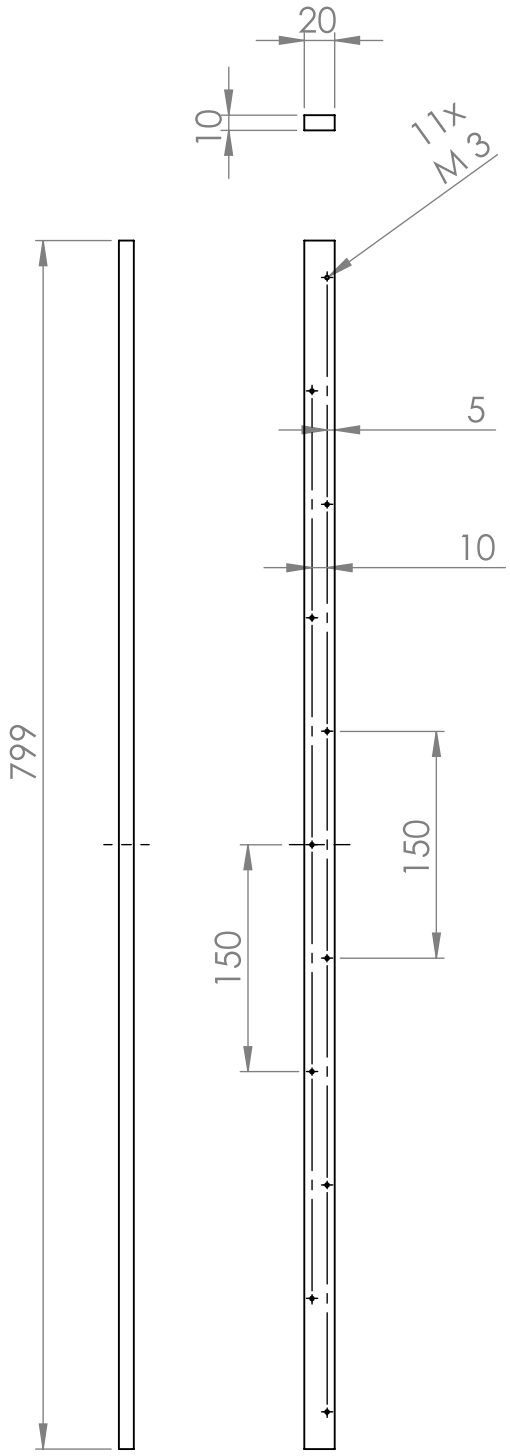
Comments: Based on Angled section 30x30x3	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Tub-Frame_Grip-shortside	
		Project name:	A Plastic Plate Press for Low resource settings
	Deburr and break sharp edges	Drawing no. 1.1.3.1	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:5	DO NOT SCALE DRAWING Sheet 1 of 1



Comments:	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Tub-Frame_Wall-Shortside	
		Project name: A Plastic Plate Press for Low resource settings	
	Deburr and break sharp edges	Drawing no. 1.1.3.2	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:5	DO NOT SCALE DRAWING / Sheet 1 of 1

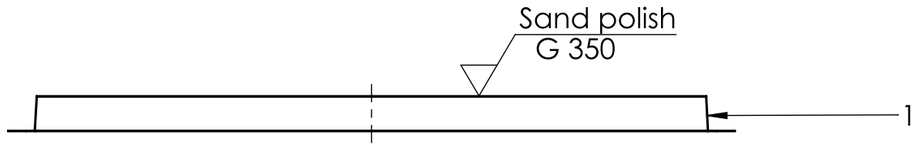


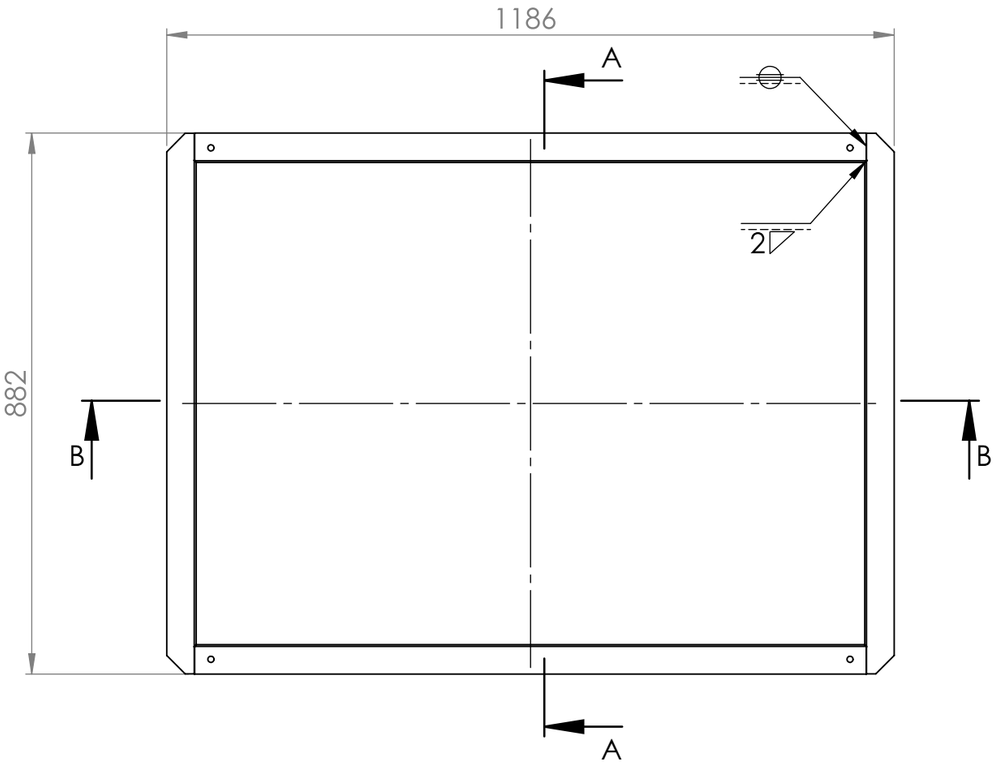
Comments: Strip can also be cut in pieces for ease of production	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Tub-Frame_Cut-off-edge-shortside	
		Project name:	A Plastic Plate Press for Low resource settings
	Deburr and break sharp edges	Drawing no. 1.1.3.3	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:5	DO NOT SCALE DRAWING Sheet 1 of 1



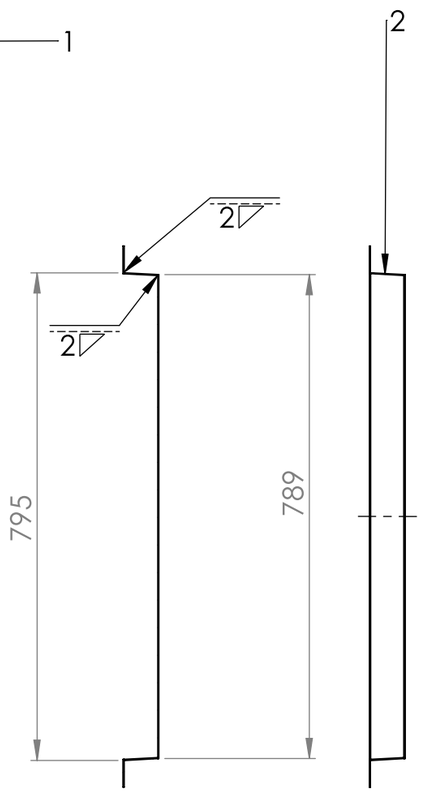
Comments: Based on Steel section 10x20 Match holes to baseplate	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Tub-Frame_Base-Bar-shortside	
		Project name:	A Plastic Plate Press for Low resource settings
	Deburr and break sharp edges	Drawing no. 1.1.3.4	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:5	DO NOT SCALE DRAWING Sheet 1 of 1

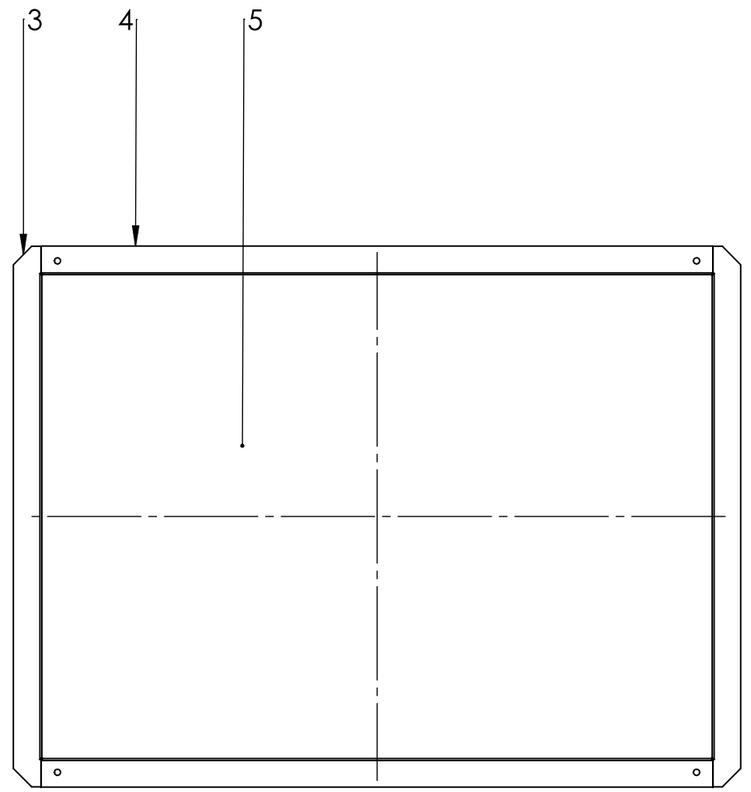
A.21.14. MOULD-LID WELD ASSEMBLY

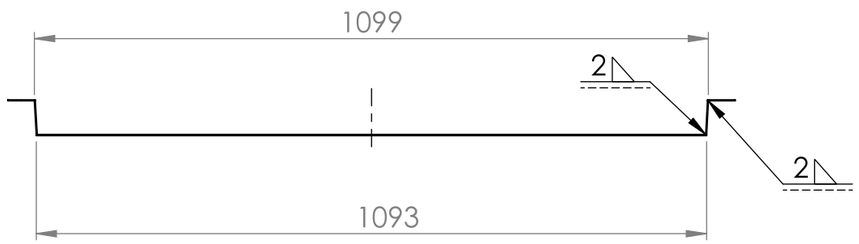




SECTION A-A







SECTION B-B

Item No.	PART NAME	Drawing No.	QTY.
1	Mould-Lid_Wall-Longside	1.2.3	2
2	Mould-Lid_Wall-Shortside	1.2.4	2
3	Mould-Lid_Flange-Longside	1.2.1	2
4	Mould-Lid_Flange-Shortside	1.2.2	2
5	Mould-Lid_Base-Plate	1.2.5	1

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

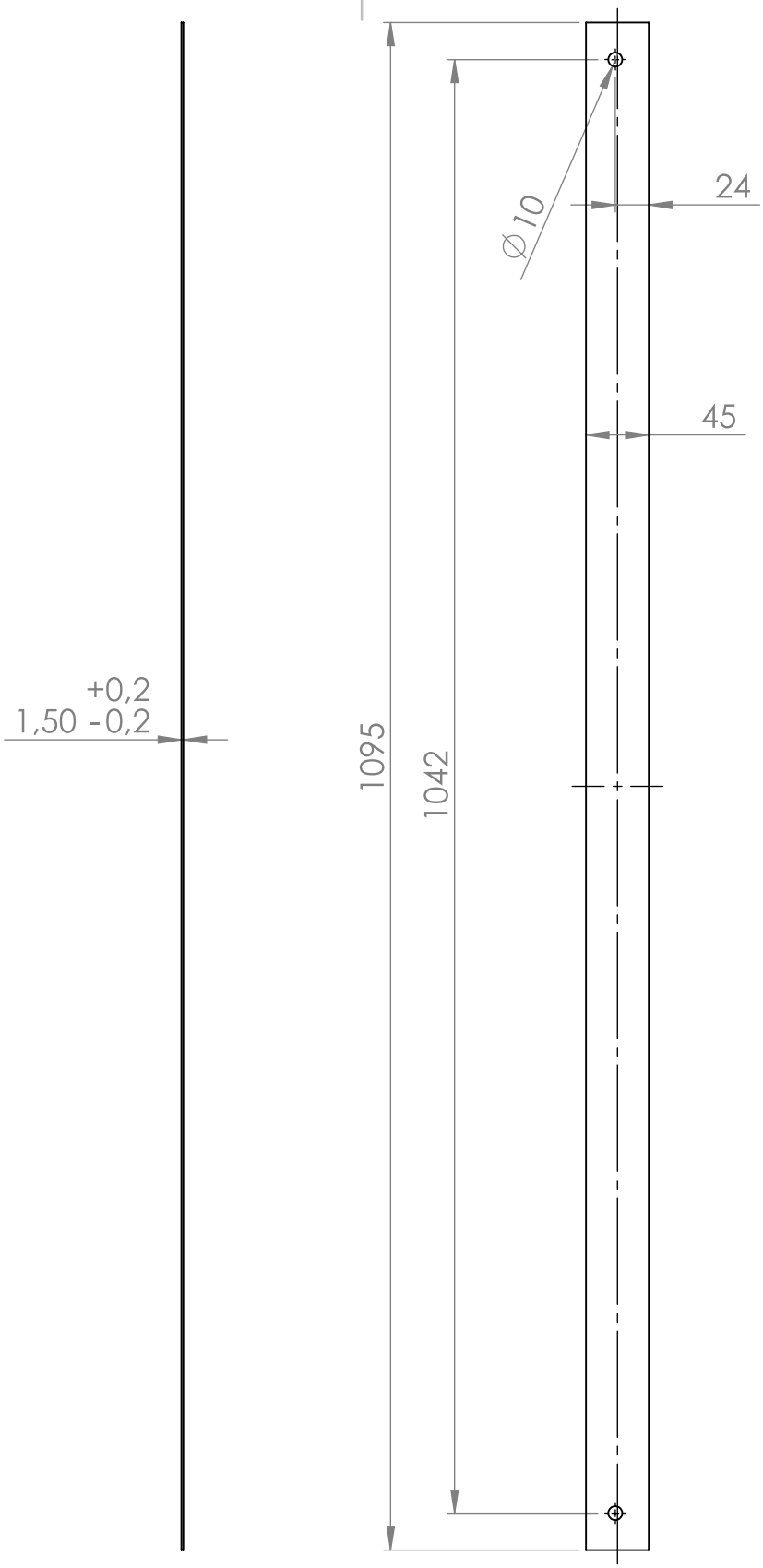
Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title: Mould-Lid_Weld-Assembly

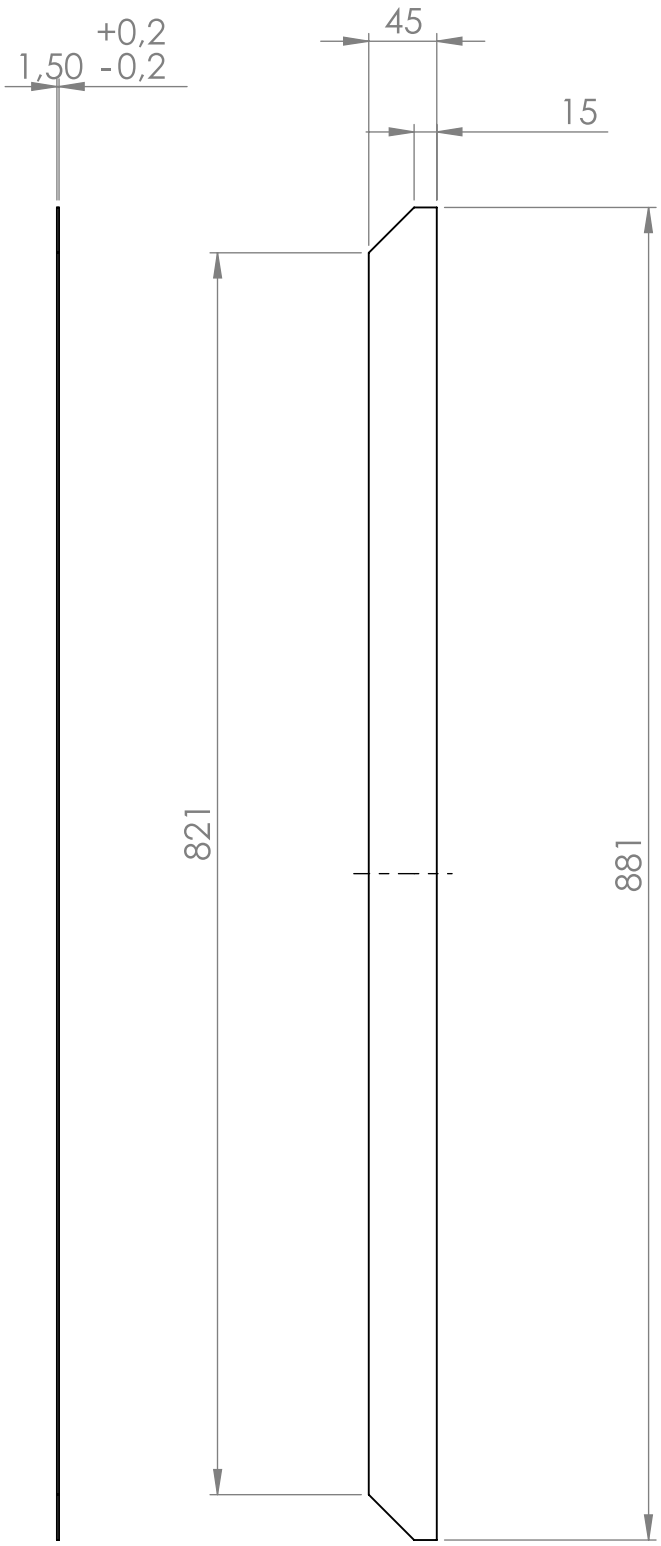
Project name: A Plastic Plate Press for Low resource settings

Drawing no. 1.2 | A3

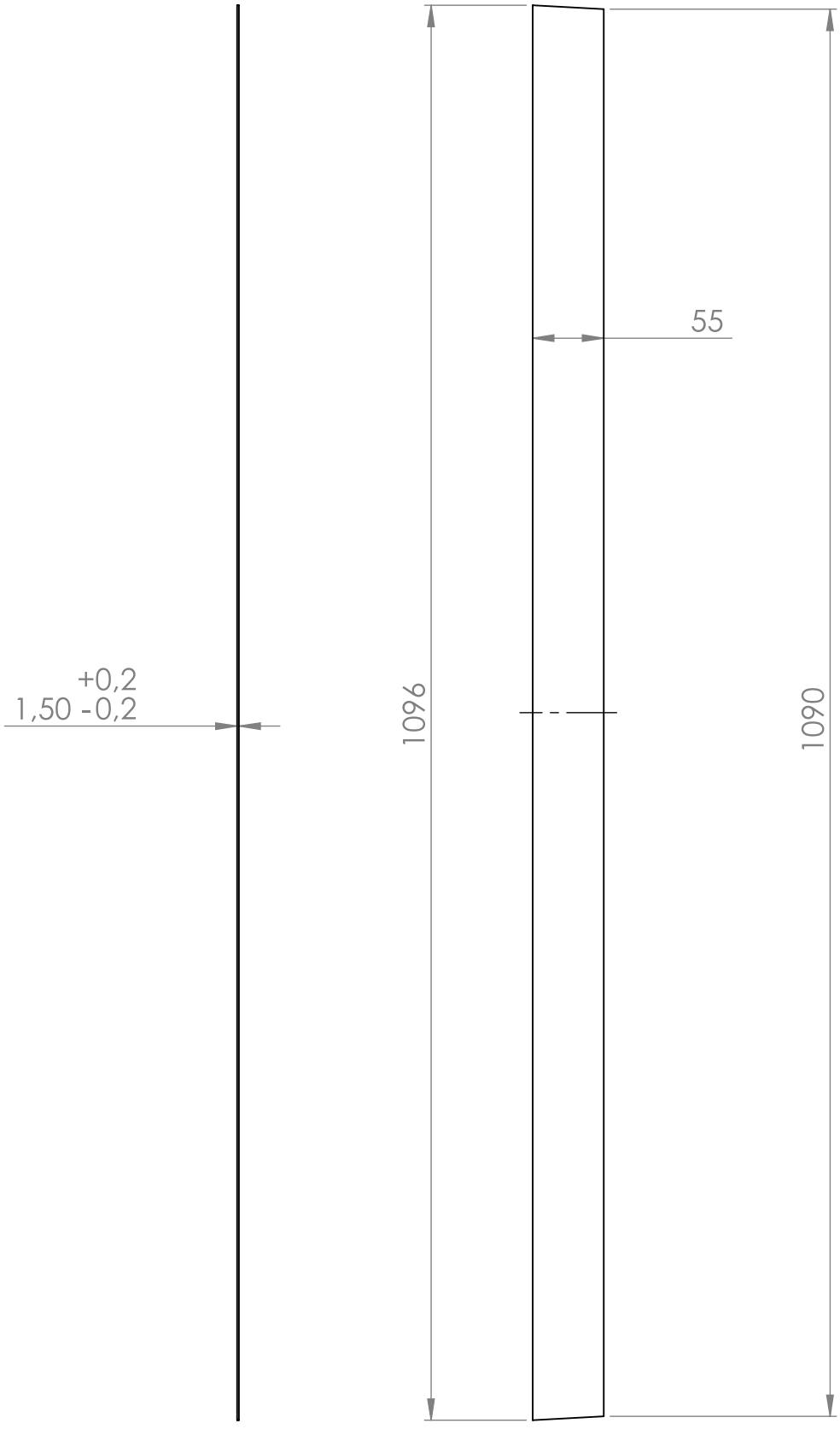
Scale: 1:10 | DO NOT SCALE DRAWING | Sheet 1 of 1



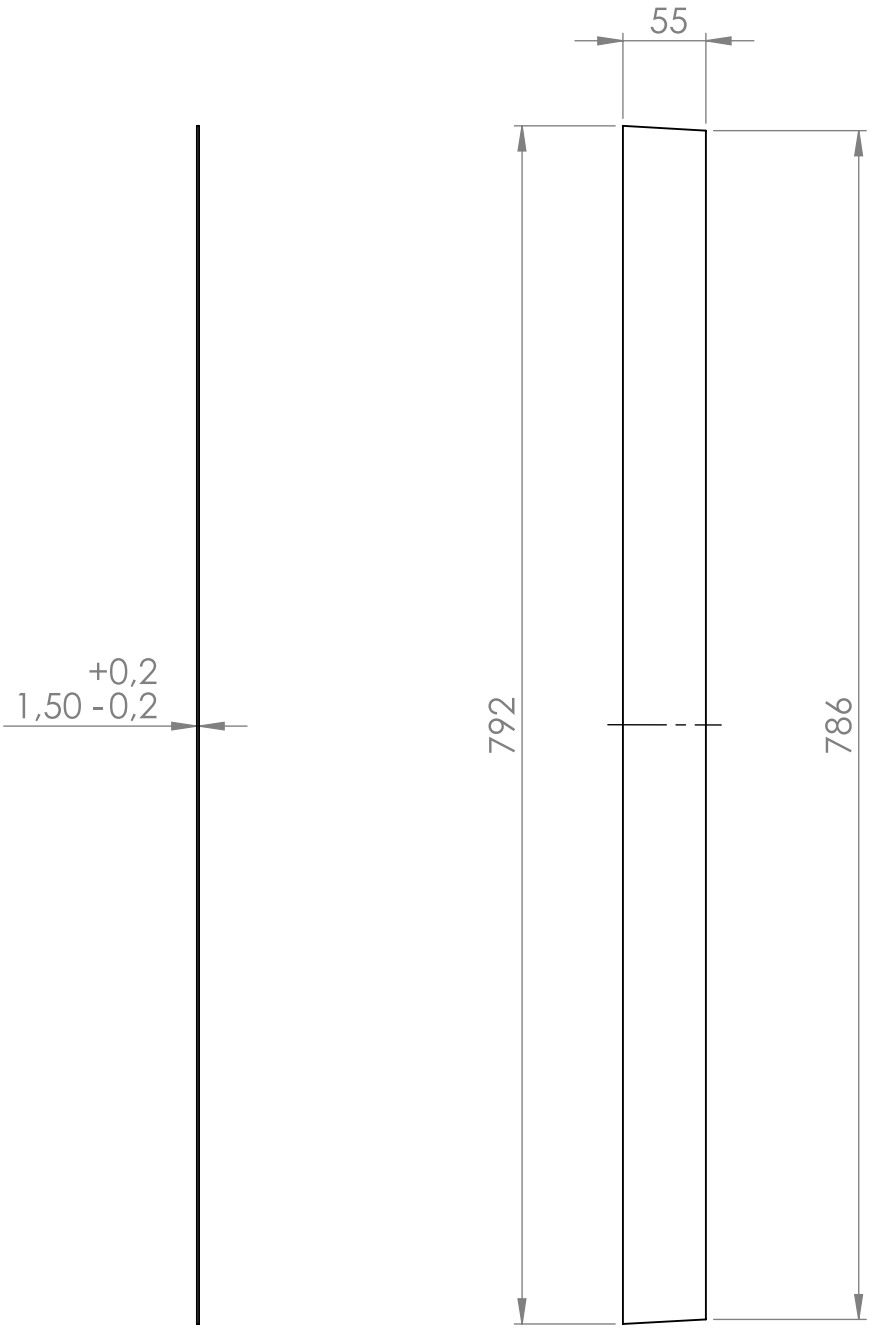
Comments:	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Lid-Flange-Longside	
		Project name: A Plastic Plate Press for Low resource settings	
	Deburr and break sharp edges	Drawing no. 1.2.1	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:5	DO NOT SCALE DRAWING / Sheet 1 of 1



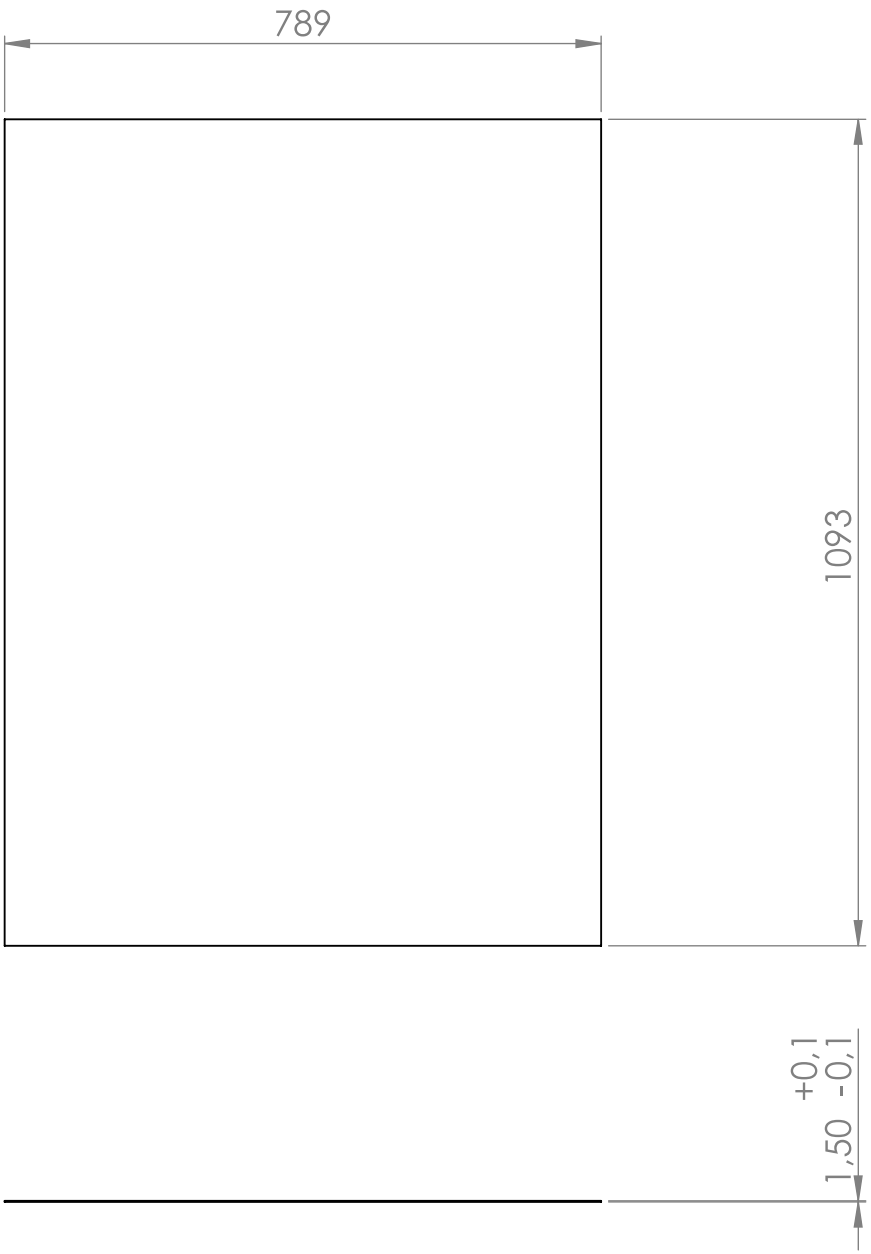
Comments:	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Lid-Flange-shortside	
		Project name: A Plastic Plate Press for Low resource settings	
	Deburr and break sharp edges	Drawing no. 1.2.2	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:5	DO NOT SCALE DRAWING / Sheet 1 of 1



Comments:	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Lid-Wall-Longside	
		Project name: A Plastic Plate Press for Low resource settings	
	Deburr and break sharp edges	Drawing no. 1.2.3	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:5	DO NOT SCALE DRAWING / Sheet 1 of 1



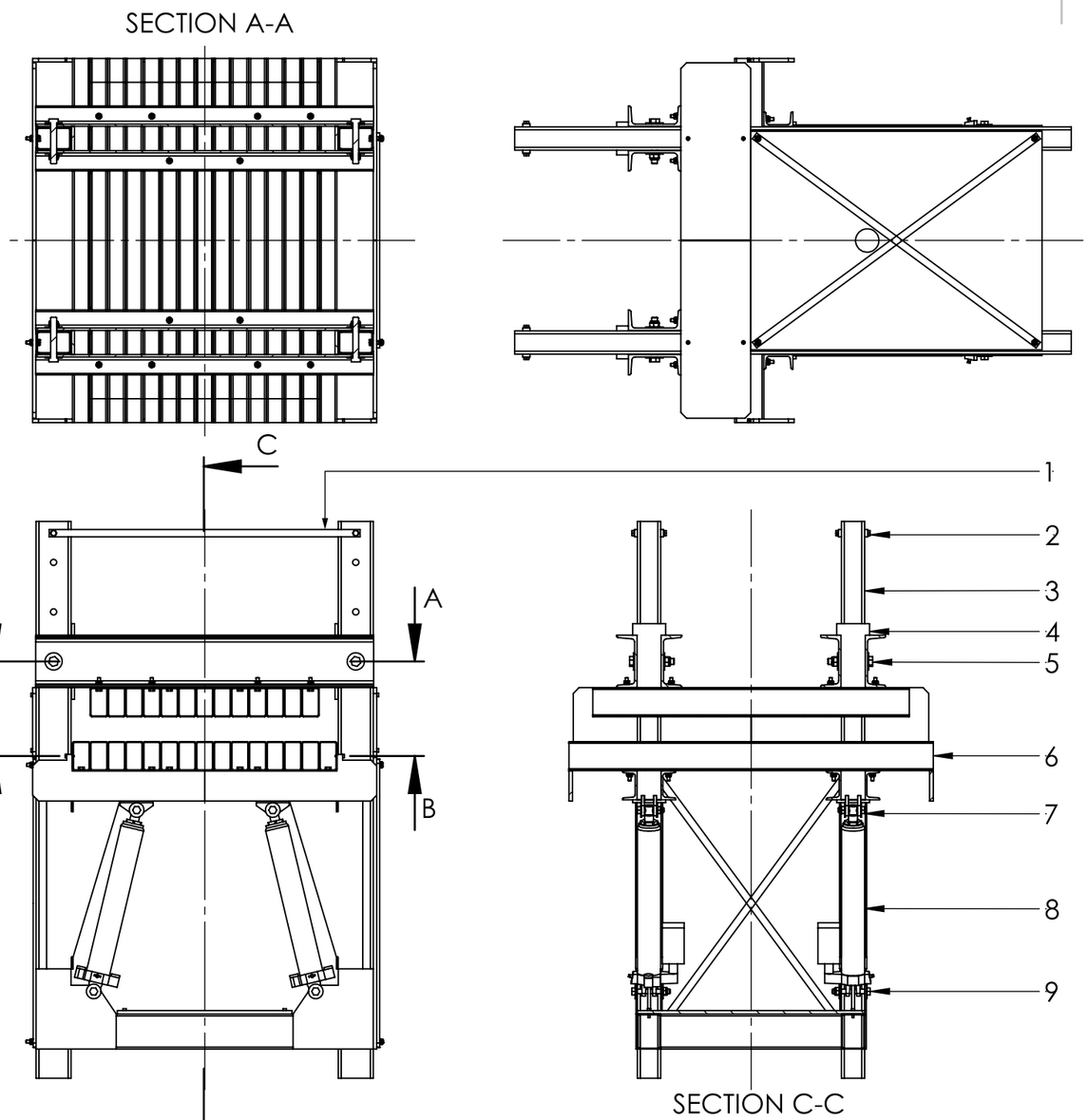
Comments:	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Lid-Wall-shortside	
		Project name: A Plastic Plate Press for Low resource settings	
	Deburr and break sharp edges	Drawing no. 1.2.4	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:5	DO NOT SCALE DRAWING / Sheet 1 of 1

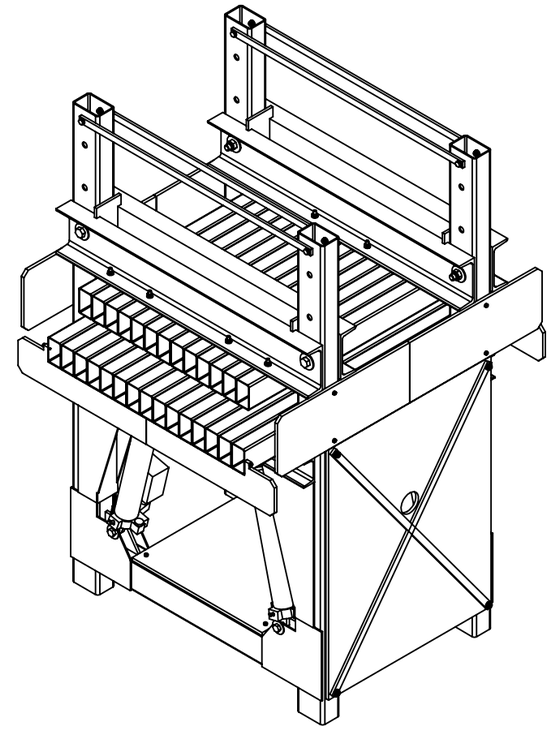


Comments:	Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
		Title: Mould-Lid_Base-Plate	
		Project name: A Plastic Plate Press for Low resource settings	
	Deburr and break sharp edges	Drawing no. 1.2.5	A4
Material: Steel	Finish: Untreated (No rust)	Scale: 1:10	DO NOT SCALE DRAWING / Sheet 1 of 1

A.22. TECHNICAL DRAWING SET: PLATE PRESS

A.22.1. PLASTIC-PLATE-PRESS-ASSEMBLY





ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Top Scaffold		4
2	M10 x 30 , rings and nylon nut		8
3	Frame assembly		1
4	Top press-bed		1
5	M20x 140, rings and nylon nut		4
6	bottom press-bed		1
7	M16x80, rings and nylon nut		4
8	8 ton hydraulic pneamatic long ram jack main body		4
9	M16x120, rings and nylon nut		4

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title:
Plastic-Plate-Press_Assembly

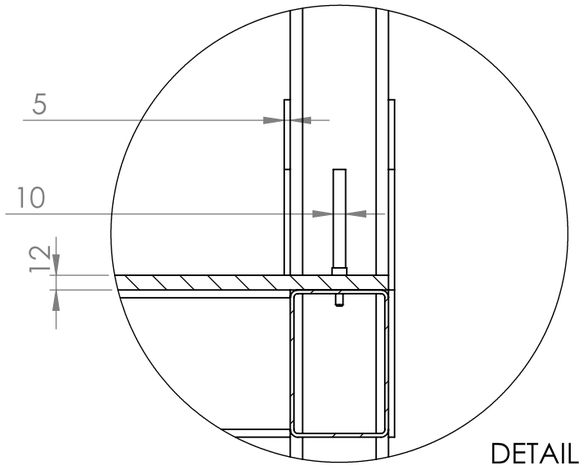
Project name: A Plastic Plate Press for Low resource settings

Drawing no. 2.

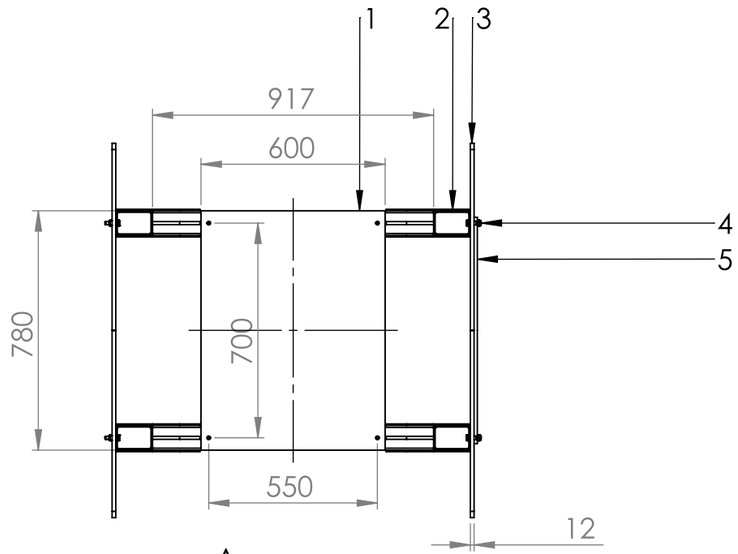
A3

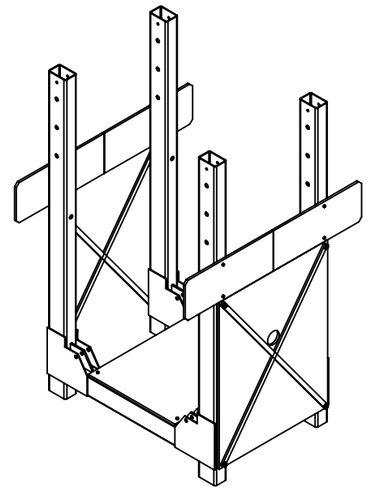
Scale: 1:20 | DO NOT SCALE DRAWING | Sheet 1 of 1

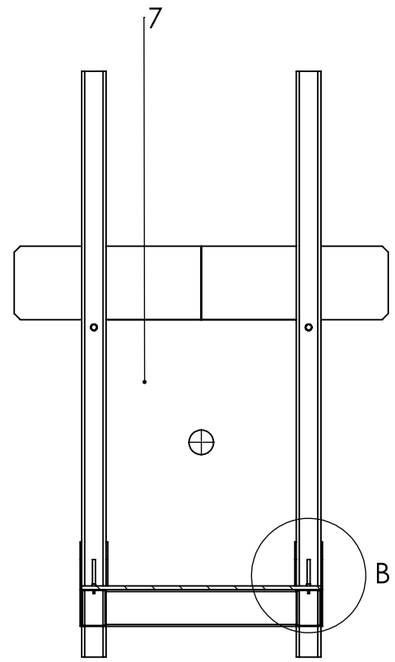
A.22.2. PRESS FRAME ASSEMBLY



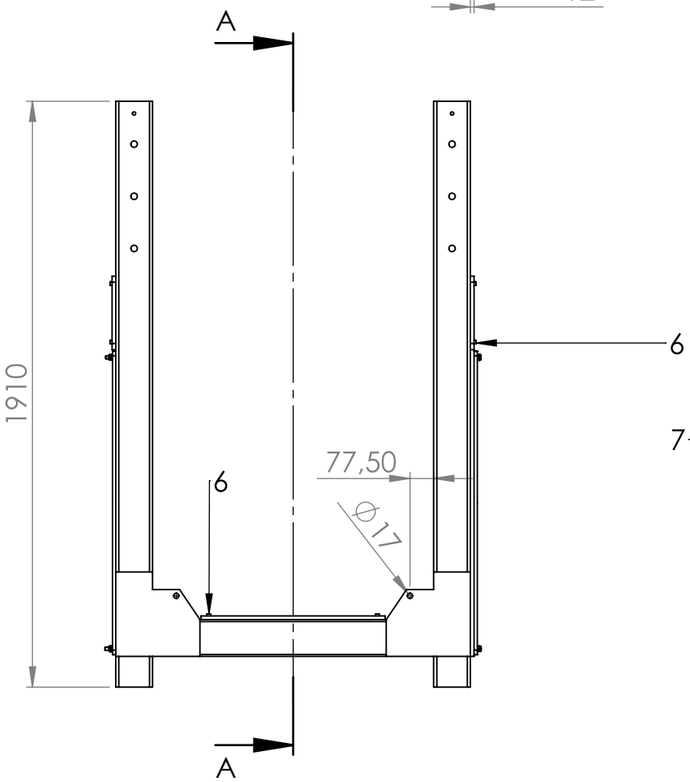
DETAIL B
SCALE 1 : 5

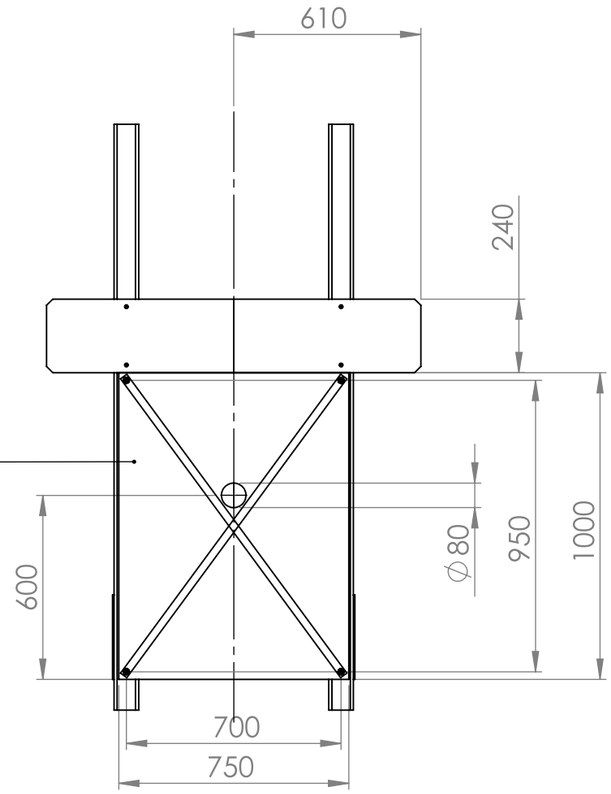






SECTION A-A





No.	Description	Draw. no.	QTY.
1	Plastic Plate cutout #1, T12mm	-	1
2	Press_Frame_Weld-Assembly	2.1.1	1
3	Plastic Plate cutout #2, T12mm	-	4
4	M10 x 40, rings and Nylon nut	-	8
5	Steel rod 10x20x1075	-	4
6	M6 x 25	-	12
7	Plastic Plate cutout #3, T12mm	-	1

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title:
Press_Frame_Assembly

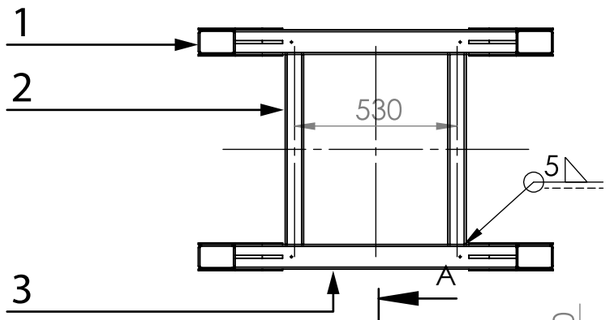
Project name: A Plastic Plate Press for Low resource settings

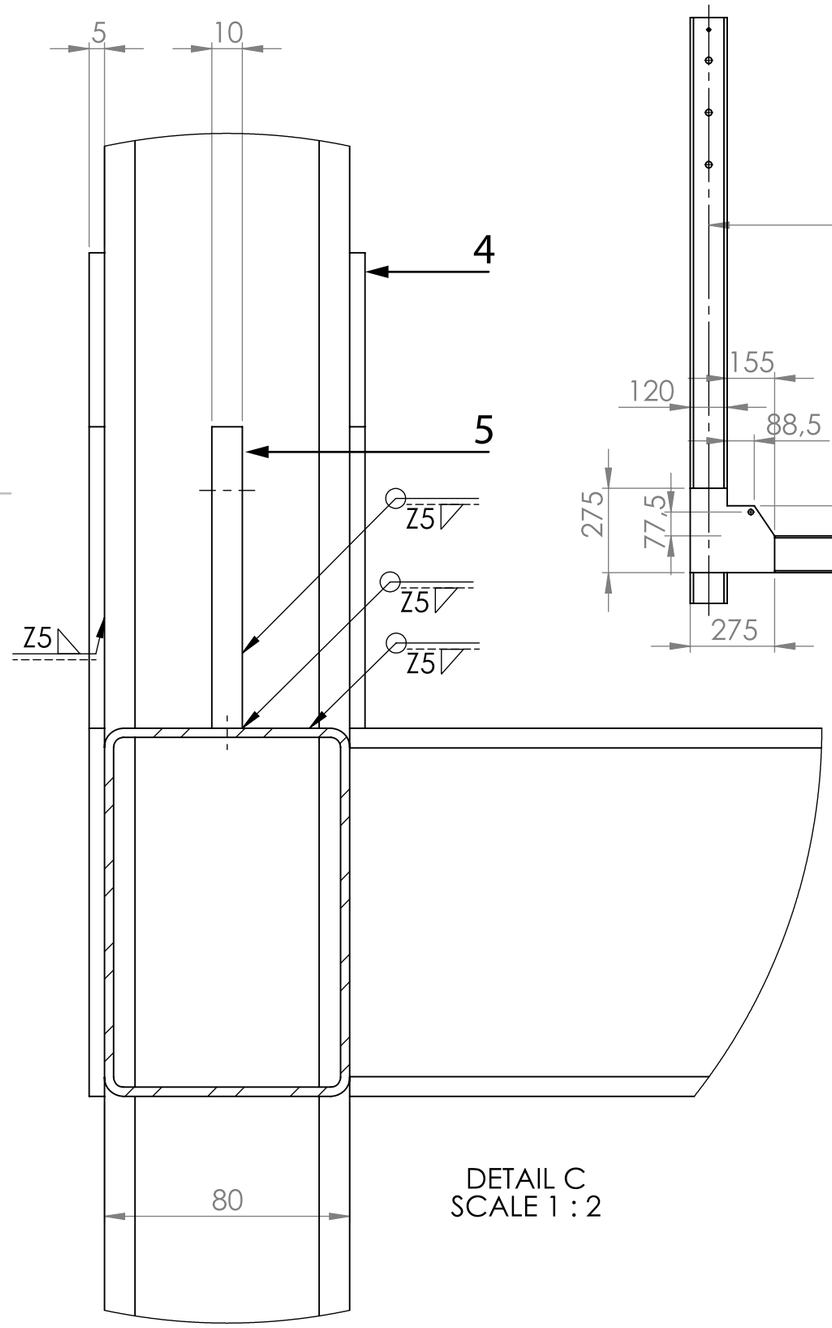
Drawing no. 2.1

A3

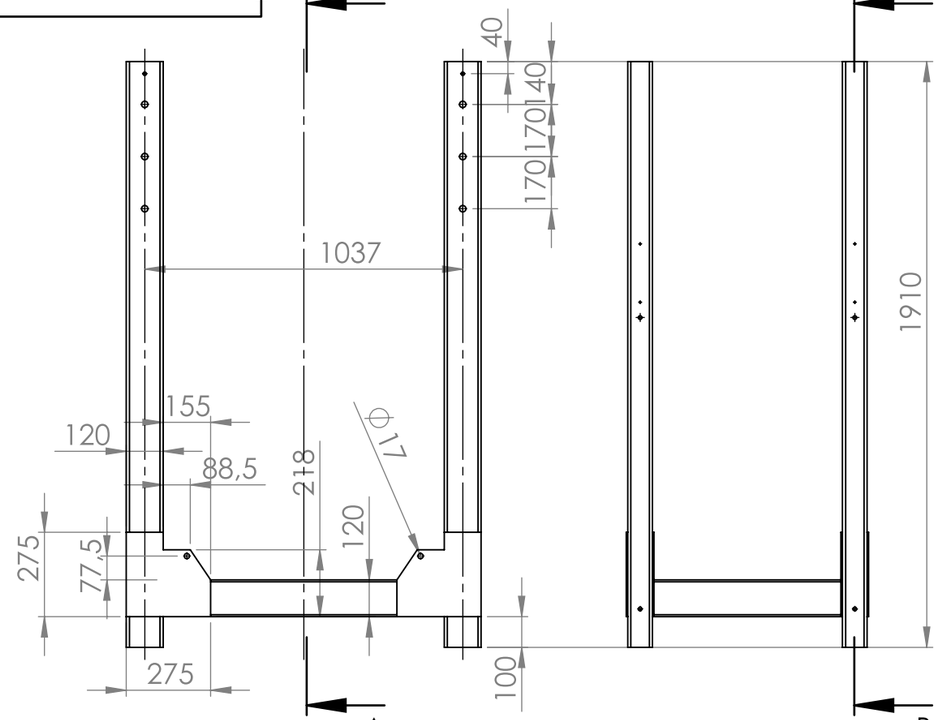
Scale: 1:20 | DO NOT SCALE DRAWING | Sheet 1 of 1

A.22.3. PRESS FRAME WELD-ASSEMBLY

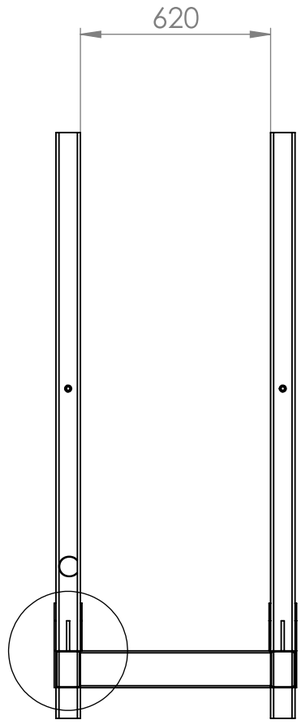


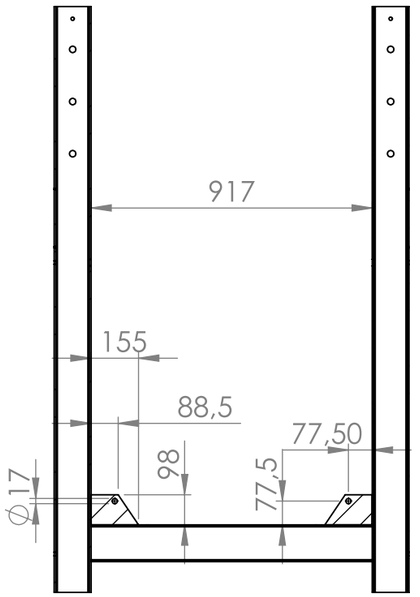


DETAIL C
SCALE 1 : 2



SECTION A-A





SECTION B-B

Item No.	Description	Length	QTY.
1	Steel section 120 x 80 x 5.0	1910	4
2	Steel section 120 x 60 x 3.0	620	2
3	Steel section 120 x 80 x 3.0	917	2
4	Steel plate cutout T5mm	-	8
5	Steel plate cutout T10mm	-	4

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach

Commissioned by The MMID Foundation

Title:
Press_Frame_Weld-Assembly

Project name: A Plastic Plate Press for Low resource settings

Drawing no. 2.1.1

A3

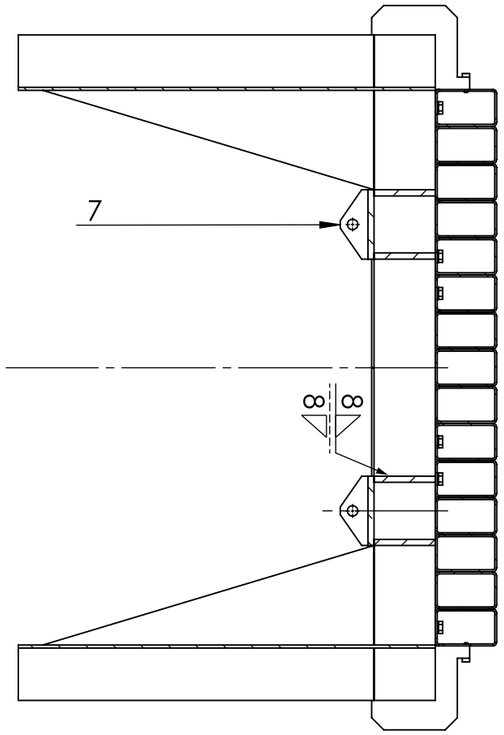
Scale: 1:20

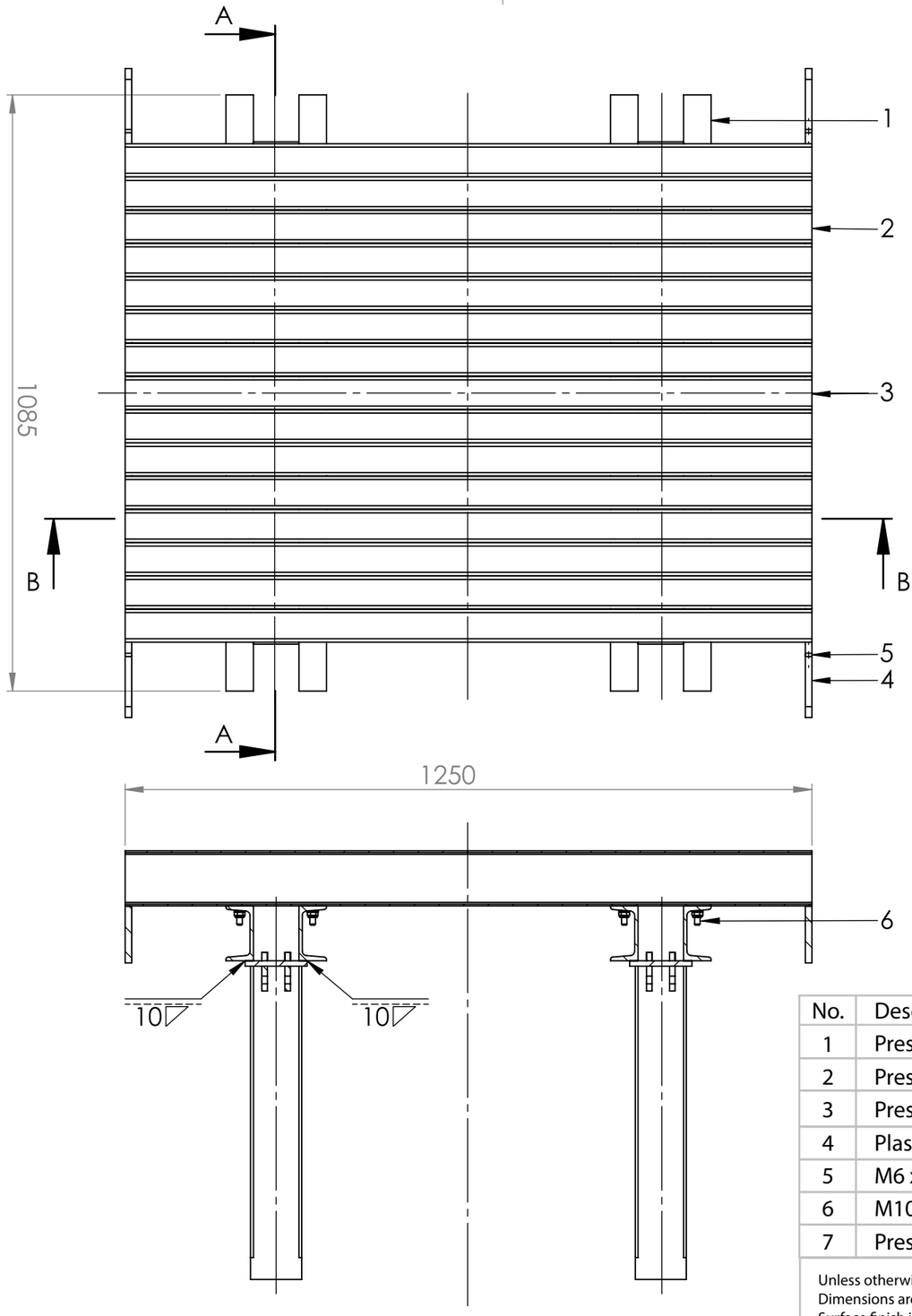
DO NOT SCALE DRAWING

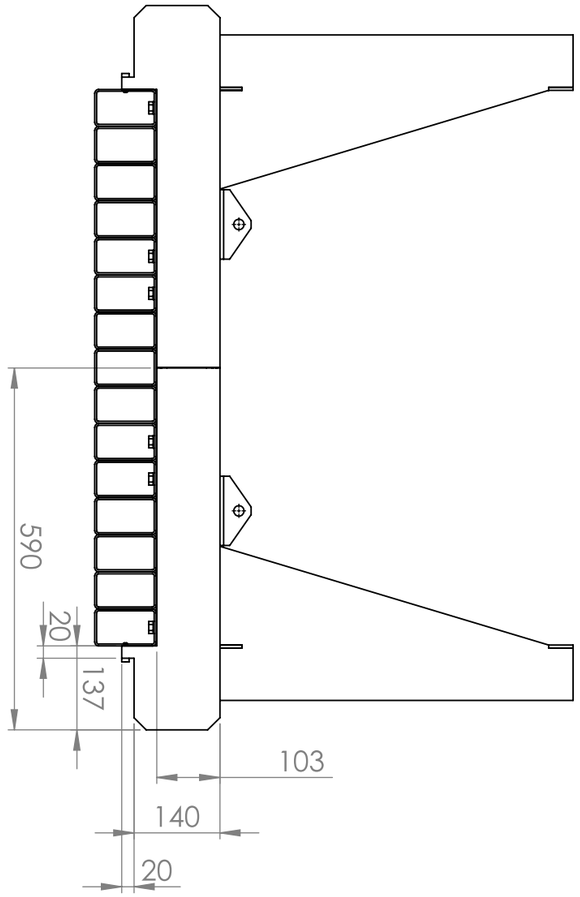
Sheet 1 of 1

A.22.4. PRESS BOTTOM-PRESS-BED ASSEMBLY

SECTION A-A







SECTION B-B

No.	Description	Draw. no.	QTY.
1	Press_Bottom-Press-Bed_Legs_Weld-Assembly	2.2.1	2
2	Press_Bottom-Press-Bed_Flatbed-side_Weld-Assembly	2.2.2	2
3	Press_Bottom-Press-Bed_Flatbed-Mid_Weld-Assembly	2.2.3	1
4	Plastic Plate Cutout T12mm	-	4
5	M6 x 25, rings and nylon nut	-	4
6	M10 x 40, rings and nylon nut	-	12
7	Press_Bottom-Press-Bed_Jack-Hand_Weld-Assembly	2.2.4	4

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title:
Press_Bottom-Press-Bed_Assembly

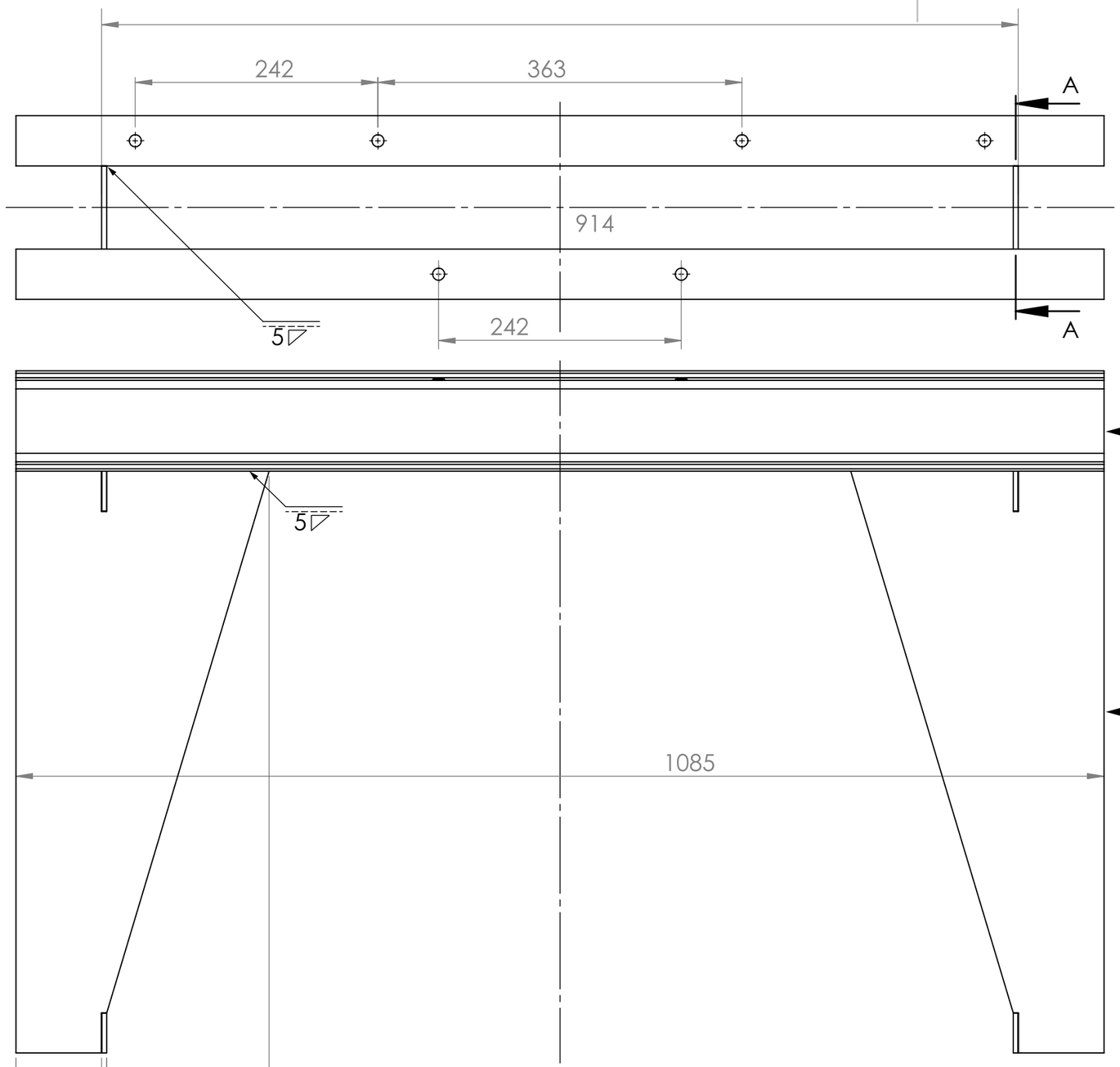
Project name: A Plastic Plate Press for Low resource settings

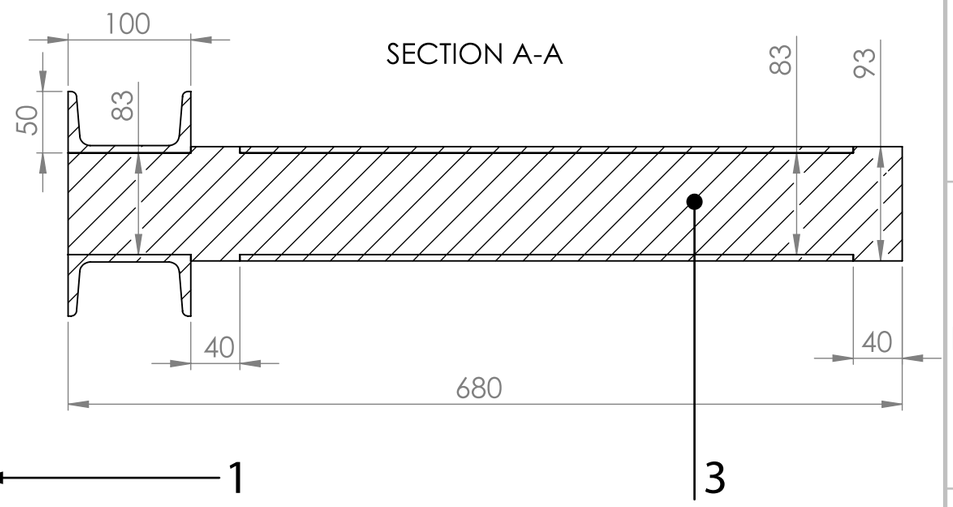
Drawing no. 2.2

A3

Scale: 1:10 | DO NOT SCALE DRAWING | Sheet 1 of 1

A.22.5. PRESS BOTTOM-PRESS-BED LEGS WELD-ASSEMBLY





Item No.	Description	Length	QTY.
1	UNP 100	1085	2
2	Steel plate cutout #1, T5mm	620	4
3	Steel plate cutout #2, T5mm	917	2

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

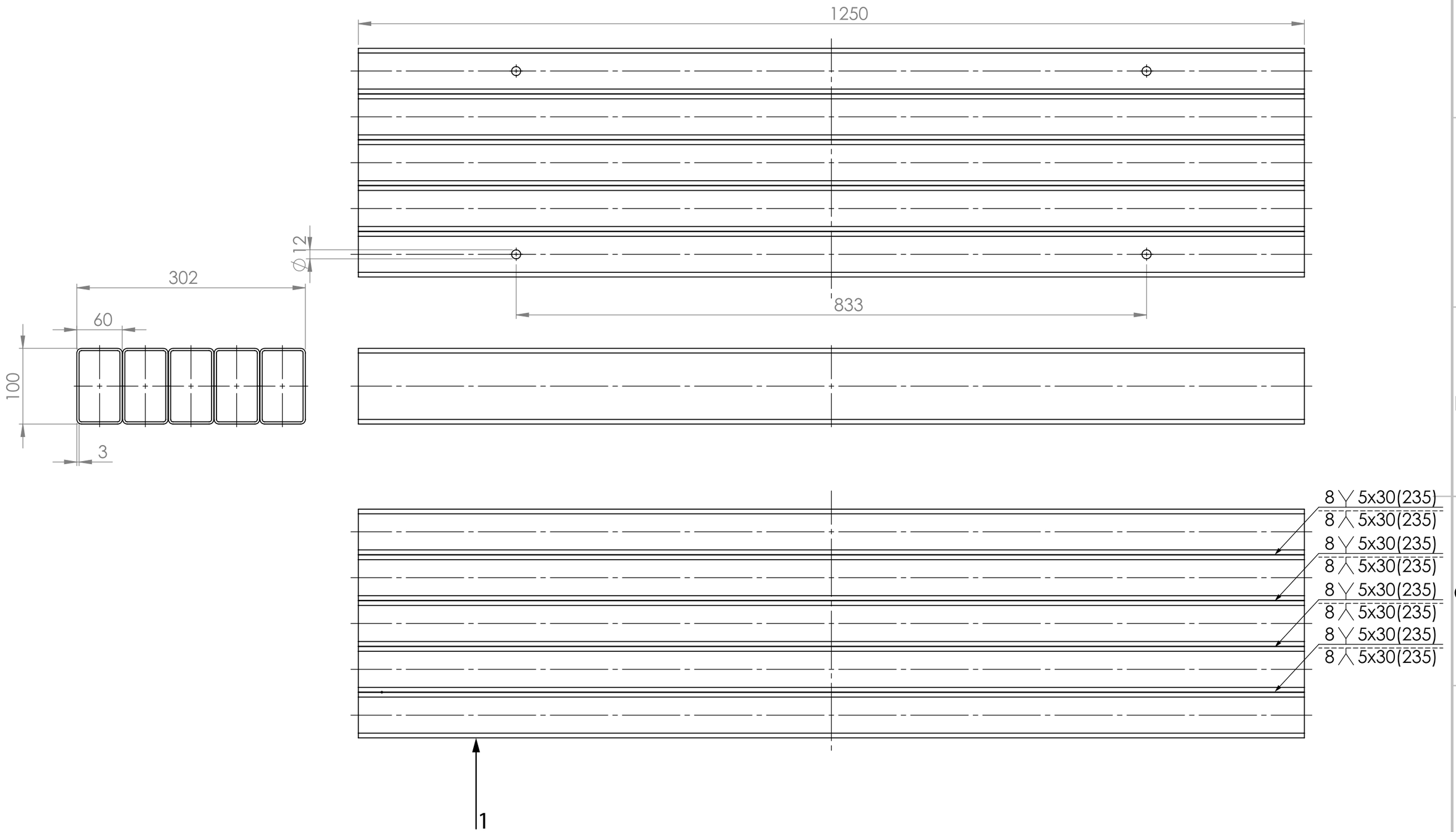
Title:
Press_Bottom-Press-Bed_Legs_Weld-Assembly

Project name: A Plastic Plate Press for Low resource settings

Drawing no. 2.2.1 | A3

Scale: 1:5 | DO NOT SCALE DRAWING | Sheet 1 of 1

A.22.6. PRESS BOTTOM-PRESS-BED FLATBED-SIDE WELD-ASSEMBLY



Item No.	Description	Length	QTY.
1	Steel section 100 x 60 x 3.0	1250	4

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title:
Press_Bottom-Press-Bed_Flatbed-side_Weld-Assembly

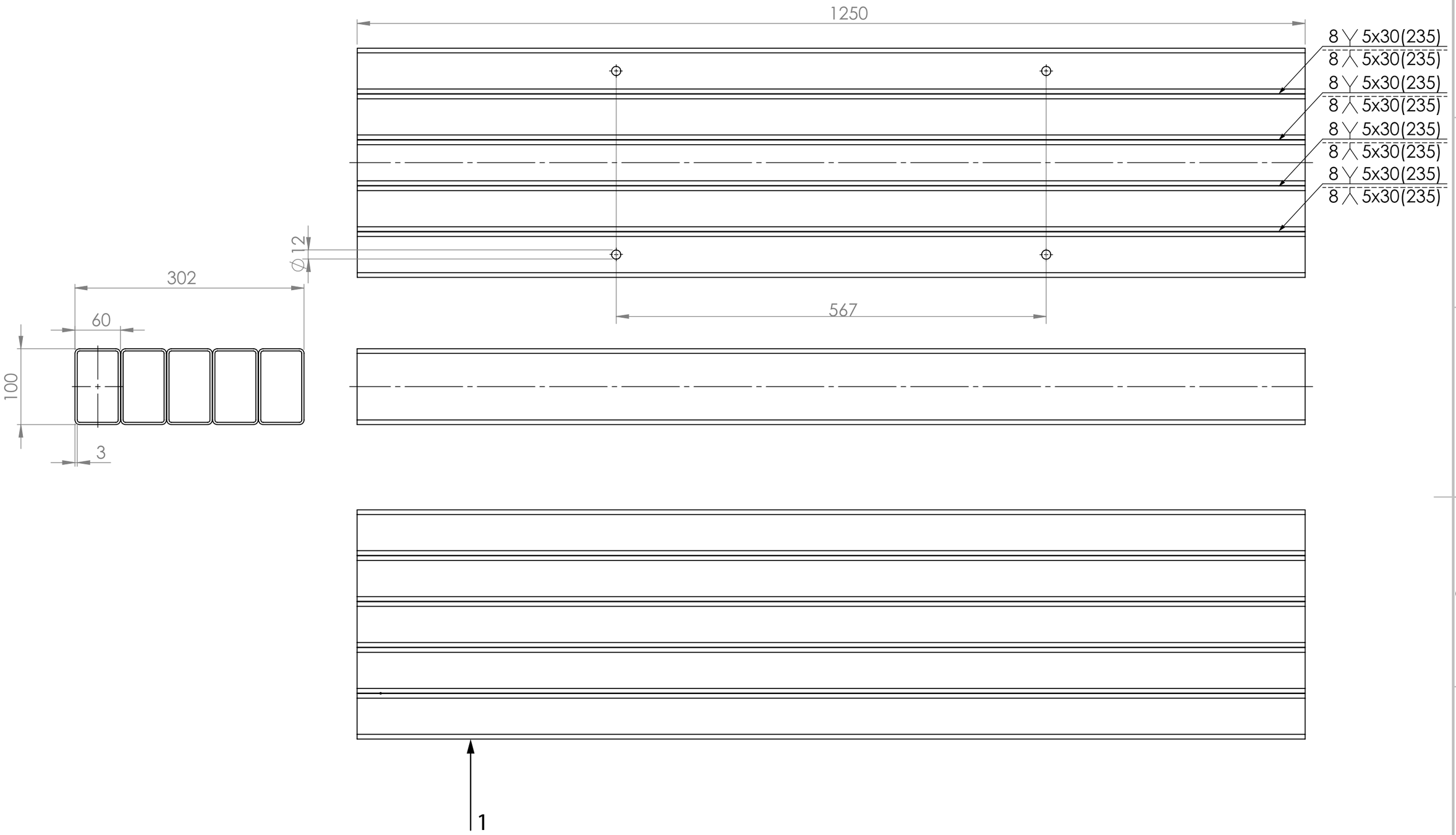
Project name: A Plastic Plate Press for Low resource settings

Drawing no. 2.2.2

A3

Scale: 1:5 | DO NOT SCALE DRAWING | Sheet 1 of 1

A.22.7. PRESS BOTTOM-PRESS-BED FLATBED-MID WELD-ASSEMBLY



Item No.	Description	Length	QTY.
1	Steel section 100 x 60 x 3.0	1250	4

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title:
Press_Bottom-Press-Bed_Flatbed-mid_Weld-Assembly

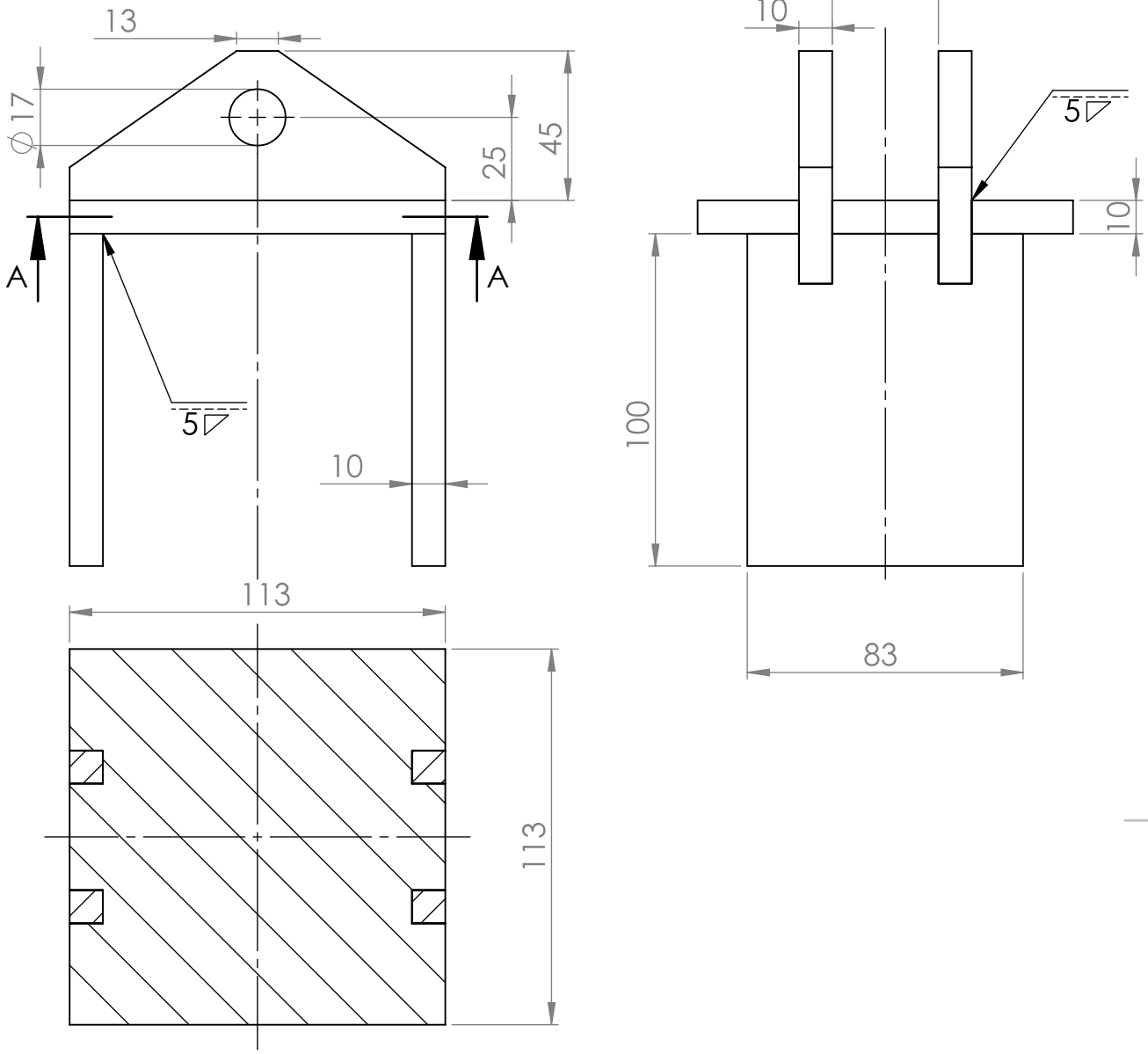
Project name: A Plastic Plate Press for Low resource settings

Drawing no. 2.2.3

A3

Scale: 1:5 | DO NOT SCALE DRAWING | Sheet 1 of 1

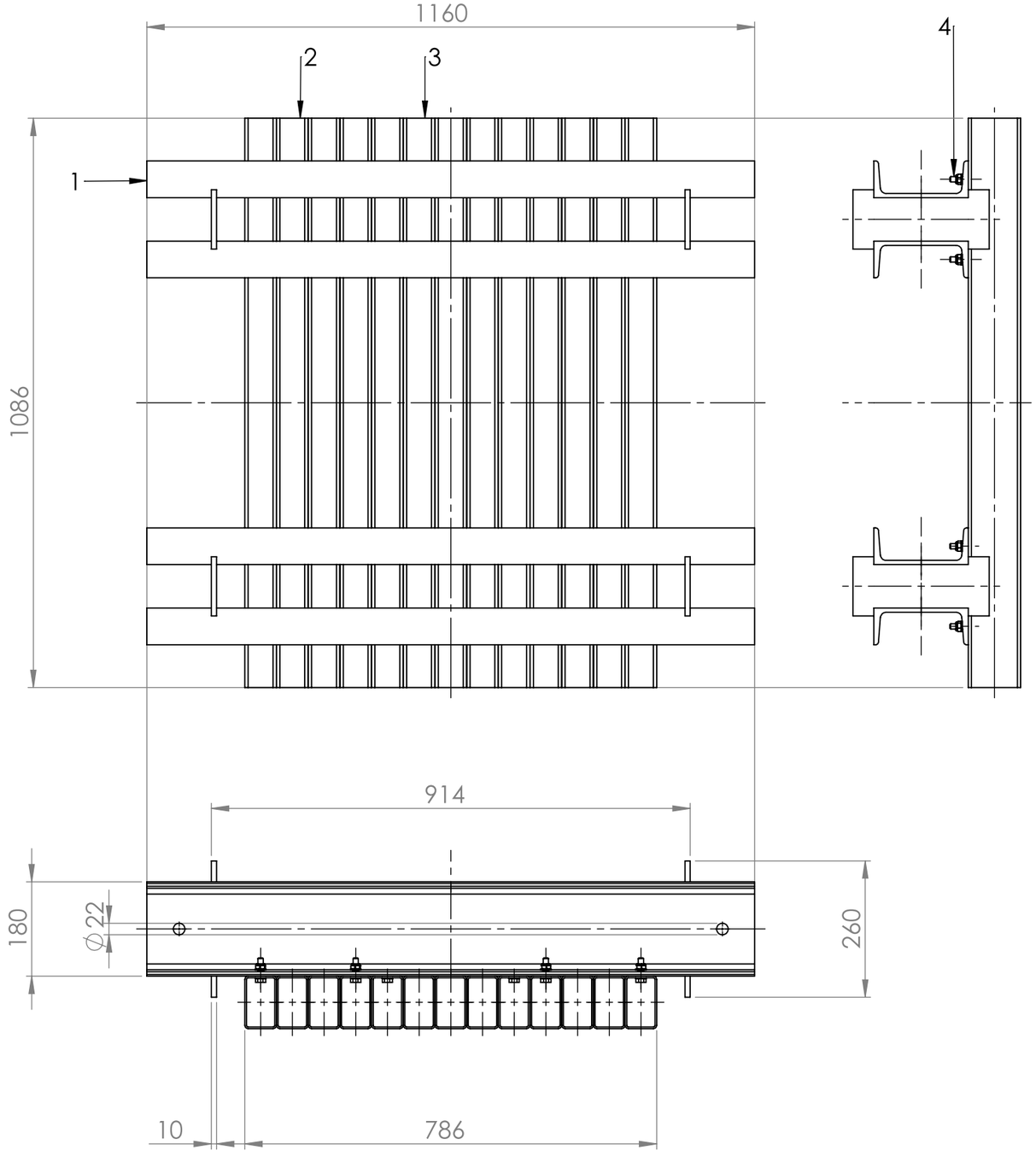
A.22.8. PRESS BOTTOM-PRESS-BED JACK-HAND WELD-ASSEMBLY

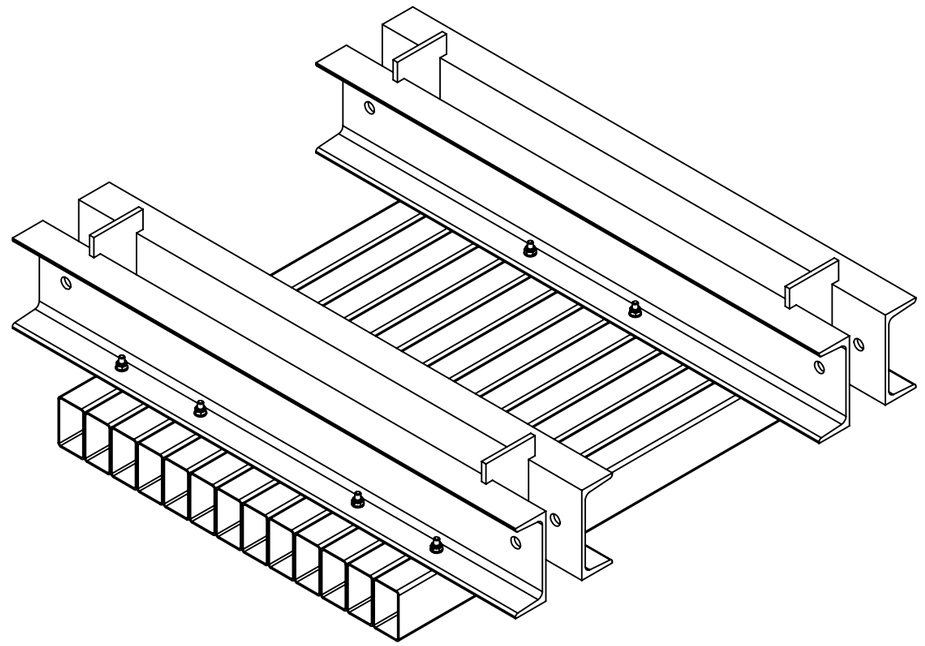


SECTION A-A

Unless otherwise specified: Dimensions are in millimeters Surface finish is untreated Tolerances are +/- 1mm Angles are in degrees	Drawn by Mark Bachrach	Commissioned by The MMID Foundation
	Title: Press_bottom-Press_jack-Hand_Weld-Assembly	
	Project name: A Plastic Plate Press for Low resource settings	
Deburr and break sharp edges	Drawing no. 2.2.4	A4
Finish:	Scale: 1:2 DO NOT SCALE DRAWING	Sheet 1 of 1

A.22.9. PRESS TOP-PRESS-BED ASSEMBLY





Item No.	Description	Draw. no.	QTY.
1	Press_Top-Press-Bed_Beam_Weld-Assembly	2.3.1	1
2	Press_Top-Press-Bed_Flatbed-side_Weld-Assembly	2.3.2	2
3	Press_Top-Press-Bed_Flatbed-Mid_Weld-Assembly	2.3.3	1
4	M10x 40, Rings and Nylon nut	-	12

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title:
Press_Top-Press-Bed_Assembly

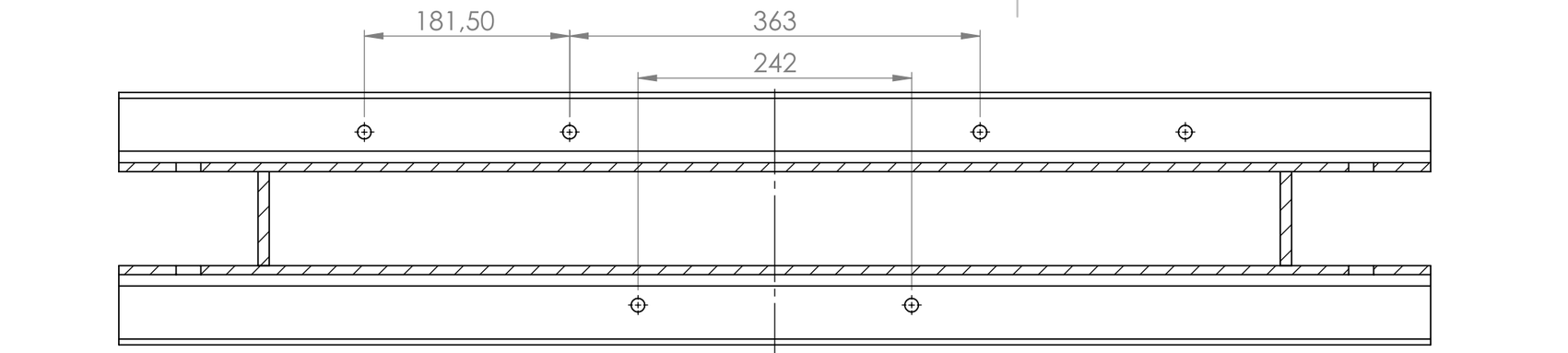
Project name: A Plastic Plate Press for Low resource settings

Drawing no. 2.3

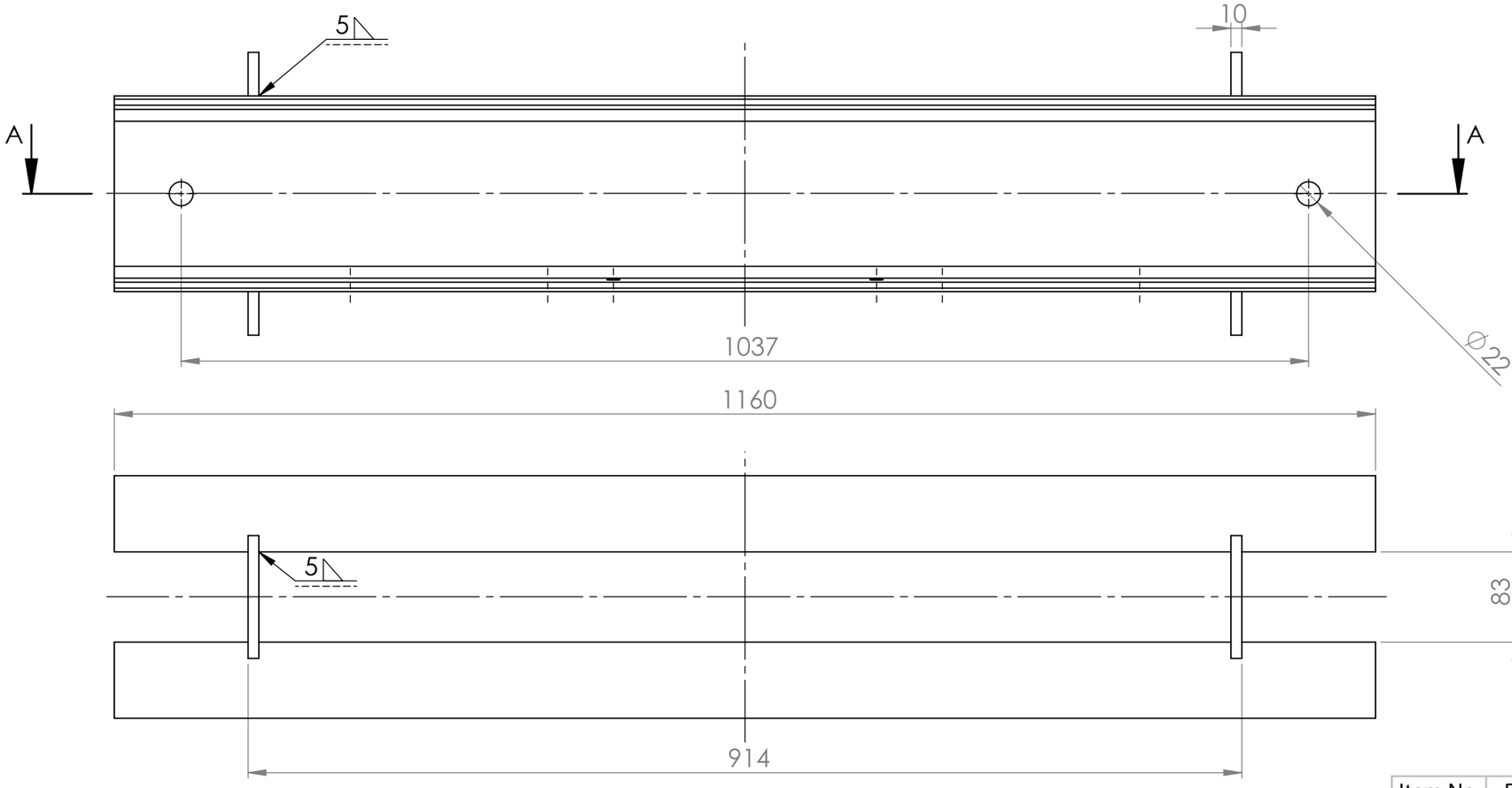
A3

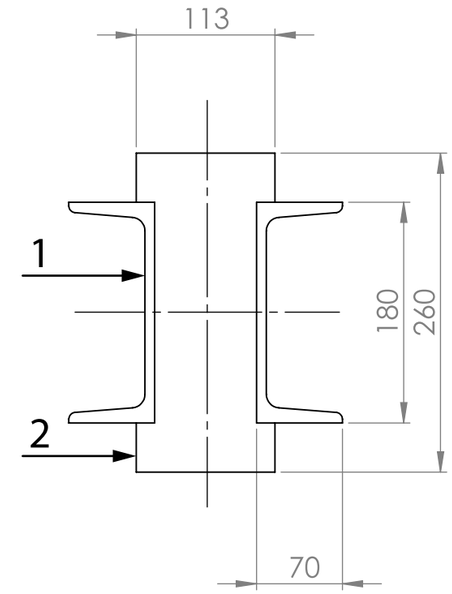
Scale: 1:10 | DO NOT SCALE DRAWING | Sheet 1 of 1

A.22.10. PRESS TOP-PRESS-BED BEAM WELD-ASSEMBLY



SECTION A-A





Item No.	Description	Length	QTY.
1	UNP 180	1160	2
2	Steel plate cutout T10mm	-	2

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title:
Press_TOp-Press-Bed_Beam_Weld-Assembly

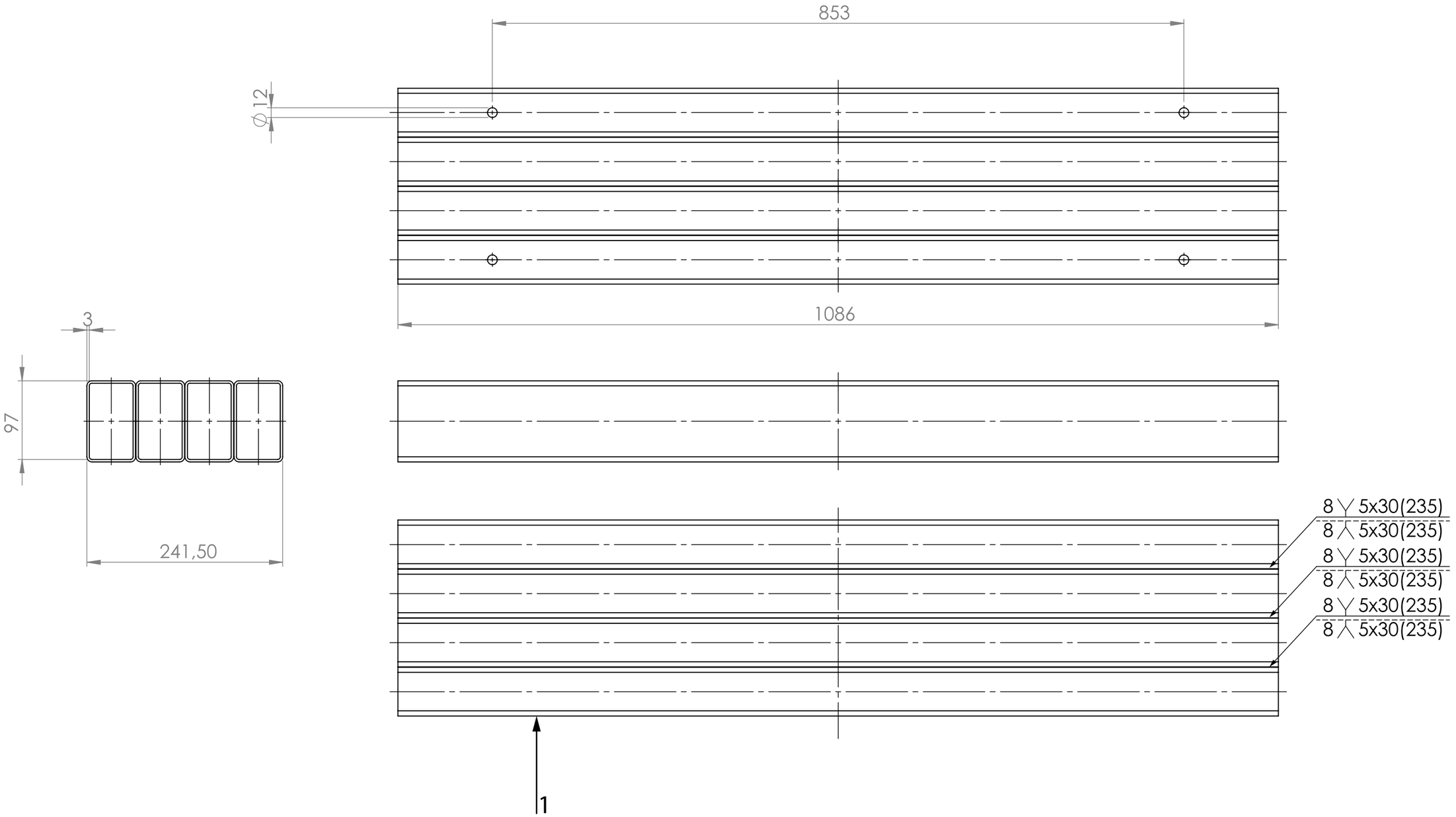
Project name: A Plastic Plate Press for Low resource settings

Drawing no. 2.3.1

A3

Scale: 1:5 | DO NOT SCALE DRAWING | Sheet 1 of 1

A.22.11. PRESS TOP-PRESS-BED FLATBED-SIDE WELD-ASSEMBLY



Item No.	Description	Length	QTY.
1	Steel section 100 x 60 x 3.0	1086	4

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title:
Press_Top-Press-Bed_flatbed-side_Weld-Assembly

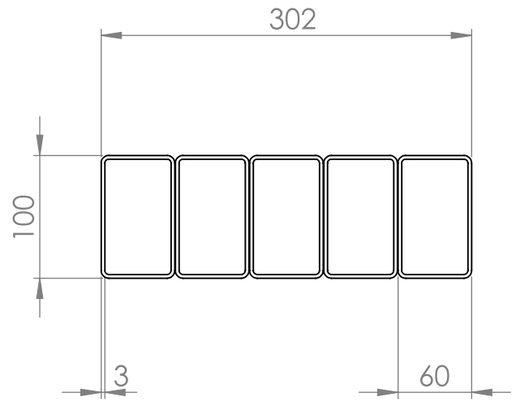
Project name: A Plastic Plate Press for Low resource settings

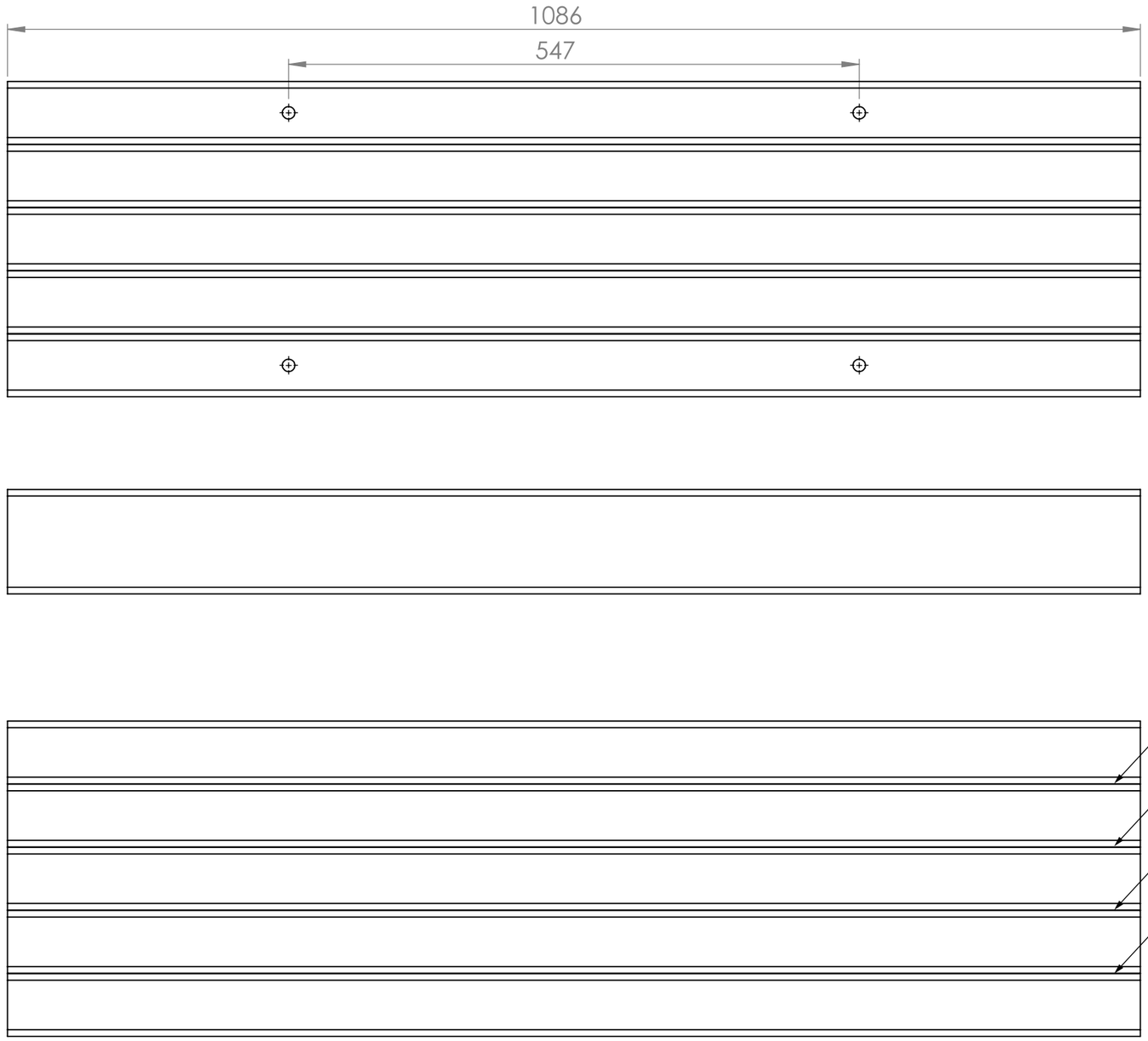
Drawing no. 2.3.2

A3

Scale: 1:5 | DO NOT SCALE DRAWING | Sheet 1 of 1

A.22.12. PRESS TOP-PRESS-BED FLATBED-MID WELD-ASSEMBLY





Item No.	Description	Length	QTY.
1	Steel section 100 x 60 x 3.0	1086	4

Unless otherwise specified:
Dimensions are in millimeters
Surface finish is untreated
Tolerances are +/- 1mm
Angles are in degrees

Deburr and break sharp edges

Finish:

Drawn by Mark Bachrach | Commissioned by The MMID Foundation

Title:
Press_Top-Press-Bed_flatbed-Mid_Weld-Assembly

Project name: A Plastic Plate Press for Low resource settings

Drawing no. 2.3.3

A3

Scale: 1:5 | DO NOT SCALE DRAWING | Sheet 1 of 1

Master Thesis - Appendix

“A locally producible plastic plate press for bottom-up recycling in low-resource settings”

A design assignment commissioned by
The MMID Foundation

Graduate student
Mark Bachrach

Delft, Juli 2018

Delft University of Technology
Faculty of Industrial Design Engineering
Master Integrated Product design