Nonlinear finite element modelling of a simply supported beam at ambient temperature and under fire



Bachelor's thesis

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ABSTRACT

The primary purpose of this Bachelor's thesis was to develop a finite element model of simply supported IPE beam with nonlinear behaviour material definition, which can numerically simulate the structural response of IPE beam and replicate the simulation results with the physical lab test under mid-span loading by using FEA techniques in LS-DYNA. Mesh sensitivity analysis, structure only the analysis of IPE in a fire, implicit and explicit static analysis was also performed in LS-DYNA. Seven finite element models of simply supported IPE beam were created, and simulation was run in LS-DYNA.

The thesis presents the finite element modelling of a simply supported beam to examine the deformations, mesh sensitivity analysis, load versus displacement curve with explicit and implicit code, deformation in the fire of the steel IPE beam under mid-span loading. In addition, a detailed description of the numerical simulations and the theoretical background are presented in this thesis. The theoretical part of the thesis includes the general description of the finite element method; numerical method; input possible in LS-DYNA; the manual calculation of time-step; the detailed temperature calculation of unprotected steel IPE beam in a fire; LS-DYNA, and its history.

Findings revealed that LS-DYNA was able to replicate the simulation results with the physical lab test under mid-span loading, although there was a huge difference in load versus displacement curve between the LS-DYNA simulation and experimental results. Lateral torsional buckling failure was noticed on the structure with and without fire in both cases, during numerical simulation in LS-DYNA. The maximum effect of loading was observed in the mid-span of a beam by the local deformation in the upper flange of the structure.

 Keywords LS-Dyna, LS-PrePost, FE modelling, Nonlinear analysis, Explicit code, Implicit code, structural analysis in a fire, mesh sensitivity analysis, temperature calculation.
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Symbols and Abbreviations

- CAD Computer-Aided Design
- CFL Courant-Friedrichs-Lewy
- DEM Discrete Element Method
- DOF Degree of Freedom
- FEM Finite Element Method
- MPP Massively Parallel Processing
- SMP Shared Memory Parallel
- FEA Finite Element Analysis

Latin Letters

A	Area of the element
с	Speed of sound
E	Elastic modulus
f	Time step safety factor
L	Shell dimension
Δt	Time step, time interval.
К	Total heat transfer coefficient
A _m	Perimeter surface area per unit length exposed to fire
Q_{f}	Temperature of hot gases.
Qs	Temperature of steel during the time interval.
Q _{cr}	Critical temperature
α _c	Heat transfer coefficients for convection
α _r	Heat transfer coefficients for radiation
ε _r	Resultant emissivity of the flames
A _m /V	Section factor for unprotected steel members
C _i	Protection coefficient of member's face I
Ea	Modulus of elasticity of steel for nominal
	temperature design
V	Volume of a member per unit length
fy	Yield strength at 20°C
f _{y,θ}	Effective yield strength of steel at elevated
	temperature
f _{p,θ}	Proportional limit for steel at elevated
•	temperature
$f_{u,\theta}$	Ultimate strength at elevated temperature
h _{net,d}	Design value of the net heat flux per unit area
k _{sh}	Correction factor for the shadow effect

Greek letters

Y	Shear strain
ρ	Density
Φ	Configuration factor
8	Strain
σ	Stress
α	Convective heat transfer coefficient
ε _f	Emissivity of the fire
ε _{z,m}	Total emissivity of the flame
θ	Temperature
θ_a	Steel temperature

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1 INTRODUCTION

1.1 Background

Finite element method (FEM) is a mathematical computer-based numerical technique for calculating the strength and behaviour of engineering structures. The development of finite element analysis (FEA) software tools make it easy to analyse dynamic loads, static loads, structural fire and blast loads et cetera. Structures subjected to extreme loads, including fire loads, blast loads are challenging to study experimentally, and the evaluation of the damages caused by loads is hard to conduct, expensive and dangerous.

Using FEA software in predicting damages and replicating the physical lab test caused by different loads (static, dynamic, blast, fire) in the structures is widely used in modern engineering analysis. It is because of the variety of material models, the ease of accessing them and changing parameters, the ability to simulate problems that are difficult to conduct in laboratories, the costless efforts compared to laboratories, and the safety of using FEA software. There are many FEA software tools available for nonlinear static analysis, but for this thesis, LS-DYNA software is used. (Younis, 2010, p.4)

Nonlinear analysis is an analysis which uses nonlinear material and geometrical behaviour for performance evaluation of structural systems at the life safety and collapse prevention levels. In the modern product design engineering, it is important to understand the sources of nonlinearities and their effect on designs during their lifetime for a better performance and durability of the product. With the help of nonlinear fem simulation solutions, we can simulate product behaviour accurately, reducing the possible failures, warranty costs and saving on material costs. (Krawinkler, 2007)

Computational tools are often necessary for the safe design of structures under fire conditions due to the complex structure's response. In recent years, the use of the finite element code in LS-DYNA has increased in research and industry for structural fire analysis. The nature of isolated structural elements under standard fire conditions through furnace testing has been extensively studied.

(Rackauskaite et al., 2017)

The purpose of this thesis is to develop a finite element modelling of steel IPE beam for nonlinear static analysis at both ambient and elevated temperatures. To achieve this, the FEM software LS-DYNA was used for nonlinear static analysis of structures in three dimensions using implicit and explicit solvers.

1.2 Aim and objectives

The aim of this thesis is to develop a nonlinear FE model, numerically simulate the structural response of simply supported IPE steel beam, compare the simulation results with the physical lab test under point load by using FEA techniques in LS-DYNA.

The following objectives are set to achieve the aim of the study:

- 1. To develop an FEA model to simulate steel IPE beam under point load in LS-DYNA to replicate lab test.
- To perform a mesh sensitivity analysis from four different element sizes of 2mm, 4mm, 6mm and 8mm meshing using implicit code and 6mm, 8mm, 12mm and 14mm meshing using explicit code.
- 3. To develop an FEA model to simulate the structural response of IPE beam in a fire, heated from four sides in an unprotected IPE beam.
- 4. Manual calculation of the temperature of carbon steel in unprotected IPE beam using Eurocode.
- 5. To compare the load versus displacement curve from the lab test and the numerical simulation.
- 6. Running the finite element model with implicit and explicit solvers in LS-DYNA.

1.3 Methodology

To complete this study and meet the objectives set first publications and studies were conducted on nonlinear analysis, FEA, LS-DYNA, Fire design, static analysis, explicit analysis and implicit analysis in LS-DYNA. Also, LS-DYNA software and material model definition for steel were explored in detail including videos about the LS-DYNA and successfully running them in LS-DYNA Manager.

Calculation of material definition for steel based on Eurocode were completed in excel sheet. Modelling was carried out for the numerical simulation in LS-DYNA. The several approaches involved in solving physical problems by using LS-DYNA are as follows:

-Creating a finite element model in LS-PrePost.

-Choosing material model and properties.

-Assigning material and property.

-Assigning loads and boundary condition.

-Specifying the control parameters. Selecting implicit or explicit solver.

-Creating input files and saving them.

-Running the input files in LS-DYNA manager to get a results output file

-Post-processing the d3plot file in LS-PrePost.

By using the above approaches eleven finite element model was created (four implicit static analysis, five quasi-static explicit analysis and two structure fire analysis) and run successfully in LS-DYNA.

2 THEORETICAL BACKGROUND

LS-DYNA is an advanced multipurpose finite element code for analysing the large deformation with a static and dynamic response of structures. This chapter presents the basic theoretical background for the finite element simulation in LS-DYNA.

2.1 FINITE ELEMENT METHOD

2.1.1 Basic Concept

The finite element method is a numerical method for solving the problems of engineering and mathematical physics. In modern engineering analysis, it is rare to find a project that does not require some types of finite element analysis (FEA). The basic idea in the Finite Element Method (FEM) is to obtain the solution of a complicated problem by analysing the real-life structures into finite pieces. FEM is a numerical or computational technique for solving different complex engineering problems.

FEM can be applied to solving different static and dynamic engineering problems, from stress analysis of simple beam structure or a large, complicated machine to dynamic responses under different mechanical, structural, or thermal loading. In manufacturing, FEA is used in simulation and optimization of manufacturing processes like casting, machining, plastic melding, forging, metal forming, heat treatment and welding etc. Structural, dynamic, thermal, magnetic potential and fluid flow problems can easily be handled accurately by using Finite Element Analysis. (Radhakrishnan., 2008, p.189)

In the finite element method, the boundary and interior of the region are subdivided by lines or surfaces into a finite number of discrete sized subregions or finite elements. Several nodal points are established with the mesh. The size of an element is usually associated with a reference length. Table 1 shows the application of the finite element method. (Akin, 2005, p.6)

Area of Study	Application examples
Solid or Structure mechanics	Structure failure analysis,
	crash simulation, nuclear
	reactor, wind turbine blade
	design, beam and truss
	design, limit load analysis.
Acoustic Conduction	Aerodynamic analysis of cars
	and aeroplane, seepage
	analysis, air conditioning
	modelling of a building.
Heat Conduction	Cooling and casting
	modelling, combustion
	engine, electronic cooling
	modelling.
Electromagnetics	Electromagnetic interference
	suppression analysis, sensor
	and actuator field
	calculations, antenna design
	performance predictions.

Table 1. Application of FEM (Akin, 2005, p.5)

2.1.2 Brief history of FEM

The Finite Element Method was developed originally for the analysis of aircraft structures. Courant first developed the foundation of the FEM in the 1940s (Rao, 2014, p.3). The stiffness matrix for truss, beam and other elements were developed during 1956. Clough created the name 'finite element' presents the application of simple finite elements for the analysis of aircraft structure and is considered as one of the key commitments in the advancement of a finite element method. The digital computer provided a rapid means of performing the many calculations involving the finite element analysis, which made the method practically possible. Several significant developments have emerged in FEM software with the introduction of integrations sensitivity, FEM codes and development of CAD programs to model complex geometry in recent years. Table 2 below summarizes history of finite element modelling from the year 1943 till 2014. (Rao, 2014, p.3)

Year	Major Achievements
1943	Variation method which was the foundation of FEM
1956	Stiffness method for beam and truss
1960	A finite element was created
1967	The first book of FEM by Zienkiewicz and Chung was published
1970	EFM applied to non-linear problems and large
1570	deformation
1970	Digitalization of FEM in computers
1980	Used of GUI and microcomputer
1990	Large structural systems analysis, nonlinear and
	dynamic problems
2000	Multiphysics and complex engineering problems
2014	Advanced FEA tools

Table 2. Summarized history of FEM (Rao, 2014, p.4)

2.1.3 General steps involved in Finite Element Analysis

In the finite element method, the actual body of matter, such as a solid, liquid, or gas, is represented as an assemblage of subdivisions called finite elements. These elements are interconnected at specified joints called nodes or nodal points. The nodes usually lie on the element boundaries where adjacent elements are connected. The general procedure of FEM, which is shown in Figure 1 below, can be summarized as an orderly step by step process with reference to static structural problems as follows:

1. Select the element type and discretize (Rao, 2004, p.16)

The first step in the finite element method is to divide the structure into subdivisions or elements. Therefore, the structure is to be modelled with suitable finite elements. The number, type, size, and arrangement of the elements are to be decided.

Selection of proper interpolation to connect different nodes (Rao, 2004, p.16)

Since the displacement solution of a complex structure under any predefined load conditions cannot be anticipated precisely, we expect some reasonable solution within an element to approximate the unknown solution. The expected solution must be straightforward from a computational point of view; however, the solution or the interpolation model is taken in the form of a polynomial. Development of the element stiffness matrices and load vectors (Rao, 2004, p.16)

From the assumed displacement model, the stiffness matrix $[k^{(e)}]$ and the load vector $p^{(e)}$ of an element, (e) is to be derived by using either equilibrium conditions or a suitable variational principle.

4. Assembly of the element matrices to an obtained global matrix for entire FEM modal (Rao, 2004, p.16)

Since the structure is composed of several finite elements, the individual element stiffness matrices, and load vectors are to be assembled in a suitable manner and the overall equilibrium equations should be formulated as $[k]\Phi=P$.

Where [k] is the assembled stiffness matrix, Φ is the vector of nodal displacements, and P is the vector of nodal forces for the complete structure.

5. Solution for the unknown nodal displacements (Rao, 2004, p.16)

The overall equilibrium equations must be modified to account for the boundary conditions of the problem. After incorporation of the boundary conditions, the equilibrium equations can be expressed as $[k]\Phi=P$.

6. Computation of element strains and stresses

From the known nodal displacement Φ , if required, the element strains and stresses can be computed by using the necessary equations of solid or structural mechanics (Rao, 2004, p.16).



Figure 1. General stages in Finite Element Analysis (Akin, 2005, p.4)

2.1.4 Possible errors by Finite element Method

FEM is a numerical method or computational technique which discretises the structure into finite pieces. The result of these types of technique contains the following types of errors. (Akin, 2005, p.12)

Modelling errors due to simplification

The finite element description is a boundary value problem (BVP), which means there is a differential equation with several constraints. Errors of this type can include the wrong geometric description, the wrong definition of the material, wrong boundary conditions, the wrong type of analysis and wrong definition of a load.

Discretization errors

These types of error are due to the discretization of the structure into finite pieces. The geometry and displacement distribution of a real structure is continuously changing. When using a finite number of elements to model the structure, the discretized structure cannot be fully matched with a real model which causes errors. These errors can be reduced using smaller element sizes checking the software is operating with the input value and good interpolation functions.

Numerical errors

These errors are due to round off errors from the computer floating-point calculation and errors generated by numerical integration. These errors cannot be eliminated but can be reduced so that they do not influence the results. Rounding error in FEA can be caused by adding, subtracting minimal and large numbers.

2.2 Types of Analysis in FEA

2.2.1 Linear Analysis

Linear Analysis is the properties of the structure in which stiffness remained constant during the entire analysis. A linear analysis is an analysis where a linear relation holds between applied forces and displacements. In a linear, the stiffness matrix is constant and solving process is relatively short compared to nonlinear analysis. Figure 2 denotes force versus displacement curve in linear and nonlinear analysis.



Figure 2. Force vs Displacement curve in linear and nonlinear analysis. (communities.bently.com, n.d)

A linear FEA analysis is performed when:

- The structure is expected to behave linearly (for small deformation /strain).
- The stress is proportional to the strain.
- The structure will return to its original state when the load is removed.
- Superposition principle applies

2.2.2 Nonlinear analysis

Nonlinear analysis is the analysis in which properties vary due to large displacements in the structure (geometric nonlinearity), large scale yielding in the material (material nonlinearity) or changes in boundary conditions.

Nonlinear analysis is an analysis where a nonlinear connection holds between applied forces and displacements. Nonlinear effects can start from geometrical nonlinearities (i.e. Big deformations), material nonlinearities (i.e elasto-plastic material), and contact. These impacts bring about a firmness framework which is not steady during the heap application. This is against the linear static analysis, where the stiffness matrix remained constant. As a result, a different solving strategy is required for the nonlinear analysis. Modern analysis software makes it possible to solve complex nonlinear problems. (Femto.eu, n.d) Figure 3 denotes the stress-strain curve of steel material with nonlinear behaviour of structures with different categories.



Figure 3. Nonlinear behaviour of structure with different categories. (Younis, 2009)

Types of Nonlinear Analysis:

Geometric Nonlinearity

Geometrical nonlinearity is about a change in geometry where it significantly affects load-deformation treatment no matter how small or big deformation happens. Geometrical nonlinearity can be defined for extremely large deformations where the relation between displacement and strain is nonlinear.

Material nonlinearity

Material nonlinearity involves the nonlinear behaviour of a material based on a current deformation, deformation history, rate of deformation, temperature, pressure, etc. Examples of nonlinear material models are large strain Visco elastoplasticity and hyperelasticity (rubber and plastic materials).

Constraint and contact Nonlinearity

Constraint nonlinearity in a system can occur if kinematic constraints are present in the model. The kinematic degrees-of-freedom of a model can be constrained by imposing restrictions on its movement.

2.2.3 Finite Element Methods in Static Analysis

FEM has been most broadly utilized in both linear and nonlinear static analysis. The different kinds of static problems are solved using FEM different field, which includes elastic, elastoplastic, viscoplastic analysis of beam, frame, truss, plate, shells and solid structure. Usually, the static analysis includes an analysis of stress, strain, and displacement under static loading for one-dimensional, two-dimensional or three-dimensional problems. Basic static analysis is the static loading analysis which can cause non-permanent or permanent deformation generally used for determining stresses and strains caused by a force that does not create notable inertia or damping effects. (Jenkins, 2019)

A linear static analysis is an analysis where a linear relation holds between applied forces and displacements. In practice, this is between applied forces and displacements. In practice, this is applicable to structural problems where stresses remain in the linear elastic range of the used material. In linear static analysis, the model stiffness matrix is constant, and the solving process is relatively short compared to a nonlinear analysis on the same model. Therefore, for the first estimate, the linear static analysis is often used before performing a fully nonlinear analysis. (Rusu, 2017)

2.2.4 Dynamic Analysis in Finite Element Analysis

Dynamic FEA is a powerful simulation technique which can be applied in complex engineering systems. Dynamic analysis is used to evaluate the impact of transient loads or to design out potential noise and vibration problems. Vibration analysis testing is expensive in real life in which dynamic analysis at the design stage can avoid or reduce the requirement and the cost of testing.

Modal analysis is used to identify natural frequencies. Modal analysis is a powerful tool in FEM software which allows an engineer to design the product to avoid excitation to coincide with natural frequencies which minimize excessive vibration. Animations can be produced with valuable information into how the structure behaves under dynamic loading. Modal analysis is a standard tool in design to avoid the vibration in the structure design. Dynamic loading on a machine will introduce vibrations. Transient dynamic analysis is used to determine the dynamic result of a structure under the action of time-dependent loads. The flexible, dynamic analysis is the most versatile dynamic analysis which is used to determine the time-varying displacements, strains, stresses, and forces in a structure as it responds to transient loads. (trivista.co.uk, n.d.)

2.3 Structural Fire Analysis

Finite Element Analysis (FEA) is a powerful and well-recognized tool used in the analysis of heat transfer, thermal stresses, thermal displacement, temperature distribution problems. The two types of heat transfer are convection and radiation, which is approximated by boundary conditions in FEA. Modelling all three mechanisms of heat transfer without arbitrary assumption requires the combined use of FEA and Computational Fluid Dynamic (CFD). (sae.org, n.d)

Fire is a complex process which has many forms, involves in different chemical reactions and causes structural damage. During design criteria for structure, structural fire safety requires expectation for the structural and heating models.

A temperature vs time curve usually represents fire. Fire safety in buildings is concerned with achieving two fundamental objectives to reduce the loss of life in, or in the neighbourhood of, building fires and to reduce the property or financial loss. (University of Ljubljana, 2019)

Figure 4 is a temperature vs time curve, which gives the average temperature reached during a fire in a small size compartment or the furnaces used for fire resistance tests. International standards are based on the standard fire defined by the ISO 834 curve (Figure 4)



Figure 4. ISO Standard fire curve (University of Ljubljana, 2019)

Below Figure 5 and 6 illustrate the influence of fire load density and ventilation of compartment gas temperature.



Figure 5. Evolution of the gas temperature for different fire load densities (University of Ljubljana, 2019)



Figure 6. Evolution of gas temperature as a function of the ventilation. (University of Ljubljana, 2019)

The temperature of steel increases similarly but with some delay compared to the gas temperature in the fire. When a structural member is exposed to fire the response is governed by the rate heated due to mechanical properties of materials decrease as temperature rises and the structural resistance of a member reduces with temperature rise. (University of Ljubljana, 2019)



Figure 7. Influence of insulation on the heating rate. (University of Ljubljana, 2019)

In Figure 7, the temperature rise in the three cases is compared to the same element. Curve (a) denotes the delay for the bare element, while curve (b) and (c) apply to the cases of some protective coating, without and with moisture content. (University of Ljubljana, 2019)

2.3.1 Heat reaction in steel material

Steel is isotropic material in which no heat is generated within the body of steel elements. The rise of temperature in steel structure depends on the heat transfer between the fire environment and the element. According to the second law of thermodynamics, energy in the form of heat is transferred between any two elements, which are at different temperatures. Conduction, radiation and convection are the modes by which thermal energy flows from regions of high temperature to low temperature. The approach to study the increase of temperature in structural elements exposed to fire is based on the integration of the Fourier heat transfer equation for non-steady heat conduction inside the element. (University of Ljubljana, 2019)

$$\frac{k_s}{\rho_s c_s} \Delta^* 2\theta = \frac{d\theta}{dt} \tag{1}$$

Fourier heat transfer equation Equation (1) where for steel material,

The specific mass of steel(ρ s) = 7850 kg/m³ The thermal conductivity (Ks) depends on the temperature. The specific heat cs depends on the temperature.



Figure 8. Specific heat of steel as a function of the temperature. (University of Ljubljana, 2019)



Figure 9. Thermal conductivity of steel. (University of Ljubljana, 2019)

Figure 8 denotes the specific heat of steel in temperature and Figure 9 illustrates the thermal conductivity of steel in fire.





Figure 10. Heat flow for (a) element in continuum and (b) length of the steel section. (University of Ljubljana, 2019)

The quantity of heat transferred per unit length in the time interval Δt is,

 $\Delta Q = K^* A_m^* (\theta_f - \theta_s)^* \Delta t$ ⁽²⁾

where, K is a total heat transfer coefficient

Am is the perimeter surface area per unit length exposed on fire

 θ_f is the temperature of hot gases

 $heta_s$ is the temperature of steel during the time interval Δt

If this quantity of energy is entirely absorbed by the section, i.e no loss of heat is considered, the internal energy of the unit length of a steel element increases by the same quantity.

$$\Delta Q = c_s^* \rho_s^* A^* \Delta \theta_s \tag{1}$$

where,

A is the cross-sectional area of the member(m²)

The temperature rise of the steel is given by combining mass density ρ_s and specific heat c_s ,

2.4 Material properties

2.4.1 Tensile tests

The aim of the tensile test is to assess material properties for the metal. The properties obtained are utilized for the plan of parts. For the tensile test first, the specimen is placed in the testing machine and then a force is applied. The force is increased gradually, and a strain gauge measures the change of length in the specimens. The results of a single test can be applied to all sizes and cross-sections of specimens if the force is converted to stress and the distance between gauge marks to strain. (Askieland et al. 2010, p. 160.)

$$\sigma = \frac{F}{A} \tag{2}$$



Figure 11. The behaviour of metal at small strains. (Wikipedia.com, n.d)

Figure 11 above presents a typical stress-strain curve at the small strains obtained from a tensile test. The maximum stress that can be applied without causing permanent deformations is called the elastic limit.

2.4.2 Behaviour of the material at larger strains

Figure 12 below shows the behaviour of test material at larger strains. After the initial region, the specimen becomes plastic. The maximum stress on the stress-strain curve is the point at which necking starts. In necking the cross-sectional area of the specimen starts to decrease, and with a reduced area, less force is needed to continue the deformation. As engineering stress is based on the initial cross-sectional area A, the curve starts to decrease. Due to necking, the stress becomes rather localized, and the final rupture takes place. (Baeker 2006, p. 40)



Figure 12. Illustration of necking and final rupture of a ductile test in large strains. (Engineeringnotes,com, n.d)

2.4.3 True stress and strain

Engineering strain (ϵ) is a small strain result, which is computed using original geometry. The engineering strain result is a linear measure since it depends on the initial geometry. Engineering strain is defined as the change in length divided by the original length.

$$\varepsilon = \frac{\Delta l}{l} \tag{5}$$

Where,

ε is an engineering strain [Pa]
ΔI is changed in length [m]
I is original length

Engineering stress (σ), is the conjugate stress measure to engineering strain (ϵ). It is also defined as the force per unit area. Which is given by,

$$\sigma = \frac{F}{A} \tag{3}$$

Where

σ is engineering stress [Pa]F is force [N]A is the cross-sectional area [m2]

True stress is defined by using the deformed cross-section instead of the initial one.

 $\sigma t = \sigma (1 + \varepsilon) \tag{4}$

A true strain is a logarithmic strain which provides a correct measure of the strain.

$$\varepsilon t = \ln(1 + \varepsilon) \tag{5}$$



Figure 13. True stress-strain and engineering stress-strain curves. (Engineeringnotes.com, n.d)

The true stress-strain curve (Figure 13) is compared with the engineering stress-strain curve in the above figure. The curve is the same until the yield point after that true stress continues to rise although the required load fall. (Beer et al, 2012, p.62)

3 LS-DYNA

3.1 LS-DYNA BACKGROUND

LS-DYNA is an advanced Finite Element Package software which specializes in highly nonlinear transient analysis using an explicit integration scheme. LS-DYNA was known as DYNA3D earlier in 1974. John Hallquist developed his code on a language called FORTRAN. FORTRAN was a programming language which was related to mathematics. In 1984 LSTC was born as a software company where they developed or expanded the code as LS-DYNA. (d3view.com, n.d.)

LS-DYNA is an advanced general-purpose finite element program capable of solving and simulating complex real-world problems created by the Livermore Software Technology Corporation (LSTC). While the package continues to contain more and more possibilities for the calculation of many complex, realworld problems, its origins and core-competency lie in highly nonlinear transient dynamic finite element analysis (FEA) using explicit time integration. LS-DYNA is used by a wide range of industries such as automobile, aviation, structural designing, military, manufacturing, construction and bioengineering industries. LS-DYNA potential applications are numerous and can be tailored to numerous fields. In a given simulation, any of LS-DYNA's numerous features can be combined to model a broad scope of physical occasions. An example of a simulation, which involves a one of a kind features, is the NASA JPL Mars Pathfinder landing simulation which simulates the space test's utilization of airbags to help in its landing. LS-DYNA is one of the most flexible finite element analysis software packages available.

LS-DYNA run requires a command shell, executable, an input file and enough free disk space to run the calculation because LS-DYNA consists of a single executable document and is entirely command-line driven. All input files are in a simple ASCII format and along these lines can be prepared using any content editor. Input documents can also be prepared with the instant help of a graphical processor. (lstc.com, n.d.)

3.2 LS-PrePost

LS-PrePost is an advanced pre-processing and post-processing software by Livermore Software Technology Corporation that can be downloaded free. For this thesis, LS-PrePost was used for post-processing and pre-processing software. Table 3 shows the list of features of LS-PrePost. (lstc.com, n.d)

Table 3. Capabilities of LS-PrePost (Livermore Software Technology Corporation, n.d)

Pre-processing capabilities	Post-processing capabilities
Modelling the specimen	D3PLOT Animation
Meshing	Eigen Mode Animation
Importing different format	BINOUT Processing
files	
Editing the imported files	DYNAIN Generation
Model-checking	ASCII Plotting
Metal forming	Time history plotting
Timestep checking	Fringe Plotting

3.3 Capabilities of LS-DYNA

Analysis capabilities in modern CAE software are extended to spread composite solid, laminated composite shell, sandwich shell, fatigue, and fracture. Typical loading situations are concentrated loads, surface forces, body forces, non-zero nodal displacement, nodal temperature gradients etc. Table 4 gives the capabilities of finite element software packages and illustrates the capabilities of LS-DYNA. (Radhakrishnan, 2008, p. 215)

Capabilities	Application
Static	Stresses and displacements calculation of
analysis	structure under static loading.
Dynamic	Transient and steady-state response of a
analysis	structure calculation under dynamic loading.
Modal	Computation of natural frequencies associated
analysis	mode shapes of the structure, response
	spectrum analysis, random vibration and
	forced vibration problems.
Stability	Determination of buckling loads on the
analysis	structure
Heat transfer	Computation of temperature distribution and
	heat flow within a structure under steady-
	state and transient conditions
Field	Analysis of field intensity and flux, the density
problems	of a magnetic field, analysis of field problems
	in acoustics and fluid mechanics.
Coupling	Solution techniques for interfacing multiple
effects	field effects such as displacement, forces,
	temperature, heat flows, electrical voltage and
	current, magnetic field intensity and flux, and
	fluid pressure and velocity.
Non-linear	Computations considering the temperature
	dependence of material properties, plasticity,
	non-linear elasticity, creep, swelling, large
	deflections, and work hardening.
Material	Analysis of isotropic, orthotropic, sandwich
properties	plates, and composites.

Table 4. Capabilities of LS-DYNA (Livermore Software Technology Corporation, 2006)

3.4 Implicit analysis in LS-DYNA

An implicit code is a numerical code which uses Iterative solving method to solve the static problem. Static analysis is done using an implicit solver in LS-DYNA. In the nonlinear implicit analysis, the solution of each step requires a series of trial solutions to establish equilibrium within an individual tolerance. Implicit analysis requires a numerical solver to invert the stiffness matrix once or even several times throughout a load/time step in which matrix inversion is an expensive operation, especially for large models. (dynasupport.com, n.d.) Benefits of implicit analysis

- Can be used to apply pre-loads (gravity, bolt pre-load) to a structure before an explicit analysis.
- Good for static and quasi-static problems.
- Time step size is in practice limited by accuracy consideration, automatic time step control is available.

Implicit keyword setup in LS-PREPOST to activate implicit analysis in LS-DYNA are as follows:

*CONTROL_IMPLICIT_GENERAL *CONTROL_IMPLICIT_SOLVER *CONTROL_IMPLICIT_SOLUTION *CONTROL_IMPLICIT_AUTO *CONTROL_IMPLICIT_DYNAMICS *CONTROL_IMPLICIT_EIGENVALUE

Objectives of LS-DYNA Implicit

- To provide a complete implicit solver, fully comparable to any implicit code when it comes to functionality, robustness and performance.
- Implicit functionality, both linear and nonlinear, is implemented in LS-DYNA
- Efficiently parallelized code in both MPP and SMP

3.5 Explicit analysis in LS-DYNA

Explicit code is the direct solving method used to solve the dynamic problem. In the explicit analysis, no iteration is required as the nodal accelerations are solved directly. Explicit analysis handles nonlinearities with relative ease as compared to implicit analysis. (dynasupport.com, n.d.)

The explicit analysis runs into its limit for long-duration processes in which implicit analysis is more preferable than explicit analysis in LS-DYNA.

In general, implicit input card can easily be transformed into explicit input card. After running the implicit analysis, *CONTROL_IMPLICIT_GENERAL card is edited with IMFLAG= 0. Figure 14 shows transforming the implicit code to explicit code in LS-Dyna keyword.

Keyword Input Form					\times
	Clear	Accept	Delete	Default	Done
Use *Parameter Comment		(5	Subsys: 1 ellip	se.k)	Setting
*CONTROL_IMPLICIT_GENERAL (1)					
IMFLAG DT0 IMFORM NSBS IGS CNSTN FORM ZERO V 0 0.0100000 2 0 2 0 0 0 0 > 0					
COMMENT:					
\$ imflag dt0 iefs nstepsb igso					<u>^</u>
IMFLAG:=Implicit/Explicit switching flag EQ.0: explicit analysis (default) EQ.1: implicit analysis EQ.2: explicit followed by one implicit step (springback analysis) EQ.4: implicit with automatic implicit-explicit switching EQ.5: implicit with automatic switching and mandatory implicit finish					^

Figure 14. Transforming to explicit analysis in LS-DYNA.

Quasi-static analysis solves the static problem in which kinetic energy should equal to zero using explicit code.

3.6 Time step Controls

Time integration is the relation between physical properties (time) with the numerical method. Time step is only specific to explicit code in LS-DYNA. During the solution, a new time step size is determined by taking the minimum value overall elements. (dynasupport.com, n.d)

 $\Delta t^{n+1} = \alpha^* \min \left(\Delta t_1, \Delta t_2, \Delta t_3, \dots, \Delta t_n \right)$ (6)

where n is the number of elements. For stability, the scale factor α is typically set to a value of 0.90 or smaller. (lstc.com, 2006)

"Shock wave propagation speed in any material cannot exceed acoustic wave speed in that material" according to Courant-Friedrichs-Lewy (CFL). (Sormunen, 2016, p.9)

The maximum time step Δt that can be used in the analysis is limited by CFL condition as

 $\Delta t \le f\left[\frac{h}{c}\right] \tag{10}$

)

where c is the speed of sound in the material, f is the time step safety factor (0.9 is the default) and (h) is the characteristic element dimension. (simscale.com, n.d) The CFL condition restricts the wave from travelling more

than the dimension h in a one-time step. Characteristic dimensions for different element types are calculated by the differential equation as shown in Table 5. (Sormunen, 2016)

Element	Geometry	Characteristic		
Туре		dimension(h)		
Hexahedral		The volume of		
solid	×	the element		
		divided by the		
		area of the		
	X	largest face		
	×	h=x		
Tetrahedral		Minimum		
solid		distance from		
	x n x	a node to an		
		opposing		
		surface.		
	×			
		$h = \sqrt{\frac{2}{2}}$		
		$n = \sqrt{\frac{-x}{3}}$		
Quad shell		The square		
	× ×	root of the		
	- ~ -	area of the		
		element.		
	×			
		h=x		
	·			
Triangular		Two times the		
shell	•X•	area of the		
		element		
	$\langle \langle \rangle \rangle$	divided by the		
		length of the		
	XXX	longest side.		
	\setminus \checkmark /			
	$\sim \sim$			
Beam		Length of the		
		element		
	V V	h=x		
	- X			

Table 5. Calculation of characteristic dimension for low order element. (Sormunen, 2016)

Time step Control for Beam and Truss Elements (Dynamore, 2019)

$$\Delta t = \frac{l}{c}, \qquad (7)$$

where I is the length of the element and c is the sound of speed

$$c=\sqrt{\varepsilon/\rho}$$
, (8)

where ϵ is the Modulus of elasticity and ρ is the density.

4 EXPERIMENTAL TESTING RESULTS

In the lab test, IPE 100 Steel Beam of length 1700mm with steel grade S 355 was used. One end of the beam was placed in a hinge support and the other end of span was placed in a roller support. The force was applied exactly at the centre of the beam and the maximum deflection of the beam is noted as shown in Figure 15 and 16 below.



Figure 15. Simply supported beam under point loading.



Figure 16. Beam testing in Lab.

Figure 18 below shows the load versus displacement curve during the lab test. The ultimate load on the beam was 34.19 kN and its corresponding displacement was 19.12mm. Figure 17 below shows the stress versus strain curve of the steel.

Manual Analysis

From the statics table, the elastic deflection of the beam in the simply supported beam is given by

Where,

f=deflection F=point load
L=distance between support E=Elastic modulus I=Second Moment Area

In this case, From the test result Figure 18

F=34.19 Kn L=1700mm E=210Gpa I=1710000mm^4

Therefore, From Equation (13), the elastic deformation corresponding to maximum load is given by f,

f=F*L^3/48*E*I =34.19*1700^3/48*210*171000 =9.74mm



Figure 17. Properties of steel, stress versus strain diagram



Figure 18. Load versus Displacement Graph from lab test results.

5 MANUAL CALCULATION DATA

5.1 Element size calculation

In numerical modelling, element size is defined by mesh refinement. During this research analysis time step (Δ t) was defined as 0.3 microseconds for the calculation of the fine mesh size. The formula used in the calculation of the element size taken from excel sheet is described below in Figure 19.

In an explicit analysis, the time step is affected by element size and material wave speed. Time step is proportional to the element size/ speed of a wave.

The smaller the time step, the more steps it takes to complete the analysis and more time steps means longer run time at LS-DYNA. (dynasupport.com, n.d)

Speed of sound (c) = $\sqrt{\epsilon/\rho}$ Characteristic length (Lc)= $\Delta t \times c$

Edge Length (Le) = $\sqrt{2}$ ×Lc

User defined	Micro Sec	Sec								
Tiume Step(Delta T)	0,3	0,0000003								
Formula										
Sound Speed(c)	SQRT(E/Rho)									
Charecteristic Length	Lc =(Delta T)*C									
Edge Length, Le	Le=SQRT(2)*Lc									
Value										
SQRT (2)	1,414213562									
Material	(Delta T) sec	Modulus of elasticity(E	Density(kg/m3)	Speed of Sound(m/s)	Chaeristic Length, Lc (m)	Edge Length le(m)	Edge Length Le(mm)	Chareistic length (mm)	DT 2ms	Speed (c)mm/sec
Steel	0,0000003	2,10E+11	7850	5172,194153	0,001551658	0,002194376	2,194376136	1,551658246	4,24E-07	5172194,153

Figure 19. Element size calculation in Excel sheet.

5.2 Effective plastic stress-strain calculation

The methodology of engineering to true strain and true stress is described below shortly. Figure 20 shows effective plastic stress-strain calculation in Excel sheet. (dynasupport.com, n.d)

True strain = In (1+engineering strain) where In is the natural log

True stress = (engineering stress) × exp (true strain) = (engineering stress) × (1+ engineering strain)

where exp (true strain) is 2.71 raised to the power of (true strain).

Calculating the effective plastic strain from using the experimental data from true stress vs true strain curve.

effective plastic strain (input value) = total true strain – true stress/E

Engineering Strain	Engineering Stress	1	True Strain	True Stress	Effective Pl strain	Effective plastic stress
0,00209	402,253		0,002088	403,0937	0,000168325	403,0937088
0,00584	429,699		0,005823	432,2084	0,003764878	432,2084422
0,02728	453,507		0,026915	465,8787	0,024696063	465,878671
0,03652	482,183		0,035869	499,7923	0,033488985	499,7923232
0,06574	537,572		0,063669	572,912	0,060941241	572,9119833
0,08375	554,965		0,080427	601,4433	0,077563233	601,4433188
0,12266	572,385		0,115701	642,5937	0,112640899	642,5937441
0,14213	575,564		0,132895	657,3689	0,129764612	657,3689113

Figure 20. Effective plastic strain calculation sheet from Excel.

Figure 21 shows the graphical representation of the engineering stress and strain, effective plastic strain and true strain versus stress curve.



Figure 21. Graphical representation of Effective stress, strain curve after calculation.



Figure 22. Effective plastic stress-strain curve in LS-PrePost after inputting values.

The data illustrated in Figure 22 above was taken for the material linear plasticity (Mat-24) in LS-PrePost.

5.3 Temperature calculation of steel beam under ISO fire

The temperature distribution and time history in the cross-section were conducted in the Excel for unprotected steel members under fire. The temperature of the carbon steel was calculated in every 5 seconds till 2000 seconds under fire. Later these value time in second and temperature of the carbon steel were used to run structural analysis in LS-DYNA. Below is the process of Excel calculation of the steel beam under fire.

Properties of carbon steel taken from Eurocode. According to EN 1994-1-2,

The density of carbon steel (ρ) =7850 $\frac{\text{kg}}{m^3}$

Coefficient of heat transfer (\propto_c)=25 $\frac{W}{m^{2}.K}$

The surface emissivity of the member (ϵ_m)= 0.7

The emissivity of the fire (ϵ_f)= 1

Configuration factor (Φ) =1

Specific heat capacity of the carbon steel (ca)= 420 $\frac{J}{kg.K}$

Properties of IPE 100 steel beam exposed on fire,

Depth(h)=100mm

Width(b)=55mm

Web thickness(s)=4.1mm

Flange thickness(t)=5.7mm

Fillet(r) =7mm

Section area (A)= 1030m²

According to the EN 1994-1-2,

Surface area of steel exposed on fire is given by $(A_m)=2.h + 4.b+2.pi.r-8.r-2t = 397mm$



Table 4.1: Definition of section factors for unprotected steel members



Section factor
$$\left(\frac{A_m}{V}\right) = \frac{\text{Surface area*1000}}{\text{Area of IPE beam exposed to fire}} = 385.049 \frac{1}{m}$$

Where Figure 23 above illustrates the rate at which a steel member will increase in temperature is proportional to the surface, A, of steel, exposed to the fire and inversely proportional to the mass or volume (V) of the member. In the fire, a member with a low section factor will heat up more slowly than the one with a high section factor.



Figure 24. Box value of the section factor $\left[\frac{A_m}{V}\right]$ box

Above Figure 24 shows the formula for the calculation of section factor under different condition of heat in the section.

Surface factor $\left[\frac{A_m}{Vb}\right] = 2(b+h) = 310$ mm, in our case for the section exposed with fire in four sides of the structure.

Where $\left[\frac{A_m}{Vb}\right]$ is the box value of the section factor.

Influence of shape on the shadow effect,



Figure 25. Influence of shape on the shadow effect.

Above Figure 25 shows the influence of shape on the shadow effect taken from the Eurocode. For cross-sections with a convex shape (e.g. rectangular or circular hollow sections) fully embedded in the fire, the shadow effect does not play a role and consequently the correction factor k_{sh} equals unity. For I-section under nominal fire actions, the correction factor for the shadow effect may be determined from.

Correction factor $(k_{sh}) = 0.9 \frac{\frac{\text{Am}}{\text{v}}\text{box}}{\frac{\text{Am}}{\text{v}}}$

The time interval (Δt)=5s

Time in minute (Tm) = $\frac{\Delta t}{60}$

Nominal Temperature-Time Curves

Temperature-time curves are analytical functions of time that give the temperature. The term curve comes from the fact that these functions are continuous and can be used to draw a curve in a time-temperature plane.

Eurocode 1 proposes three different nominal temperature-time curves. The standard temperature-time curve is the one that has been historically used, and it is still used today, in standard fire tests to rate structural and separating elements. It is often referred to as the ISO curve because the expression was taken from the ISO 834 standard. This standard curve is given by

$$\theta_{g}$$
=20+345log₁₀(8t+1) (14)

where θ_g is the gas temperature in degree C and t is the time in minutes?

The surface temperature of the steel θ_m =20

Heat convection $(h_{net.c}) = \alpha_c(\theta_q - \theta_m)$

 $\theta_r = \theta_g$

Heat radiation

$$h_{\text{net,r}} = \Phi.\varepsilon_{\text{f}}.\varepsilon_{\text{m}}.5.67.10^{-8} - \{(\theta_{\text{r}}+273)^{4}-(\theta_{\text{m}}+273)^{4}\}$$
 (15)

The same formula is applied to calculate the temperature of steel in every 5 seconds till 2000 second more calculation is presented in Excel file in Appendix 2. Figure 26 represents the temperature of steel and gas till 2000 seconds calculated in Excel which shows the temperature of steel is about 880° C in 2000 seconds.



Figure 26. Graphical representation of gas and steel temperature till 2000 seconds.

6 3D FINITE ELEMENT MODEL DESCRIPTION

6.1 **3D Modelling of the geometry in LS-PRE-POST**

6.1.1 General dimensions and process of modelling in LS-PrePost

The Finite Element model is created using shell element with ELFORM 16 (fully integrated shell element modified for higher accuracy) in LS-PrePost. Figure 27 shows the dimensions of IPE Beam. The same specimen and same dimension were used in a lab test and FE model created on LS-PrePost with the length of 1700mm. Figure 27 shows the cross-section of a simply supported beam.



Figure 27. Cross-section of IPE 100 beam.

Figure 28 shows the definition of the dimensions of the IPE Beam in LS-PrePost(v4.6.8-29May2019). Seven points (0,0,0), (0, 47.15,0), (27.5, 47.15, 0), (-27.5, 47.15, 0), (0,-47.15,0), (27.5, -47.15,0) and (-27.5, -47.15, 0) individually along (x,y,z) direction. Figure 29 shows the result after above inputs in LS-PrePost.



Figure 28. 3D point input in LS-PrePost.



Figure 29. 3D Sketch input of point in LS-PrePost.

Figure 30 below shows the input parameter of the line segment of IPE Beam in LS-PrePost. Three lines were created one by one as shown in Figure 30.



Figure 30. 3D sketch input of line segment in LS-PrePost.

Figure 31 below shows the 3D model of IPE Beam in LS-PrePost. After the input of the line segment, the length of 1700 mm is extruded through the surface and extrude command in LS-PrePost.



Figure 31. 3D model of IPE Beam in LS-PrePost.

6.1.2 Meshing

The IPE Beam has meshed with mixed type mesh with triangular and square types of mesh as shown in Figure 32. Mesh was created from Auto Mesher in LS-PrePost with the average value of 2.19mm mesh size.



Figure 32. The meshing of IPE Beam in LS-PrePost.

6.1.3 Creation of Three different Part ID

This chapter shows how we can separate the Part ID in LS-PrePost from the single Part ID meshing. This is done using move or copy tool as in figure 33 below which separates the Part ID.

Whereby creating the mesh three-time can also be done during auto mesh which makes the process complicated and long.

As shown in Figure 33 using the move tool, the three-part id is created. Here unique name should be given each time.



Figure 33. Process of separating the Part ID in LS-PrePost.

6.2 Boundary Conditions

Seven boundary conditions, shown in Figure 34, were applied in the model. From the create entity keyword different boundary conditions were created from set data set node in LS-PrePost. The different colour which represents the different node selected for the definition of the boundary conditions.



Figure 34. Creating an entity in LS-PrePost for the definition of Boundary condition (BC).

Figure 35 shows the definition of the Displacement loading in the IPE Beam from the keyword manager tool. Degree of Freedom for the displacement loading was along the z-direction.



Figure 35. Connecting the set data with BC in LS-PrePost.

6.3 Material

Stainless steel IPE beam was modelled as an elastoplastic material during this research in LS-PrePost. Table 6 shows the material parameters used for steel.

Property	Value
Modulus of Elasticity(E)	2.100e+05 Newton/ mm2
Mass density (ρ)	7.850e-09 ton/mm3
Poisson`s ratio (PR)	0.30
Yield stress (SIGY)	355 Mpa

Table 6. Material properties of the steel IPE Beam.

*Mat- 024_PIECEWISE_LINEAR_PLASTICITY which is an elastoplastic material was used during the modelling of IPE Beam in LS-PrePost. Figure 36 below gives a detailed input in LS-PrePost. The effective plastic stress (EPS1) and strain (ES1) value were taken from the manual calculation from chapter 5.2.

Ke	yword input F	orm										
1	lewID			MatDB	RefBy	Pick	Add A	Accept	Delete	Default	Done	
	Use *Parameter Comment (Subsys: 1 implicit1final2.19.k) Setting											
	*MAT_PIECEWISE_LINEAR_PLASTICITY_(TITLE) (024) (1)											
-	TTT: C											
	Steel											
1	MID	<u>R0</u>	E	PR	SIGY	ETAN	FAIL	TDEL				
	þ	7.850e-09	2.100e+05	0.3000000	355.00000	0.0	1.000e+21	0.0				
2	<u>C</u>	P	LCSS •	LCSR •	<u>VP</u>							
	0.0	0.0	0	0	0.0 ~							
3	EPS1	EPS2	EPS3	EPS4	EPS5	EPS6	EPS7	EPS8				
	0.0	0.0035844	0.0245015	0.0332803	0.0607020	0.0773121	0.1123726	0.1294	901			
4	<u>ES1</u>	ES2	ES3	ES4	ES5	ES6	<u>ES7</u>	ES8				
	403.09369	432.20840	465.87869	499.79230	572.91199	601.44330	642.59381	657.36	890			
			F	Plot	Raise	New	Pad	d			~	
To	tal Card: 1 S	mallest ID: 1	Largest ID: 1	Total deleted	card: 0						~	
											\sim	

Figure 36. Keyword input for Steel IPE Beam in LS-PrePost.

6.4 Choice of the element type in LS-DYNA

During this research shell sections were created during modelling of IPE Beam. Shell elements are suitable for modelling structures that have one-dimension thickness small compared to the other side of the structure.

There are forty (40) available shell element formulation options that can be chosen for the model. Choosing the right element formulation depends on terms of robustness, accuracy and speed with full integration. From an accuracy standpoint, shell type 16 is preferred over-under integrated formulations. Shell type 16 is chosen for modelling the section as shown in Figure 37. (LS-DYNA Theory Manual, 2006)

Ke	Keyword Input Form														
N	lewID Dr	aw			RefBy		Sort/T1	Add	Acc	ept	Delete	Default	Done	e	1 Upperflange 2 Websection
	Use *Parameter Comment (Subsys: 1 explicitinal6.57.k) Setting 3 Lowerflange														
	*SECTION_SHELL_(TITLE) (3)														
-	ттіғ													~	
	Upperflange	1													
1	SECID	ELFORM	SHRF	NIP	PROPT		QR/IRID •	ICOMP	5	SETYP					
	1	16	1.0000000	7	1	\sim	0	0	\sim	1	\sim				
2	<u>T1</u>	<u>T2</u>	<u>T3</u>	<u>T4</u>	NLOC		MAREA	IDOF	E	DGSE	Ξ				
	5.6999998	5.6999998	5.6999998	5.6999998	0.0		0.0	0.0		0					
	Repeated Dat	a by Button a	nd List												
								Data P	۰t.						
								Repla	ce		Insert				
								Delet	e		Help			~	
То	Total Card: 3 Smallest ID: 1 Largest ID: 3 Total deleted card: 0														
														\sim	

Figure 37. Element formulation type 16 keyword in shell section.

7 MESH SENSITIVITY ANALYSIS

In Finite element analysis, the size of the mesh is critical. The size of the mesh is closely related to the accuracy and number of mesh required for the meshing of the element. According to the theory of Finite Element Analysis, the finite model with small element size yields high accuracy as compared to the model with large element size. This chapter presents mesh sensitivity analysis with different element size using implicit code in 7.1 and explicit code in 7.2.

7.1 Mesh sensitivity analysis using implicit code

Convergence study on the different mesh size was studied in this finite element simulation model using implicit analysis in LS-Dyna. From the manual calculation of the element size, Figure 18 shows an edge length of 2.1943 mm for the fine mesh of the FE model. So, for the point load to be exactly on the middle node element size of 2mm was meshed. Four different mesh sizes were created in this research to accurately correlate with the test data. The mesh sizes ranged from 2 mm to 8mm as shown in Figure 38 below.

The results, plotted in Figure 38, shows that there is a huge change in the shape of the force history. For the mesh size of 2mm maximum force was 34.30 kN for 4mmm maximum force of 30.50 kN, for 6mm maximum force of 36.30 kN and for 8mm maximum force of 34.20 Kn.

Four finite element model with the different mesh size of 2mm, 4mm, 6mm and 8 mm were modelled in LS-Prepost. In all four finite element model material properties, boundary conditions and load defined are similar. The models were run using implicit static analysis in LS-DYNA.

Figure 38 below illustrates the load vs displacement curve of the simply supported beam when the point load is applied in the mid-span of the beam. The maximum displacement for 2mm mesh size was 13mm while the load was 34.34 kN, for 4mm mesh size was 15 mm and load 30.54 kN, for 6mm mesh size model was 20 mm displacement and load 36.34 kN and for 8mm mesh size model 15.1 mm and load were 34.20 Kn. Figure 39 shows the finite element model of a simply supported beam with different mesh sizes.



Figure 38. Load versus displacement curve of a simply supported beam with different mesh size.



Figure 39. Meshing with the different element size of IPE beam in LS-PrePost of (a) 2mm (b) 4mm (c) 6mm (d) 8mm



Figure 40. Displacement resultant of a simply supported beam (a) 2mm mesh (b) 4mm mesh size (c) 6mm mesh size and (d) 8mm mesh size.

Figure 40 above shows that the resultant displacement of a simply supported beam with different mesh size has similar later torsional buckling and the maximum impact is in the mid-span of the beam. The maximum resultant displacement was seen in fine mesh size of 2mm with 35.60mm, 31mm in 4mm mesh size, 27 mm in 6mm and 27mm in 8mm mesh size finite element model. The results, plotted in Figure 38, show that there is a huge change in the shape of the force history as well as in the peak force as the mesh is refined. The solution time was also monitored along with the accuracy of the predicted force. The smallest mesh size of 2mm took 11 minutes and 41 seconds while the largest mesh size of 8mm took 44 seconds only while running with implicit analysis in LS-DYNA.

From the mesh sensitivity analysis results in Figure 38 analyzing the loaddisplacement curve of four different finite element model of the simply supported beam, it was observed that there was some error in a mesh sensitivity analysis. It was difficult to determine which element size was sufficient. Implicit static analysis was unsuccessful for the mesh sensitivity analysis in this research work.

7.2 Mesh Sensitivity analysis using explicit code

Again, to perform the mesh sensitivity analysis new finite element was modelled to run with the explicit code in LS-DYNA. The finite element model was modelled with different element size because while running the element size of 2 mm and 4mm it was taking more than 14 hours run time in LS-DYNA. In our University computers are automatically shut down after 14 hours So, a new finite element model was modelled with 12mm and 14mm element size.

Four finite element models with the different element size of 6mm, 8mm, 12mm, and 14mm were modelled in LS-PrePost. In all finite element material properties, boundary conditions and load defined are similar. The models were run using explicit static analysis in LS-DYNA.



Figure 41. Load versus displacement curve of a simply supported beam with different mesh size.

Mes	Von	Num	Numh	Simulati
IVIES			Numb	Sinuati
h	mises	ber of	er of	on run
size	(Mpa	node	Eleme	time
(m)	S	nts	
m)				
6m	597	1054	10224	2hour 5
m		5		minutes
8m	635	5373	5134	1hour
m				49
				minutes
12m	558.3	2447	2288	20
m	35			minutes
				35
				seconds
14m	538.3	1853	1716	14
m	35			minutes
				25
				seconds

Table 7. Mesh sensitivity analysis results.

The results, plotted in Figure 41 above, show that there is little change in the shape of the load history as well as in the peak force as the mesh is refined. Table 7 shows the mesh sensitivity analysis results of the different element size. The solution was also monitored along with the accuracy of the predicted force. An explicit solver, LS-DYNA, was successful for the mesh sensitivity analysis in this research. By seeing the accuracy and the less solution time 8mm element size was sufficient.

8 STRUCTURAL RESPONSE ANALYSIS TO THERMAL LOAD IN LS-DYNA

The steel IPE beam was subjected to a thermal load in every node in the FEM model and point load in the middle of the steel IPE beam. The simulation was set up as "structural-only" analysis using static implicit time integration. For the definition of the thermal load, the keyword *LOAD_THERMAL_VARIABLE was used.

At first, FE model was created using shell elements with fully integrated shell element modified for higher accuracy. The element size of 10mm was chosen due to its shorter simulation time. Three integration points are defined through the thickness. Temperature-dependent piecewise linear plastic material model MAT255 was used in this model for shell element. The material properties and stress-strain relations are defined according to EN1993-1-2. The temperature distribution and time history in the cross-section are specified according to the Excel calculation for the unprotected steel member open section exposed to the fire according to the EN 1991-1-2. Keyword Input Form

1	lewID			MatDB	RefBy	Pick	Add	Accept	Delete	Default	Done	
	Use *Parameter Comment (Subsys: 1 implicitthermal14.k) Setting											
			*MAT_	PIECEWISE_LI	NEAR_PLASTI	C_THERMAL_(TITLE) (25	5) (1)				
_	TITLE											^
	Steel_Mat25	55										
1	MID	<u>R0</u>	<u>E</u> •	PR •	<u>C</u>	Р	FAIL	<u>TDEL</u>				
	1	7.850e-09	-2	-5	0.0	0.0	0.0	0.0				
2	TABIDC •	TABIDT •	LALPHA •									
	19	19	4									
3	ALPHA	TREF	-									
	0.0	20.000000										
-	COMMENT											
_												
To	Fotal Card: 1 Smallest ID: 1 Largest ID: 1 Total deleted card: 0											

Figure 42. Material input for MAT_255 in LS-PrePost.

Figure 42 above shows the material properties of steel were calculated according to the EN 1993-1-2.

Steel Temperature	Reduction factor(ky,θ)	Slope of linear elastic(Ea,θ)
20	1	210000
100	1	210000
200	1	189000
300	1	168000
400	1	147000
500	0,78	126000
600	0,47	65100
700	0,23	27300
800	0,11	18900
900	0,06	14175
1000	0,04	9450
1100	0,02	4725
1200	0	0

Figure 43. Calculation of Young's modulus according to the EN.

Figure 43 above shows the calculation of the temperature vs Young's modulus curve where steel temperature and reduction factor were taken from EN 1993-1-2. The slope of the linear elastic (Ea, θ) were calculated using the formula

 $(Ea, \theta) = Ea^*(ky, \theta)$



Figure 44. Graphical representation of Temperature versus Young's modulus in LS-PrePost.

Figure 44 above shows the Elastic Modulus vs Young's modulus curve during the material definition of structure analysis. Figure 45 below shows the coefficient of thermal expansion versus Temperature curve.



Figure 45. Graphical representation of thermal expansion due to fire on steel.



Figure 46. Graphical representation of Temperature versus plastic stress-strain curve.

Figure 46 shows the graphical representation of the plastic stress versus strain curve of steel S 355 20°C, 100°C, 200°C, 300°C, 400°C, 500°C, 600°C, 700°C, 800°C, 900°C and 1000°C temperature.

8.1 Analysis time in LS-DYNA

In an explicit analysis, the time step is affected by element size and material sound speed. The computing time to simulate the simply supported beam under displacement loading in the mid-span of the beam is shown in Table 8 below. All the analysis cases were run using shared memory parallel (SMP) double precision R9 version in LS-DYNA.

Total simulation time
11 minutes 41 seconds.
3 minutes 13 seconds
58 seconds
43 seconds
2 hours 5 minutes and 15
seconds
1 hr 2 minutes and 21
seconds
47 minutes and 46 seconds

Table 8. Analysis cases and simulation time in LS-DYNA Manager.

9 ANALYSIS RESULTS AND COMPARISON WITH TEST

In this chapter, the results of the finite element simulations using shell elements are presented and compared.

9.1 Implicit and Explicit simulation results

The FE model was run with the two cases static implicit analysis and explicit analysis in LS-DYNA with the same element size of 6mm. Point load was loaded in the middle of the steel IPE beam with the keyword *BOUNDARY_PRESCRIBED_MOTION_SET in LS-DYNA. The total CPU run time during explicit analysis was 2 hour and 5 minutes where only 58 seconds for the implicit analysis until normal termination.

Figure 47 shows the force vs time curve for the implicit and explicit analysis in LS-DYNA. The maximum peak load during the numerical simulation was 36.34 KN for implicit analysis and 40.04 KN for explicit analysis.



Figure 47. Force versus Time curve of steel IPE beam with a mesh size of 6mm.



Figure 48. Load versus displacement curve of the simply supported beam.

Figure 48 shows the load vs displacement curve of simply supported beam modelled with the same material, size and mesh size but run with the two different types of solvers in LS-DYNA. The maximum load and vertical displacement in the implicit analysis was 20 mm displacement and load 36.34 kN wherein explicit analysis maximum displacement 15 mm and the load was 40.34 Kn. Figure 49 and Figure 50 shows the displacement result from the explicit code and implicit code respectively.



Figure 49. Displacement result from the explicit analysis.



Figure 50. Displacement result from the implicit analysis.

9.2 Comparing the lab test and numerical simulation results.

Figure 51 shows the residual deformation of the steel beam under the midspan point load. It was noticed from Figure 52 that later-torsional buckling behaviour is observed while the maximum of the lateral deformation is produced at mid-span of the simply supported beam.



Figure 51. Lab test (a) and (b) LS-Dyna simulation.



Figure 52. Plastic deformation of the beam.

Figure 53 below shows the simulation results of simply supported beam from beginning to normal termination.



Figure 53. Simulation results of simply supported steel beam.



Figure 54. Load versus displacement curve of a simply supported beam from a lab test and LS-DYNA.

Above Figure 54 shows the comparison of load-displacement curves between the lab test and LS-DYNA simulation. It is seen that force and the maximum deformation comparing two tests look different. The possible reasons for different simulation and experimental results may be an error due to measurement, faulty equipment, an external force from an analyst during the experimental analysis.

9.3 The structural analysis of IPE Beam in fire

The FE model was created using shell elements with Fully integrated shell element for the accuracy and less simulation time. The element size created in finite element modelling was 10 mm and three integration points are defined through the thickness. This time different temperature-dependent piecewise linear plastic material MAT255 was used. The material properties and stressstrain relations are defined according to EN 1993-1-2.

Figure 55 below illustrates the deformation response of the simply supported beam in fire at mid-span using shell elements under two different kind of point load 5090 N and 12726 N. The deformation curve by FE analysis captures the major behaviour of the simply supported beam in a fire. The failure mode is a plastic bending failure and later-torsional buckling in the mid-span of loading within orange is 5090 N and blue 12726 N. The fire resistance time was 7.15 minutes when 5090 N load was applied on the simply supported beam and 3.30 minutes when 12726 N load was applied. The deformation response seems closer to 22mm on 12726 N load and 23 mm on 5090 N load. The fire resistance time decreased when the load was increased in a simply supported beam in a fire.



Figure 55. Mid-span displacement by shell element model.



Figure 56. Lateral torsional buckling in mid-span loading of a simply supported beam under fire.

Figure 56 above shows the simulation result of simply supported beam heated from all four sides during structural fire analysis.
10 CONCLUSION AND FUTURE STEPS

This thesis investigated the nonlinear structural response of simply supported IPE beam subjected to mid-span load at both ambient and elevated temperatures. Five simulation tests and two fire tests, with a simply supported steel beam, were performed using LS-DYNA. Finite element model was modelled in LS-PrePost using the shell element using element formation 16. Static nonlinear implicit analysis and one explicit analysis were run in LS-DYNA during this thesis research. The structure fire analysis was carried out using an implicit solver due to less simulation running time, although an explicit solver is better for a large deformation and highly nonlinear material.

Lateral torsional buckling behaviour from the numerical simulation test is not an accidental consequence due to structure or material defects, but the real response mode of the structure. The consistency between the numerical simulation and experiment results also shows that FE code LS-DYNA effectively simulates LTB with material and geometrical nonlinearities. Based on the results in chapter 10, the following conclusions are drawn:

- (1) After observing the simulation, deformation modes and lateral displacement, it was noticed that under point load in the mid-span of a simply supported beam at both ambient and elevated temperatures leads to the lateral-torsional buckling. The maximum effect of displacement loading was in the mid-span of a beam by the local deformation in the upper flange of the IPE steel beam.
- (2) LS-DYNA was able to replicate the beam testing under mid-span loading on simply supported IPE beam as in the physical lab test, after comparing the result between simulation and experiment. There was a huge difference in load vs displacement curve between the LS-DYNA simulation and experimental results. The peak load and maximum displacement during the numerical simulation was 40 kN and 15 mm whereas the lab test it was 34.19 kN and 19 mm. The possible reason for this might be an error due to measurement, faulty equipment, external force, limitation of measuring devices during the experiment.
- (3) From mesh sensitivity analysis using implicit code results analysing the load vs displacement curve of four different finite element model of the simply supported beam with 2mm, 4mm, 6mm, 8mm, it was observed that the structure response was similar in all cases but there were huge changes in the peak load and the displacement. It was observed that there was some error in a mesh sensitivity analysis. Implicit static analysis was unsuccessful for the mesh sensitivity analysis. It was also found out that the smaller the mesh size the more simulation time was required in LS-DYNA.
- (4) From mesh sensitivity analysis using explicit code results analysing the load vs displacement curve of four different finite element model of the simply supported beam with 6mm, 8mm, 12mm and 14mm, it was observed that the structure response was similar in all cases but there were little changes in the peak load and displacement. Explicit static analysis was successful for

the mesh sensitivity analysis. By seeing the accuracy and the less solution time 8mm element size was sufficient.

- (5) From correlating the result from the implicit and explicit analysis it was found that compared to an explicit solver, implicit solver could achieve comparable results with drastically reducing computation time in LS-DYNA. The simulation time for the 6mm mesh sized finite element model took 58 seconds during implicit analysis while it took 2 hours 5 minutes during explicit analysis.
- (6) From the structural analysis of the simply supported beam subjected to the fire, it was found that the fire resistance time was less in higher loads. It was noticed fire resistance time was 7.15 minute during 5090 N loading and 3.30 minute during 12726 N loading.
- (7) In general, results illustrated previously in chapter 10 indicate that implicit and explicit static solver of LS-DYNA was able to capture the key phenomena of IPE steel beam under mid-span loading.

Recommendations for further development and use for the model introduced in this thesis are presented in the following:

The author suggests that finite element modelling can be modelled using beam element in LS- DYNA and results can be checked which is more accurate and less time consuming with the shell element result of this study.

Moreover, due to the more simulation consuming time for the structure fire analysis, implicit code was used for this thesis. The result can be seen using explicit code in LS-DYNA in the future, then fire residence time can be compared.

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APPENDIX

Appendix 1

Von Mises Stress simulation



Temperature Calculation from Excel sheet.

Temperature calculation of unprotected steel IPE beam with fire exposed from all side is explained in the following excel sheet.

Properties of steel							
Density of Steel(p)	7850	kg/m3			IPE100		
Coefficient of heat transfer(α c)	25	W/m2k	From standard ISO Fire curve		Depth(H)	100	mm
Surface emmissivity(ɛm)	0,7		EN1991-1-1-2(carbon steel)		Width(B)	55	mm
Emmissivity of Fire(ɛf)	1		EN1991-1-1-2		Web thickness(tw)	4,1	mm
Configuration factor(Φ)	1		EN1991-1-1-2		Flange thickness(t	5,7	mm
					Root radius(r)	7	mm
					Area of IPE 100(A)	1030	mm2
	Ur	nprotected Section(open s	ection exposed				
	Section factor(Am/V)	385,0485437					
	Correction Factor(ksh)	0,724583964					
	Surface area/I(Am)	396,6	EN1993-1-2:2005				
	Section factor(Am/V)box	310					
		View factor(Φ)	1				
		Emissivity of fire(ɛf)	1	EN1991-1-2			
		Surface temperature(0m)	20				
		Surface emissivity(cm)	1	EN1991-1-2			
		Specific heat of steel(Ca)	420				steel
		gas					
Time in second	Time in minute	Gas temperature(8g °C)	Design value of net heat flux (hnet,d	hnet,c	hnet,r	∆a,t(°C)	θa,t(°C)
		20	0	0	0		2
0	0	20	0	0	0	0	2
5	0,083333333	96,53781862	2361,072898	1913,445465	447,6274326	0,999	20,99
10	0,166666667	146,9519909	4086,765192	3148,824821	937,9403711	1,72916	22,72
15	0,25	184,6068329	5483,809939	4046,966893	1436,843046	2,32027	25,04
20	0,333333333	214,6736435	6672,332121	4740,630525	1931,701597	2,82314	27,87
25	0,416666667	239,7036237	7713,060217	5295,801448	2417,258769	3,26349	31,13
30	0,5	261,1446515	8641,504922	5750,23995	2891,264971	3,65632	34,79
35	0,583333333	279,898045	9480,494334	6127,666695	3352,827639	4,01131	38,80
40	0,666666667	296,5631595	10245,71353	6444,011802	3801,701732	4,33508	43,13
45	0,75	311,5588238	10948,48291	6710,526323	4237,956588	4,63243	47,77
50	0,833333333	325,1892705	11597,28625	6935,476651	4661,8096	4,90695	52,67
55	0,916666667	337,6824701	12198,67258	7125,132888	5073,539687	5,1614	57,83
60	1	349,2136658	12757,81887	7284,377685	5473,441187	5,39799	63,230
65	1,083333333	359,9204764	13278.8975	7417,09832	5861,799179	5,61846	68.8
70	1,166666667	369,9129515	13765.32521	7526,448702	6238,876506	5,82427	74,67
75	1.25	379,2804764	14219.93738	7615,029995	6604,907387	6,01663	80,69
80	1.333333333	388.0966424	14645.11328	7685.018521	6960.094762	6.19652	86.89
	-,			,			,

90	1,5	404,3104565	15414,92298	7776,330402	7638,592574	6,52224	99,7795
95	1,583333333	411,8035977	15762,75658	7800,60299	7962,153595	6,66941	106,449
100	1,666666667	418,9397843	16087,64791	7812,2724	8275,375509	6,80688	113,256
105	1,75	425,7514844	16390,70817	7812,393012	8578,315158	6,9351	120,191
110	1,833333333	432,2669281	16672,90717	7801,901505	8871,005669	7,05451	127,245
115	1,916666667	438,5108147	16935,09461	7781,636027	9153,458582	7,16544	134,411
120	2	444,5048779	17178,01758	7752,351595	9425,665984	7,26822	141,679
125	2,083333333	450,2683421	17402,33522	7714,732602	9687,602622	7,36314	149,042
130	2,166666667	455,818295	17608,63103	7669,403037	9939,227994	7,45042	156,493
135	2,25	461,1699923	17797,42335	7616,934928	10180,48842	7,5303	164,023
140	2,333333333	466,3371111	17969,17445	7557,855349	10411,3191	7,60297	171,626
145	2,416666667	471,3319602	18124,29841	7492,652278	10631,64614	7,66861	179,294
150	2,5	476,1656567	18263,16806	7421,779523	10841,38854	7,72736	187,022
155	2,583333333	480,8482752	18386,12113	7345,660882	11040,46025	7,77939	194,801
160	2,666666667	485,3889741	18493,4658	7264,693679	11228,77212	7,82481	202,626
165	2,75	489,7961034	18585,48567	7179,251768	11406,23391	7,86374	210,49
170	2,833333333	494,0772974	18662,44429	7089,688105	11572,75619	7,8963	218,386
175	2,916666667	498,2395539	18724,58931	6996,33695	11728,25236	7,9226	226,309
180	3	502,289303	18772,15627	6899,515755	11872,64052	7,94272	234,251
185	3,083333333	506,2324673	18805,37215	6799,526785	12005,84536	7,95678	242,208
190	3,166666667	510,0745136	18824,45856	6696,658515	12127,80004	7,96485	250,173
195	3,25	513,8204986	18829,63478	6591,186821	12238,44796	7,96704	258,14
200	3,333333333	517,475109	18821,1205	6483,376007	12337,74449	7,96344	266,104
205	3,416666667	521,0426965	18799,13837	6373,479683	12425,65869	7,95414	274,058
210	3,5	524,5273093	18763,91637	6261,741515	12502,17485	7,93924	281,997
215	3,583333333	527,9327194	18715,68988	6148,395851	12567,29403	7,91883	289,916
220	3,666666667	531,2624475	18654,70365	6033,668266	12621,03538	7,89303	297,809
225	3,75	534,5197844	18581,2135	5917,776001	12663,4375	7,86193	305,671
230	3,83333333	537,7078109	18495,48782	5800,928343	12694,55948	7,82566	313,496
235	3,916666667	540,8294154	18397,80886	5683,326921	12714,48194	7,78433	321,281
240	4	543,8873093	18288,47379	5565,165961	12723,30783	7,73807	329,019
245	4,083333333	546,8840411	18167,79561	5446,632475	12721,16313	7,68701	336,706
250	4,166666667	549,8220096	18036,10371	5327,906417	12708,19729	7,63129	344,337
255	4,25	552,7034753	17893,74434	5209,160797	12684,58354	7,57106	351,908
260	4,333333333	555,5305704	17741,08077	5090,561762	12650,51901	7,50646	359,415
265	4,416666667	558,3053089	17578,49329	4972,268655	12606,22463	7,43767	366,852
270	4,5	561,0295948	17406,3789	4854,434051	12551,94485	7,36485	374,217
275	4,583333333	563,7052301	17225,15093	4737,203775	12487,94716	7,28817	381,505
280	4,666666667	566,333922	17035,23829	4620,716906	12414,52138	7,20781	388,713
285	4,75	568,9172894	16837,08464	4505,105781	12331,97886	7,12397	395,837
290	4,833333333	571,4568688	16631,14735	4390,495985	12240,65137	7,03684	402,874

300	5	576,4104306	16197,81224	4164,748922	12033,06332	6,85349	416,674
305	5,083333333	578,8271216	15971,38576	4053,829012	11917,55675	6,75768	423,432
310	5,166666667	581,2054509	15739,11517	3944,345151	11794,77002	6,65941	430,091
315	5,25	583,5466172	15501,50495	3836,389128	11665,11582	6,55887	436,65
320	5,333333333	585,8517641	15259,06387	3730,046013	11529,01786	6,45629	443,106
325	5,416666667	588,1219833	15012,30312	3625,394196	11386,90892	6,35188	449,458
330	5,5	590,3583173	14761,7343	3522,505436	11239,22886	6,24587	455,704
335	5,583333333	592,5617628	14507,86751	3421,444931	11086,42258	6,13845	461,842
340	5,666666667	594,7332732	14251,20936	3322,2714	10928,93796	6,02986	467,872
345	5,75	596,873761	13992,26105	3225,037181	10767,22387	5,92029	473,793
350	5,833333333	598,9841	13731,51646	3129,788346	10601,72811	5,80997	479,603
355	5,916666667	601,0651279	13469,4603	3036,564835	10432,89547	5,69909	485,302
360	6	603,1176476	13206,56641	2945,400598	10261,16581	5,58786	490,889
365	6,083333333	605,1424297	12943,29604	2856,323759	10086,97228	5,47646	496,366
370	6,166666667	607,1402139	12680,09636	2769,356793	9910,739562	5,3651	501,731
375	6,25	609,1117108	12417,39899	2684,516716	9732,882274	5,25395	506,985
380	6,333333333	611,057603	12155,61875	2601,815284	9553,80347	5,14319	512,128
385	6,416666667	612,9785472	11895,15249	2521,259209	9373,893285	5,03298	517,161
390	6,5	614,875175	11636,37809	2442,850384	9193,527704	4,92349	522,085
395	6,583333333	616,7480944	11379,65359	2366,586111	9013,067483	4,81487	526,9
400	6,666666667	618,5978906	11125,31655	2292,459341	8832,85721	4,70725	531,607
405	6,75	620,4251279	10873,68344	2220,458921	8653,224517	4,60079	536,208
410	6,833333333	622,2303497	10625,04927	2150,569839	8474,479435	4,49558	540,703
415	6,916666667	624,0140802	10379,68737	2082,773477	8296,913897	4,39177	545,095
420	7	625,7768252	10137,84924	2017,047866	8120,801375	4,28944	549,384
425	7,083333333	627,5190727	9899,764596	1953,367932	7946,396664	4,18871	553,573
430	7,166666667	629,2412939	9665,641533	1891,705752	7773,935781	4,08965	557,663
435	7,25	630,943944	9435,6668	1832,030801	7603,635999	3,99234	561,655
440	7,333333333	632,6274628	9210,006179	1774,310193	7435,695985	3,89686	565,552
445	7,416666667	634,2922755	8988,804971	1718,508924	7270,296047	3,80327	569,355
450	7,5	635,9387931	8772,188576	1664,590102	7107,598475	3,71162	573,067
455	7,583333333	637,5674134	8560,263142	1612,515172	6947,74797	3,62195	576,689
460	7,666666667	639,1785214	8353,116285	1562,244136	6790,872149	3,5343	580,223
465	7,75	640,7724896	8150,817874	1513,735764	6637,08211	3,44871	583,672
470	7,833333333	642,3496788	7953,420854	1466,947791	6486,473064	3,36519	587,037
475	7,916666667	643,9104387	7760,962112	1421,837109	6339,125003	3,28376	590,321
480	8	645,455108	7573,463371	1378,359952	6195,103419	3,20442	593,525
485	8,083333333	646,9840151	7390,932103	1336,472064	6054,460039	3,12719	596,652
490	8,166666667	648,4974785	7213,362453	1296,128861	5917,233592	3,05206	599,704
495	8,25	649,9958069	7040,736167	1257,285581	5783,450586	2,97902	602,683
500	8,333333333	651,4793002	6873,023516	1219,897428	5653,126088	2,90806	605,591

510	8,5	654,4029363	6552,168301	1149,307903	5402,860397	2,7723	611,203
515	8,583333333	655,8436358	6398,917056	1116,017879	5282,899177	2,70746	613,91
520	8,666666667	657,2706142	6250,363816	1084,005886	5166,35793	2,6446	616,555
525	8,75	658,6841303	6106,434819	1053,228703	5053,206117	2,58371	619,139
530	8,833333333	660,0844358	5967,049997	1023,643706	4943,406292	2,52473	621,663
535	8,916666667	661,4717753	5832,123734	995,2089439	4836,91479	2,46764	624,131
540	9	662,8463867	5701,565591	967,8832032	4733,682388	2,4124	626,543
545	9,083333333	664,2085015	5575,280995	941,6260642	4633,654931	2,35897	628,902
550	9,166666667	665,5583449	5453,171888	916,3979513	4536,773937	2,3073	631,21
555	9,25	666,8961359	5335,137338	892,1601755	4442,977163	2,25736	633,467
560	9,333333333	668,2220879	5221,074108	868,87497	4352,199138	2,2091	635,676
565	9,416666667	669,5364085	5110,877194	846,5055197	4264,371674	2,16247	637,839
570	9,5	670,8393002	5004,440312	825,0159845	4179,424328	2,11744	639,956
575	9,583333333	672,1309599	4901,656365	804,3715181	4097,284847	2,07395	642,03
580	9,666666667	673,4115796	4802,417855	784,5382804	4017,879575	2,03196	644,062
585	9,75	674,6813465	4706,617272	765,4834467	3941,133826	1,99143	646,053
590	9,833333333	675,9404429	4614,147443	747,1752113	3866,972232	1,9523	648,006
595	9,916666667	677,1890468	4524,90185	729,5827882	3795,319062	1,91454	649,92
600	10	678,4273315	4438,774917	712,6764081	3726,098509	1,8781	651,798
605	10,08333333	679,6554662	4355,662264	696,4273115	3659,234952	1,84293	653,641
610	10,16666667	680,873616	4275,460935	680,8077401	3594,653194	1,809	655,45
615	10,25	682,0819419	4198,069601	665,7909249	3532,278676	1,77625	657,227
620	10,33333333	683,280601	4123,388734	651,3510717	3472,037662	1,74465	658,971
625	10,41666667	684,4697469	4051,320759	637,463346	3413,857413	1,71416	660,685
630	10,5	685,6495294	3981,770185	624,1038545	3357,666331	1,68473	662,37
635	10,58333333	686,8200947	3914,643713	611,2496263	3303,394087	1,65633	664,026
640	10,66666667	687,9815857	3849,850328	598,8785923	3250,971736	1,62892	665,655
645	10,75	689,1341422	3787,301374	586,9695638	3200,33181	1,60245	667,258
650	10,83333333	690,2779004	3726,910605	575,5022099	3151,408395	1,5769	668,835
655	10,91666667	691,4129936	3668,594236	564,4570343	3104,137202	1,55223	670,387
660	11	692,5395523	3612,270965	553,8153521	3058,455613	1,52839	671,915
665	11,08333333	693,6577037	3557,861993	543,5592653	3014,302728	1,50537	673,421
670	11,16666667	694,7675725	3505,29103	533,6716386	2971,619392	1,48313	674,904
675	11,25	695,8692804	3454,484292	524,1360751	2930,348216	1,46163	676,365
680	11,33333333	696,9629465	3405,370482	514,9368916	2890,433591	1,44085	677,806
685	11,41666667	698,0486874	3357,88078	506,0590944	2851,821686	1,42076	679,227
690	11,5	699,1266173	3311,948805	497,4883549	2814,46045	1,40133	680,628
695	11,58333333	700,1968475	3267,510586	489,2109854	2778,299601	1,38252	682,011
700	11,66666667	701,2594874	3224,504524	481,2139157	2743,290609	1,36433	683,375
705	11,75	702,3146438	3182,871345	473,4846693	2709,386676	1,34671	684,722
710	11,83333333	703,3624215	3142,554054	466,0113409	2676,542713	1,32965	686,052

720	12	705,4362483	3065,650239	451,7875359	2613,862703	1,29711	688,662
725	12,08333333	706,4624961	3028,960644	445,0159025	2583,944742	1,28159	689,943
730	12,16666667	707,4817626	2993,380684	438,4578309	2554,922853	1,26654	691,21
735	12,25	708,4941421	2958,86394	432,1039423	2526,759998	1,25193	692,462
740	12,33333333	709,4997271	2925,365938	425,9453012	2499,420637	1,23776	693,7
745	12,41666667	710,4986081	2892,844081	419,9733964	2472,870685	1,224	694,924
750	12,5	711,490874	2861,25759	414,1801224	2447,077468	1,21063	696,134
755	12,58333333	712,4766117	2830,567445	408,5577611	2422,009684	1,19765	697,332
760	12,66666667	713,4559067	2800,73632	403,0989646	2397,637355	1,18502	698,517
765	12,75	714,4288425	2771,728525	397,7967381	2373,931787	1,17275	699,69
770	12,83333333	715,3955013	2743,509948	392,644424	2350,865524	1,16081	700,851
775	12,91666667	716,3559636	2716,047991	387,6356859	2328,412305	1,14919	702
780	13	717,3103082	2689,311515	382,764494	2306,547021	1,13788	703,138
785	13,08333333	718,2586126	2663,270784	378,0251103	2285,245673	1,12686	704,264
790	13,16666667	719,2009528	2637,897406	373,4120746	2264,485331	1,11613	705,381
795	13,25	720,1374033	2613,164281	368,9201919	2244,244089	1,10566	706,486
800	13,33333333	721,0680373	2589,045548	364,5445186	2224,501029	1,09546	707,582
805	13,41666667	721,9929267	2565,516528	360,2803511	2205,236177	1,0855	708,667
810	13,5	722,9121418	2542,553682	356,1232138	2186,430468	1,07578	709,743
815	13,58333333	723,8257519	2520,134555	352,0688476	2168,065707	1,0663	710,809
820	13,66666667	724,733825	2498,237732	348,1131999	2150,124532	1,05703	711,866
825	13,75	725,6364277	2476,842792	344,2524135	2132,590378	1,04798	712,914
830	13,83333333	726,5336255	2455,930261	340,4828175	2115,447444	1,03913	713,953
835	13,91666667	727,4254829	2435,481575	336,8009176	2098,680657	1,03048	714,984
840	14	728,312063	2415,47903	333,2033874	2082,275643	1,02202	716,006
845	14,08333333	729,1934279	2395,905751	329,68706	2066,218691	1,01374	717,02
850	14,16666667	730,0696385	2376,745649	326,2489195	2050,49673	1,00563	718,025
855	14,25	730,9407549	2357,983385	322,8860938	2035,097291	0,99769	719,023
860	14,33333333	731,8068359	2339,604334	319,5958469	2020,008487	0,98991	720,013
865	14,41666667	732,6679394	2321,594554	316,3755723	2005,218981	0,98229	720,995
870	14,5	733,5241223	2303,940749	313,2227861	1990,717963	0,97482	721,97
875	14,58333333	734,3754405	2286,630242	310,1351207	1976,495121	0,9675	722,938
880	14,66666667	735,2219489	2269,650943	307,110319	1962,540624	0,96032	723,898
885	14,75	736,0637017	2252,991322	304,1462287	1948,845093	0,95327	724,851
890	14,83333333	736,9007519	2236,640378	301,2407966	1935,399582	0,94635	725,797
895	14,91666667	737,7331518	2220,587619	298,3920639	1922,195556	0,93956	726,737
900	15	738,5609528	2204,823032	295,5981612	1909,224871	0,93289	727,67
905	15,08333333	739,3842054	2189,337061	292,8573035	1896,479758	0,92633	728,596
910	15,16666667	740,2029593	2174,120585	290,1677866	1883,952798	0,9199	729,516
915	15,25	741,0172634	2159,164895	287,5279821	1871,636913	0,91357	730,43
920	15,33333333	741,8271659	2144,461675	284,9363343	1859,52534	0,90735	731,337

930	15,5	743,4339545	2115,781224	279,8916244	1835,8896	0,89521	733,134
935	15,58333333	744,2309329	2101,78915	277,4357794	1824,353371	0,88929	734,023
940	15,66666667	745,0236946	2088,019826	275,0225188	1812,997307	0,88347	734,906
945	15,75	745,8122837	2074,46662	272,650596	1801,816024	0,87773	735,784
950	15,83333333	746,5967441	2061,12319	270,3188175	1790,804373	0,87209	736,656
955	15,91666667	747,3771188	2047,983468	268,0260392	1779,957428	0,86653	737,523
960	16	748,1534501	2035,041643	265,7711651	1769,270478	0,86105	738,384
965	16,08333333	748,9257796	2022,292153	263,5531438	1758,73901	0,85566	739,239
970	16,16666667	749,6941484	2009,729671	261,370967	1748,358704	0,85034	740,09
975	16,25	750,458597	1997,349092	259,223667	1738,125425	0,8451	740,935
980	16,33333333	751,2191651	1985,14552	257,1103146	1728,035205	0,83994	741,775
985	16,41666667	751,975892	1973,114262	255,0300173	1718,084245	0,83485	742,61
990	16,5	752,7288161	1961,250817	252,9819177	1708,2689	0,82983	743,439
995	16,58333333	753,4779757	1949,550864	250,9651913	1698,585673	0,82488	744,264
1000	16,66666667	754,223408	1938,010253	248,9790452	1689,031208	0,82	745,084
1005	16,75	754,9651501	1926,624999	247,0227164	1679,602283	0,81518	745,899
1010	16,83333333	755,7032383	1915,391274	245,0954707	1670,295803	0,81042	746,71
1015	16,91666667	756,4377084	1904,305395	243,1966007	1661,108794	0,80573	747,516
1020	17	757,1685957	1893,363822	241,3254251	1652,038397	0,8011	748,317
1025	17,08333333	757,8959349	1882,563147	239,4812869	1643,08186	0,79653	749,113
1030	17,16666667	758,6197605	1871,900091	237,6635528	1634,236538	0,79202	749,905
1035	17,25	759,3401061	1861,371496	235,8716118	1625,499884	0,78757	750,693
1040	17,33333333	760,057005	1850,974317	234,104874	1616,869443	0,78317	751,476
1045	17,41666667	760,7704902	1840,705622	232,3627701	1608,342852	0,77882	752,255
1050	17,5	761,4805939	1830,562581	230,6447499	1599,917831	0,77453	753,029
1055	17,58333333	762,187348	1820,542465	228,9502817	1591,592184	0,77029	753,8
1060	17,66666667	762,890784	1810,642639	227,2788517	1583,363787	0,7661	754,566
1065	17,75	763,5909329	1800,860559	225,6299626	1575,230596	0,76197	755,328
1070	17,83333333	764,2878253	1791,193766	224,0031334	1567,190632	0,75788	756,086
1075	17,91666667	764,9814914	1781,639884	222,3978985	1559,241986	0,75383	756,839
1080	18	765,6719608	1772,196617	220,8138069	1551,38281	0,74984	757,589
1085	18,08333333	766,3592629	1762,861741	219,2504217	1543,611319	0,74589	758,335
1090	18,16666667	767,0434266	1753,633105	217,7073195	1535,925786	0,74198	759,077
1095	18,25	767,7244805	1744,508627	216,1840899	1528,324537	0,73812	759,815
1100	18,33333333	768,4024527	1735,486288	214,6803345	1520,805954	0,7343	760,55
1105	18,41666667	769,0773709	1726,564134	213,1956672	1513,368467	0,73053	761,28
1110	18,5	769,7492626	1717,740268	211,7297128	1506,010556	0,7268	762,007
1115	18,58333333	770,4181548	1709,012853	210,2821074	1498,730746	0,7231	762,73
1120	18,66666667	771,0840741	1700.380103	208,8524972	1491,527606	0,71945	763,449
1125	18,75	771,7470468	1691.840288	207,4405386	1484,39975	0,71584	764,165
1130	18.83333333	772,407099	1683 391726	206.0458976	1477.345828	0.71226	764.878

1140 1145	19 19,08333333	773,7185436	1666,761871	203,3072781	1463,454593	0,70523	766,291
1145	19,08333333	774 3699864					
	40.4000007	114,0000004	1658,577447	201,9626765	1456,614771	0,70176	766,993
1150	19,1666667	775,018609	1650,47801	200,6341453	1449,843865	0,69834	767,692
1155	19,25	775,6644359	1642,4621	199,3213935	1443,140707	0,69495	768,387
1160	19,33333333	776,3074909	1634,528295	198,0241374	1436,504158	0,69159	769,078
1165	19,41666667	776,9477979	1626,675212	196,7421008	1429,933111	0,68827	769,766
1170	19,5	777,5853801	1618,901502	195,4750146	1423,426488	0,68498	770,451
1175	19,58333333	778,2202607	1611,205854	194,2226164	1416,983237	0,68172	771,133
1180	19,66666667	778,8524624	1603,586987	192,9846505	1410,602336	0,6785	771,812
1185	19,75	779,4820079	1596,043653	191,7608675	1404,282786	0,67531	772,487
1190	19,83333333	780,1089192	1588,574638	190,5510241	1398,023614	0,67214	773,159
1195	19,91666667	780,7332185	1581,178754	189,354883	1391,823871	0,66902	773,828
1200	20	781,3549272	1573,854843	188,1722125	1385,68263	0,66592	774,494
1205	20,08333333	781,9740669	1566,601775	187,0027866	1379,598989	0,66285	775,157
1210	20,16666667	782,5906587	1559,418448	185,8463845	1373,572063	0,65981	775,817
1215	20,25	783,2047235	1552,303784	184,7027907	1367,600993	0,6568	776,473
1220	20,33333333	783,8162819	1545,25673	183,5717944	1361,684936	0,65382	777,127
1225	20,41666667	784,4253543	1538,276259	182,4531901	1355,823069	0,65086	777,778
1230	20,5	785,0319608	1531,361366	181,3467766	1350,014589	0,64794	778,426
1235	20,58333333	785,6361212	1524,511068	180,2523574	1344,25871	0,64504	779,071
1240	20,66666667	786,2378554	1517,724404	179,1697405	1338,554664	0,64217	779,713
1245	20,75	786,8371825	1511,000436	178,0987379	1332,901698	0,63932	780,353
1250	20,83333333	787,434122	1504,338245	177,039166	1327,299079	0,6365	780,989
1255	20,91666667	788,0286926	1497,736931	175,9908451	1321,746085	0,63371	781,623
1260	21	788,6209131	1491,195614	174,9535994	1316,242014	0,63094	782,254
1265	21,08333333	789,210802	1484,713433	173,9272568	1310,786176	0,6282	782,882
1270	21,16666667	789,7983777	1478,289544	172,911649	1305,377895	0,62548	783,507
1275	21,25	790,3836581	1471,923123	171,9066113	1300,016512	0,62279	784,13
1280	21,33333333	790,9666611	1465,613359	170,9119822	1294,701377	0,62012	784,75
1285	21,41666667	791,5474045	1459,359461	169,9276039	1289,431857	0,61747	785,368
1290	21,5	792,1259056	1453,160653	168,9533215	1284,207331	0,61485	785,983
1295	21,58333333	792,7021817	1447,016172	167,9889837	1279,027189	0,61225	786,595
1300	21,66666667	793,2762498	1440,925275	167,034442	1273,890833	0,60967	787,205
1305	21,75	793,8481268	1434,887228	166,0895509	1268,797678	0,60712	787,812
1310	21,83333333	794,4178294	1428,901317	165,1541679	1263,747149	0,60459	788,416
1315	21,91666667	794,985374	1422,966838	164,2281536	1258,738684	0,60207	789,018
1320	22	795,5507769	1417,083101	163,3113708	1253,77173	0,59958	789,618
1325	22,08333333	796,1140542	1411,24943	162,4036856	1248,845744	0,59712	790,215
1330	22,16666667	796,6752219	1405,465162	161,5049662	1243,960196	0,59467	790,81
1335	22,25	797,2342957	1399,729646	160,6150839	1239,114562	0,59224	791,402
1340	22,33333333	797,7912911	1394,042243	159,733912	1234,308331	0,58984	791,992

1240							
1340	22,33333333	797,7912911	1394,042243	159,733912	1234,308331	0,58984 7	91,992
1345	22,41666667	798,3462236	1388,402325	158,8613266	1229,540999	0,58745 7	92,579
1350	22.5	798,8991083	1382.809279	157,9972059	1224,812073	0,58508 7	93,164
1355	22 58333333	799 4499604	1377 262498	157 1414306	1220 121067	0 58274 7	93 747
1260	22,50555555	700 0087047	1271 76120	156 2020026	1215 467506	0.58041 7	04 227
1300	22,00000007	755,5567547	13/1,/0135	150,2536630	1213,407300	0,00041 7	54,327
1365	22,75	800,545626	1366,305372	155,45445	1210,850922	0,5781 7	94,906
1370	22,83333333	801,0904687	1360,893872	154,623017	1206,270855	0,57581 7	95,481
1375	22,91666667	801,6333374	1355,526328	153,7994739	1201,726854	0,57354 7	96,055
1380	23	802,1742463	1350,202188	152,9837121	1197,218476	0,57129 7	96,626
1385	23,08333333	802,7132095	1344,920909	152,1756251	1192,745284	0,56905 7	97,195
1390	23,16666667	803,2502408	1339,681958	151,375108	1188,30685	0,56684 7	97,762
1395	23.25	803,7853543	1334,484811	150,5820582	1183,902753	0,56464 7	98,327
1400	23 33333333	804 3185633	1329 328954	149 7963747	1179 53258	0 56245 7	98 889
1405	23,41656557	804 8498816	1324 213881	1/0 017058/	1175 105023	0,56029 7	00,005
1410	23,41000007	905 2702224	1210 120004	149,0175304	1170,000200	0,50025 7	00,000
1410	25,5	805,5795224	1319,139094	146,240/12	1170,892582	0,55614 6	00,008
1415	23,58333333	805,906899	1314,104105	147,4825398	1166,621565	0,55601 8	00,564
1420	23,66666667	806,4326245	1309,108432	146,725348	1162,383084	0,5539 8	01,118
1425	23,75	806,9565117	1304,151603	145,9750443	1158,176559	0,5518 8	01,669
1430	23,83333333	807,4785735	1299,233154	145,2315381	1154,001616	0,54972 8	02,219
1435	23,91666667	807,9988227	1294,352626	144,4947402	1149,857886	0,54766 8	02,767
1440	24	808,5172716	1289.509571	143,7645633	1145,745008	0.54561 8	03,312
1445	24 08333333	809 0339328	1284 703546	143 0409213	1141 662625	0 54357 8	03 856
1450	24 16666667	800 5/88185	1270 03/116	142 3237206	1137 610386	0.54156 8	04 397
1455	24,10000007	000,0400100	1275,554110	142,3237230	1107,010080	0,54150 0	04,007
1455	24,25	610,0019409	12/5,200853	141,0129052	1100,08/948	0,53355 8	05,475
1460	24,3333333	810,5733121	12/0,503336	140,9083665	1129,594969	0,53/57 8	05,475
1465	24,41666667	811,0829438	1265,84115	140,2100331	1125,631117	0,53559	806,01
1470	24,5	811,590848	1261,213888	139,5178262	1121,696062	0,53363 8	06,544
1475	24,58333333	812,0970363	1256,621149	138,8316681	1117,789481	0,53169 8	07,075
1480	24,66666667	812,6015203	1252,062537	138,1514826	1113,911054	0,52976 8	07,605
1485	24.75	813,1043114	1247,537663	137,4771946	1110.060468	0,52785 8	08,133
1490	24 83333333	813 6054208	1243 046145	136 8087303	1106 237415	0 52595 8	08 659
1495	24,00000000	814 10486	1020 507604	136 1460172	1102 //1580	0.52406	00 182
1495	24,91000007	014,10480	1238,587000	130,1400172	1102,441369	0,52400 6	09,185
1500	25	814,6026398	1234,161675	135,4889839	1098,672691	0,52219 8	09,705
1505	25,08333333	815,0987714	1229,767987	134,8375602	1094,930427	0,52033 8	10,226
1510	25,16666667	815,5932655	1225,406183	134,1916769	1091,214506	0,51848 8	810,744
1515	25,25	816,0861331	1221,075907	133,5512663	1087,524641	0,51665 8	11,261
1520	25,33333333	816,5773847	1216,776812	132,9162614	1083,86055	0,51483 8	11,776
1525	25,41666667	817,0670308	1212,508553	132,2865965	1080,221957	0,51303 8	12,289
1530	25.5	817 5550821	1208 270793	131 6622068	1076 608586	0 51123	812.8
1535	25 5833333	818 0415487	1204.053198	131 0430286	1073 02017	0.50945 8	13 309
1540	25,56555555	010 526441	1100 99544	120 4200002	1060 456441	0,50545 0	12 017
1540	25,0000007	810,0007602	1199,00044	120,4205555	1065,450441	0,50709 0	01/ 01/
1545	25,75	819,0097692	1195,/3/196	129,8200572	1065,91713	8 0,50595	814,525
1550	25,83333333	819,4915432	1191,618146	129,2161416	1062,40200	4 0,50419	814,827
1555	25,91666667	819,9717731	1187,527977	128,6171928	1058,91078	0,50246	815,33
1560	26	820,4504687	1183,46638	3 128,0231518	1055,44322	0,50074	815,83
1565	26 08333333	820,9276398	1179,433049	127,4339608	1051,99908	8 0,49903	816,329
	20,0000000					0 49734	816 827
1570	26,16666667	821,4032961	1175,427685	5 126,8495627	1048,57812		010,011
1570 1575	26,16666667	821,4032961 821,8774471	1175,427685 1171.44999	5 126,8495627 9 126,2699016	1048,57812	0.49565	817.322
1570 1575 1580	26,166666667 26,25 26,33333333	821,4032961 821,8774471 822,3501023	1175,427685 1171,44999 1167 499675	5 126,8495627 9 126,2699016 5 125 6949219	1048,57812 1045,18008 1041,80475	0,49565	817,322
1570 1575 1580 1585	26,16666667 26,25 26,33333333 25,41665667	821,4032961 821,8774471 822,3501023 822,85012713	1175,427685 1171,44999 1167,499675 1163,57645	126,8495627 126,2699016 125,6949219 125,1245695	1048,57812 1045,18008 1041,80475 1038,4518	0,49565 0,49398 0,49398	817,322 817,816 818,309
1570 1575 1580 1585	26,16666667 26,25 26,3333333 26,41666667	821,4032961 821,8774471 822,3501023 822,8212713	1175,427685 1171,44995 1167,499675 1163,57645	126,8495627 126,2699016 125,6949219 125,1245695	1048,57812 1045,18008 1041,80475 1038,4518	0,49565 0,49398 0,49232	817,322 817,816 818,309
1570 1575 1580 1585 1590	26,16666667 26,25 26,3333333 26,41666667 26,5	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632	1175,427685 1171,44995 1167,499675 1163,57645 1159,680032	 126,8495627 126,2699016 125,6949219 125,1245695 124,5587905 	1048,57812 1045,18008 1041,80475 1038,4518 1035,12124	0,49565 0,49398 0,49232 0,49067	817,322 817,816 818,309 818,799
1570 1575 1580 1585 1590 1595	26,16666667 26,25 26,3333333 26,41666667 26,5 26,58333333 26,58333333	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873	1175,427685 1171,44995 1167,499675 1163,57645 1159,680032 1155,810142	 126,8495627 126,2699016 125,6949219 125,1245695 124,5587905 123,9975324 	1048,57812 1045,18008 1041,80475 1038,4518 1035,12124 1031,8126	0,49565 0,49398 0,49232 0,49067 1 0,48904	817,322 817,816 818,309 818,799 819,288
1570 1575 1580 1585 1590 1595 1600	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,666666667	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528	1175,427685 1171,44995 1167,49967 1163,57645 1159,68003 1155,810142 1155,810142 1151,966505	 126,8495627 126,2699016 125,6949219 125,1245695 124,5587905 123,9975324 123,4407431 	1048,57812 1045,18008 1041,80475 1038,4518 1035,12124 1031,8126 1028,52576	0,49565 0,49398 0,49398 0,49232 0,49067 10,48904 0,48741	817,322 817,816 818,309 818,799 819,288 819,776
1570 1575 1580 1585 1590 1595 1600 1605	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,666666667 26,75	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687	1175,427685 1171,44995 1167,499675 1163,57645 1159,680032 1155,810142 1151,966505 1148,148848	 126,8495627 126,2699016 125,6949219 125,1245695 124,5587905 123,9975324 123,4407431 122,8883713 	1048,57812 1045,18008 1041,80475 1038,4518 1035,12124 1031,8126 1028,52576 1025,26047	0,49565 0,49398 0,49398 0,49322 0,49067 0,48904 0,48904 0,48741 0,4858	817,322 817,816 818,309 818,799 819,288 819,776 820,262
1570 1575 1580 1585 1590 1595 1600 1605 1610	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,66666667 26,75 26,83333333	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144	1175,427685 1171,44995 1167,499675 1163,57645 1159,680032 1155,810142 1151,966505 1148,148848 1144,356904	226,8495627 126,2699016 5125,6949219 5125,1245695 2124,5587905 2123,9975324 5123,4407431 8122,8883713 4122,3403668	1048,57812 1045,18006 1041,80475 1038,4518 1035,12124 1031,8126 1028,52576 1025,26047 1022,01653	0,49565 3 0,49565 3 0,49398 8 0,49232 12 0,49067 13 0,48904 14 0,48904 15 0,48741 17 0,4858 18 0,48419	817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,66666667 26,75 26,8333333 26,66666667 26,75 26,8333333 26,91666667	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,259528 824,6912687 825,155144 825,6175875	1175,427685 1171,44995 1167,499675 1163,57645 1155,880032 1155,810142 1151,966505 1148,148846 1144,356904 1140,5990405	5 126,8495627 9 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,4407431 8 122,8883713 8 122,3403668 9 121,7966797	1048,57812 1045,18008 1041,80475 1038,4518 1035,12124 1031,8126 1028,52576 1025,26047 1022,01653 1018,7937	0,49565 33 0,49368 38 0,49398 38 0,49232 42 0,49067 51 0,48904 52 0,48741 77 0,4858 88 0,48249 93 0,48266	817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,66666667 26,75 26,8333333 26,91666667 27	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082	1175,427685 1171,44995 1167,49967 1163,57645 1159,68003 1155,810142 1151,966505 1148,148846 1144,356904 1140,590405 1136,844103	5 126,8495627 9 126,2699016 5 125,6949219 5 125,1245695 1 124,5587905 1 123,9975324 5 123,4407431 8 122,8883713 1 122,3403668 9 121,7966797 8 121,2572613	1048,57812 1045,18005 1041,80475 1038,4518 1035,12124 1031,8126 1028,52576 1025,26047 1022,01653 1018,7937 1015,59184	10 0,49565 3 0,49565 3 0,49368 8 0,49232 2 0,49067 1 0,48904 2 0,494067 1 0,48904 2 0,48741 7 0,4858 8 0,48419 '3 0,4826 42 0,48101	817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228 821,709
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,66666667 26,75 26,8333333 26,91666667 27 27,0833333	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147	1175,427685 1171,44995 1167,499675 1163,57645 1159,680032 1155,810142 1151,966505 1148,148848 1144,355904 1140,590405 1136,649103 1133,132728	 126,8495627 126,2699016 125,6949219 125,56949219 125,1245695 124,5587905 123,9975324 123,4407431 122,8883713 122,3403668 121,796679 121,2572613 120,7220632 	1048,57812 1045,18006 1041,80475 1038,4518 1035,12124 1031,8126 1028,52576 1025,26047 1022,01655 1018,7937 1015,59184 1012,41066	19 0,49565 3 0,49565 3 0,49368 8 0,4938 8 0,49232 2 0,49067 1 0,48904 2 0,48404 2 0,48414 7 0,4858 8 0,48419 3 0,4826 12 0,48101 15 0,47944	817,322 817,816 818,309 818,799 819,776 820,262 820,746 821,228 821,709 822,189
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630	26,16666667 26,25 26,3333333 26,41666667 26,58333333 26,66666667 26,75 26,8333333 26,91666667 27 27,08333333 27,1666667	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,6175875 825,6175875 826,0786082 826,5382147 826 9964156	1175,427685 1171,44995 1167,499675 1163,57645 1159,680032 1155,810142 1151,966505 1148,148846 1144,356904 1144,356904 1146,849103 1133,132728 1129,44103	5 126,8495627 9 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,407431 8 122,8883713 8 122,3403668 9 121,7966797 8 121,2572613 8 120,7220632 2 120 191038	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1031,8126 1028,52576 1022,01653 1018,7937 1015,59184 1012,41066 1009,4496	 0,49565 0,49368 0,49388 0,49232 0,49067 0,48904 0,48904 0,48741 0,4858 0,48419 0,4826 0,48104 0,4826 0,48104 0,47788 	817,812 817,816 818,309 818,799 819,288 819,776 820,262 820,746 820,262 820,746 821,228 821,709 822,189 822,667
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,666666667 26,75 26,8333333 26,91666667 27 27,0833333 27,16666667 27 5 27,5	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196	1175,427685 1171,44995 1167,49967 1163,57645 1155,880032 1155,810142 1155,810142 1151,966505 1148,14884 1144,356904 1144,356904 1136,849103 1138,132722 1129,441032 1125,72326	5 126,8495627 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,4407431 8 122,8883713 8 122,3403668 9 121,7966797 8 121,2572613 8 120,7220632 2 120,191038 5 119,664139	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1031,8126 1028,52576 1022,01653 1018,7937 1015,59184 1012,41066 1009,24999 1006,10953	0,49565 3 0,49365 3 0,49398 48 0,49232 42 0,49067 51 0,48904 52 0,48741 77 0,4858 88 0,48419 73 0,4826 52 0,48101 55 0,47788 66 0,47788	817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228 821,709 822,189 822,667 833,143
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,66666667 26,75 26,8333333 26,916666667 27 27,0833333 27,16666667 27 27,25 27,2	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,4532196	1175,427685 1171,44995 1167,49967 1163,57645 1159,68003 1155,810142 1155,810142 1151,966505 1148,148846 1144,356904 1136,844103 1133,132728 1129,441032 1122,773765 1130,132728 1129,441032 1122,773765 1130,132728 1130,132728 1130,132728 1129,441032 1122,773765 1130,132728 1130,132728 1120,13278 1120,1	5 126,8495627 126,2699016 5 125,6949219 5 125,1245695 1 124,5587905 1 123,9975324 5 123,4407431 1 122,8883713 1 122,3403668 9 121,7966797 1 121,2572613 8 120,7220632 1 120,191038 5 119,664139 1 19,143420	1048,57812 1045,18005 1041,80475 1038,4518 1035,12124 1031,8126 1028,52576 1025,26047 1022,01653 1018,7937 1015,59184 1012,41066 1009,24999 1006,1092,0002	0,49565 3 0,49365 3 0,49368 48 0,49232 2 0,49067 1 0,48304 2 0,48741 7 0,48841 7 0,4826 12 0,48101 15 0,47748 26 0,47788 21 0,47427	817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228 821,709 822,189 822,667 823,143 832,649
1570 1575 1580 1585 1590 1605 1600 1605 1610 1615 1620 1625 1630 1635 1640	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,666666667 26,75 26,8333333 26,91666667 27 27,0833333 27,16666667 27,25 27,3333333 27,16666667	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,9086352 827,9086352	1175,427685 1171,44995 1167,499675 1163,57645 1159,680032 1155,810142 1151,966505 1148,148848 1144,356904 1144,356904 1144,356904 1146,59040 1133,132722 1129,441032 1125,773765 1122,130688 1122,130688 1125,703765 1122,130688 1125,703765 1122,130688 1125,703765 1122,130688 1125,703765 1122,130688 1125,703765 1122,130688 1125,703765 1122,130688 1125,703765 1122,130688 1125,703765 1122,130688 1125,703765 1122,130688 1125,703765 1125,703765 1122,130688 1125,703765 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576 1125,70576	5 126,8495627 9 126,2699016 125,6949219 5 125,1245695 2 123,9975324 5 123,9975324 5 123,4407431 8 122,8883713 8 122,3403668 9 121,7966797 3 121,2572613 8 120,7220632 2 120,191038 5 119,664139 1 19,1413199	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1028,52576 1025,25047 1022,01653 1018,7937 1015,59184 1012,41066 1009,24999 1006,10962 1002,98933	9 0,49565 3 0,49398 8 0,49232 2 0,49067 1 0,48904 2 0,48741 7 0,4858 8 0,48101 3 0,4826 2 0,48741 4 0,47788 6 0,47633 1 0,47499 4 0,47499 4 0,47499 5 0,47494 5 0,47494 5 0,47494 5 0,47494 5 0,47495 5 0,47494 5 0,47495 5 0,47494 5 0,47495 5 0,47494 5 0,47495 5 0,47494 5 0,47495 5 0,4955 5 0,4905 5 0,4905	817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228 821,709 822,189 822,667 823,143 823,618
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645	26,16666667 26,25 26,3333333 26,41666667 26,58333333 26,666666667 26,75 26,8333333 26,91666667 27 27,0833333 27,16666667 27,25 27,3333333 27,41666667	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,9086352 828,3626706	1175,427685 1171,44995 1167,49967 1163,57645 1159,680032 1155,810142 1155,810142 1155,810142 1154,14844 1144,355904 1144,355904 1140,590405 1136,849103 1125,773765 1122,130681 1118,511536 1128,5156 1128,	5 126,8495627 9 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,4077431 8 122,8483713 8 122,3403668 9 121,7966797 8 121,2572613 8 120,7220632 2 120,191038 5 119,664139 1 19,1413199 5 118,6225354	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1031,8126 1025,26047 1022,01655 1018,7937 1015,59184 1012,41066 1009,24999 1006,10962 1002,98936 999,889000	9 0,49565 3 0,49398 8 0,49232 2 0,49067 1 0,48904 2 0,48904 2 0,48904 2 0,48904 2 0,48904 2 0,48904 2 0,48904 2 0,48904 3 0,4826 2 0,48101 5 0,47944 4 0,47788 1 0,47429 1 0,47326 5 0,47326 5 0,47326 5 0,47326 5 0,4938 5 0,49398 5 0,48904 5 0,47944 5 0,47944 5 0,47479 5 0,47326 5 0,4746 5 0,4746 5 0,	817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228 821,709 822,189 822,667 823,143 823,618 824,091
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1645	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,66666667 26,75 26,833333 26,91666667 27 27,0833333 27,16666667 27,25 27,3333333 27,16666667 27,25 27,3333333	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,5155144 825,6175875 826,0786082 826,5382147 826,964156 827,4532196 827,9086352 828,8626706 828,8153344	1175,427685 1171,44995 1167,499675 1163,57645 1155,860032 1155,810142 1155,810142 1151,966505 1144,518844 1144,356904 1144,5590405 1133,132728 1122,441032 1125,773765 1122,130683 1118,511536 1114,916091	5 126,8495627 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,4407431 8 122,8883713 8 122,3403668 9 121,7966797 8 121,2572613 8 120,7220632 1 20,7120632 1 20,7120632 1 19,664139 1 19,1413199 5 118,622354 1 18,1077408	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1031,8126 1028,52576 1025,26047 1022,01653 1018,7937 1015,59184 1012,41066 1009,24995 1006,10962 1002,98936 999,889000 9996,808345	9 0,49565 3 0,49398 8 0,49232 1 0,49067 1 0,48904 2 0,48741 7 0,4858 8 0,4419 3 0,4826 2 0,48741 7 0,4858 8 0,44419 3 0,4826 0,47748 8 0,47788 8 0,47738 1 0,47738 1 0,47739 1 0,4733 1 0,4753 1 0,4	817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228 821,709 822,189 822,667 823,143 823,614 824,091 824,563
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650	26,16666667 26,25 26,3333333 26,41666667 26,5 26,58333333 26,66666667 26,75 26,8333333 26,91666667 27 27,0833333 27,16666667 27,25 27,3333333 27,41666667 27,5 27,5833333	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,0786082 826,5382147 826,9964156 827,4532196 827,4532196 827,9086352 828,8266706 828,8153344 829,2666348	1175,427685 1171,44995 1167,49967 1163,57645 1159,68003 1155,810142 1155,810142 1151,966505 1148,148844 1144,356904 1136,849103 1133,132728 1129,441032 1122,773765 1122,130681 1118,511536 1114,916091 1111,34411	5 126,8495627 9 126,2699016 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,4407431 8 122,8883713 4 122,3403668 9 121,7966797 121,2572613 8 120,7220632 2 120,191038 5 119,664139 119,1413199 5 118,6223554 1 18,1077408 117,5968918	1048,57812 1045,18005 1038,4518 1035,12124 1031,8126 1028,52576 1025,26047 1022,01653 1018,7937 1015,59184 1012,41066 1009,24999 1006,10962 1002,98936 999,889300 999,88345 993,747217	9 0,49565 3 0,49398 8 0,49232 2 0,49067 1 0,48904 1 0,48904 1 0,48904 1 0,48504 8 0,48191 3 0,4826 2 0,48101 5 0,47944 4 0,47788 1 0,47798 1 0,47479 1 0,47479 1 0,474732 1 0,47022 7 0,47022 1 0,4702 1 0,4702 1 0,47022 1 0,47022 1 0,47022 1 0,47022 1 0,47022 1 0,4702 1 0,47022 1 0,47022 1 0,47022 1 0,4702 1 0,4702 1 0,4702 1 0,4702 1 0,4702 1 0,4702 1 0,4702 1 0,4702	817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228 821,709 822,189 822,667 823,143 823,618 824,963 824,963 824,503
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1615 1625 1630 1635 1640 1645 1650 1655 1660	26,16666667 26,25 26,3333333 26,41666667 26,5 26,58333333 26,566666667 26,75 26,8333333 26,916666667 27,25 27,16666667 27,25 27,3333333 27,16666667 27,5 27,5833333 27,5833333 27,56666667	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,4532196 827,9086352 828,8153344 829,2666348 829,7165798	1175,427685 1171,44995 1167,49967 1163,5764 1159,680032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1148,14884 1144,355904 1140,590405 1136,849102 1122,130681 1118,511536 1118,511536 1114,916092 1111,34411 1107,795355 1107,95355 1007,9555 1007,955	5 126,8495627 9 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,407431 8 122,8883713 8 122,3403668 9 121,7966797 8 121,2572613 8 120,7220632 2 120,191038 5 119,664139 1 19,1413199 5 118,6225354 1 18,1077408 1 117,5968918 9 117,5968918	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1035,12124 1025,26047 1022,01653 1018,7937 1015,59184 1002,4999 1006,10962 1002,98936 999,889000 996,80834 993,747217 990,705413	9 0,49565 33 0,49398 88 0,49232 20,49067 0,48904 12 0,49067 12 0,48904 12 0,48904 12 0,48904 12 0,48904 12 0,48904 13 0,4826 14 0,48101 15 0,47044 14 0,47784 16 0,47479 11 0,47471 19 0,47173 19 0,46872 19 0,46872	817,322 817,816 818,309 819,776 820,262 820,746 821,228 821,709 822,889 822,667 823,143 822,618 823,618 824,091 824,663 825,502
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665	26,16666667 26,25 26,3333333 26,41666667 26,5 26,58333333 26,666666667 26,75 26,8333333 26,91666667 27 27,0833333 27,16666667 27,25 27,3333333 27,41666667 27,5 27,5833333 27,666666667 27,55	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,5382147 826,5382147 826,5382147 826,9864156 827,4532196 827,9086352 828,3626706 828,8153344 829,2666348 829,7165798 830,1651778	1175,427685 1171,44995 1167,49967 1163,57645 1155,80032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1144,356904 1144,356904 1136,849103 1133,132722 1129,411032 1125,773765 1122,130683 1118,511536 1114,916093 1111,34411 1107,795355 1104,266605 1104,266605 1104,266605 107,265605 107,265605 107,265605 1064,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,265605 107,27575 1	5 126,8495627 9 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 1 123,4407431 8 122,8883713 8 122,3403668 9 121,7966797 8 121,2572613 8 120,7220632 1 20,191038 6 119,664139 1 19,664139 1 19,664139 1 19,664139 1 18,6225354 1 18,1077408 1 17,596918 9 117,0899451 9 116,5868578	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1031,8126 1025,26047 1022,01653 1018,7937 1015,59184 1012,41066 1009,24999 1006,10962 1002,98936 999,889000 9996,808346 9997,747217 990,705413 987,682751	0,4936 0,49398 0,49398 0,49398 0,49398 0,49398 0,49398 0,49398 0,49398 0,4904 20,48067 0,48904 20,4807 30,4826 20,48101 50,47944 0,47944 0,47788 60,47633 10,47479 10,47479 10,47429 90,47173 70,4852 20,47022 20,47022 20,46723 20,46732	817,322 817,816 818,309 819,288 819,776 820,262 820,746 821,228 821,228 821,709 822,189 822,667 823,143 823,618 824,091 824,563 825,503 825,503
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1670	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,66666667 26,75 26,8333333 26,916666667 27 27,0833333 27,16666667 27,25 27,3333333 27,41666667 27,5 27,5833333 27,566666667 27,5 27,5833333 27,66666667 27,75 27,8333333	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912887 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,4532196 827,4532196 827,9086352 828,8153344 829,2665348 829,7165798 830,1651778 830,6124366	1175,427685 1171,44995 1167,49967 1163,57645 1155,880032 1155,810142 1155,810142 1155,810142 1148,148844 1144,356904 1138,148446 1140,590405 1138,14275 1122,430681 1118,511535 1114,916091 1111,34411 1107,795355 1104,269605 1100,766633	5 126,8495627 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,4407431 8 122,8883713 8 122,3403668 9 121,7966797 8 121,2572613 8 120,7220632 1 20,191038 5 119,664139 1 19,64139 1 19,64139 1 19,64139 1 19,64139 1 19,642354 1 117,5968918 9 116,5868578 9 116,5868578 1 16,0875877	1048,57812 1045,18005 1041,80475 1035,12124 1031,8126 1028,52576 1025,26047 1022,01653 1018,7937 1015,59184 1012,41066 1009,24999 1006,10962 1002,98936 1002,98936 999,889000 999,88000 999,8762,513 987,62751 987,62751	9 0,49565 3 0,49398 8 0,49232 1 0,49067 1 0,48904 2 0,48741 7 0,4858 8 0,4824 2 0,48741 7 0,4858 8 0,4824 2 0,4810 5 0,47944 4 0,47788 1 0,47479 9 0,47479 9 0,47479 9 0,47479 9 0,47479 9 0,47472 9 0,46872 9 0,46872 2 0,46872 2 0,46723 5 0,4	817,322 817,322 817,816 818,309 819,776 820,262 820,746 821,228 821,709 822,189 822,667 823,143 824,951 824,951 824,953 824,951 824,553 825,502 825,502 825,502
1570 1575 1580 1585 1590 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1655 1650 1655 1660 1665 1670	26,16666667 26,25 26,3333333 26,41666667 26,5 26,58333333 26,566666667 26,75 26,8333333 26,91666667 27 27,0833333 27,16666667 27,25 27,3333333 27,41666667 27,5 27,5833333 27,56666667 27,5 27,5833333 27,6666667 27,75 27,8333333 27,6666667 27,75 27,8333333 27,6666667 27,75 27,8333333 27,6666667 27,75 27,8333333 27,6666667 27,75 27,8333333 27,6666667 27,75 27,8333333 27,6666667 27,75 27,8333333 27,6666667 27,75 27,8333333 27,6666667 27,75 27,8333333 27,6666667 27,75 27,8333333 27,9666667 27,75 27,8333333 27,9666667 27,75 27,8333333 27,9666667 27,75 27,75 27,833333 27,9666667 27,75 27,8333333 27,9666667 27,75 27,8533333 27,9666667 27,75 27,8533333 27,9666667 27,75 27,8533333 27,9666667 27,75 27,8533333 27,9666667 27,75 27,8533333 27,9666667 27,75 27,8533333 27,9666667 27,75 27,8533333 27,96666667 27,75 27,8533333 27,9666667 27,75 27,8533333 27,9666667 27,75 27,8533333 27,96666667 27,75 27,8533333 27,9666667 27,75 27,8535 27,9666667 27,75 27,8535 27,9666667 27,75 27,8535 27,9666667 27,75 27,8535 27,9666667 27,75 27,8535 27,9666667 27,75 27,8535 27,9666667 27,75 27,855 27,9667 27,75 27,9666667 27,75 27,855 27,9666667 27,75 27,855 27,9666667 27,75 27,9666667 27,75 27,855 27,9666667 27,75 27,855 27,9666667 27,75 27,9667 27,9667 27,95 27,	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,0786082 826,5382147 826,9964156 827,4532196 827,9086352 828,82626706 828,8153344 829,2666348 829,7165798 830,1651778 830,6124366 831 0583643	1175,427685 1171,44995 1167,49967 1163,57645 1159,68003 1155,810142 1155,810142 1151,966505 1148,148844 1144,356904 1133,132728 1129,441032 1125,773765 1122,130681 1118,511536 1114,916091 1111,34411 1107,795355 1104,266603 1100,766633 1092,286206	5 126,8495627 9 126,2699016 125,6949219 5 125,1245695 1 23,9975324 1 23,9975324 1 23,4407431 8 122,8883713 1 122,3403668 9 121,7966797 3 121,2572613 8 120,7220632 1 120,191038 5 119,664139 1 19,1413199 1 18,622354 1 18,622354 1 18,622354 1 18,627408 1 17,0899451 9 116,588578 1 16,0875877 5 115,5920931 1 15,5920931 1 15,5920931 1 15,5920931 1 12,5920931 1 12,59209 1 12,59209 1 12,59209 1 12,59209 1 12,5	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1035,12124 1028,52576 1025,25047 1022,01653 1018,7937 1015,59184 1012,41066 1009,24999 1006,10962 1002,89936 999,88900 996,808345 993,747217 990,705413 987,682751 984,67504	9 0,49565 3 0,49398 8 0,49232 2 0,49067 1 0,48904 1 0,48904 1 0,48904 1 0,48904 1 0,48904 1 0,48578 8 0,48101 1 0,48101 1 0,48101 1 0,47788 1 0,47788 1 0,47788 1 0,47732 1 0,47722 1 0,46772 1 0,46575 1 0,46575	817,322 817,822 817,816 818,309 819,776 820,262 820,746 821,228 821,709 822,189 822,667 823,143 823,618 824,563 824,563 824,563 825,502 825,502 825,502
1570 1575 1580 1585 1590 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1660	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,666666667 26,75 26,8333333 26,91666667 27 27,0833333 27,16666667 27,25 27,5833333 27,16666667 27,5 27,5833333 27,56666667 27,75 27,5833333 27,916666667 27,75 27,8333333 27,916666667 27,75 27,8333333 27,916666667 27,75 27,8333333 27,916666667 27,75 27,91667 27,916	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,4532196 827,9086352 828,8153344 829,2666348 829,7165798 830,1651778 830,6124366 831,058643 831,058643 831,058643	1175,427685 1171,44995 1167,49967 1163,57645 1155,860032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1144,355904 1144,355904 1144,355904 1135,81392 1125,773765 1122,130681 1118,511536 1114,916091 1111,34411 1107,795355 1104,266605 1100,766633 1097,285206 1097,28520	5 126,8495627 9 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 1 23,4077431 8 122,8483713 8 122,3403668 9 121,7966797 8 121,2572613 1 20,7220632 1 19,1413199 5 118,6225354 1 18,1077408 1 17,5968918 9 117,0899451 9 116,5868578 3 116,0875877 5 115,592093 1 15,592093 1 15,59209 1 15,59209 1 15,592093 1 15,592093 1 1 1 1 1 1	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1031,8126 1025,26047 1022,01655 1018,7937 1015,59184 1009,24999 1006,10962 1002,98936 999,889300 999,889300 999,889300 999,889300 999,747217 990,705413 987,682751 984,67904 981,664794	9 0,49565 30 0,49368 33 0,49398 48 0,49232 20 0,49067 12 0,48904 12 0,48904 12 0,48904 12 0,48904 12 0,48904 12 0,48904 13 0,4826 14 0,47484 15 0,47479 10 0,47173 17 0,46827 19 0,46723 19 0,46723 10 0,4627 12 0,46273 13 0,46273 14 0,47738 15 0,46273 16 0,46273 17 0,46273 18 0,46273 19 0,46273 10 0,46273 10 0,46273 13 0,46273 14 0,46273 15 0,46273	817,322 817,816 818,309 819,776 820,262 820,746 821,228 821,709 822,889 822,667 823,143 823,618 824,091 824,603 825,502 825,969 825,863 825,969
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1655 1660 1675 1660	26,1666667 26,25 26,333333 26,41666667 26,5 26,5833333 26,91666667 27,5 26,833333 26,91666667 27,25 27,0833333 27,16666667 27,25 27,333333 27,41666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,5666667 27,5 27,833333 27,91666667 28,27 27,8333333 27,91666667 28,28 28,2920000000000000000000000000000000000	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9664156 827,4532196 827,9086352 828,8153344 829,2666348 829,7165798 830,6124366 831,0583643 831,5029687 831,042572	1175,427685 1171,44995 1167,49967 1163,57645 1155,86003 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1140,590405 1144,5590405 1133,132722 1129,441033 1122,130683 1118,511536 1124,310693 1114,916093 1114,916093 1114,916093 1114,916093 1114,926905 1100,766633 1097,286206 1093,828105 1097,286206 1093,828105 1093,828	5 126,8495627 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,407431 8 122,8883713 8 122,3403668 9 121,7966797 8 121,2572613 8 120,7220632 120,7120632 120,7120632 119,664139 119,664139 119,664139 119,664139 119,664139 119,664139 119,664139 117,5968918 9 117,5968918 9 117,598918 9 116,5888578 116,0875877 5 115,5920931 8 115,100335 114,6103567 115,100335 114,6103567 114,510335 114,6103567 114,510335 114,6103567 114,510335 114,6103567 115,100335 114,610356 114,6103567 115,5920931 114,610356 114,6103567 115,5920931 114,610356 114,6103567 115,5920931 114,610356 114,6103567 115,5920931 114,610356 114,6103567 115,5920931 115,100335 114,6103567 115,5920931 115,100335 114,6103567 115,5920931 115,100355 114,6103567 115,5920931 115,100355 115,5920931 115,10035 115,5920931 115,10035 115,5920931 115,592093 115,592093 115,592093 115,592093 115,592093 115,592093 115,592093 115,592093 115,592093 115,592093 115,592093 115,592093 115,5920 115,59209 115,5920 115,59209 115,59209 115,59209 115,5920	1048,57812 1043,18002 1041,80475 1038,4518 1035,12124 1031,8126 1028,52576 1022,01653 1018,7937 1015,59184 1012,41066 1009,24995 1006,10962 1002,98936 999,889000 9996,808345 9997,47217 990,705413 987,682751 984,67904 981,694112 978,727775	9 0,49565 3 0,49398 8 0,49232 1 0,49067 1 0,48904 2 0,48741 7 0,4858 8 0,4824 2 0,48741 7 0,4858 8 0,48419 3 0,4826 3 0,4826 3 0,4826 1 0,47798 1 0,47798 1 0,47799 1 0,4737 1 0,4737 1 0,4737 1 0,4737 2 0,46872 2 0,46872 2 0,46231 5 0,46237 5 0,46247 2 0,46281 2 0,46281	817,322 817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,728 822,189 822,189 822,667 823,143 824,091 824,563 825,033 825,502 825,650 825,502 825,6435 826,839 827,362
1570 1575 1580 1585 1590 1605 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1670 1675 1680 1685	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,66666667 26,75 26,8333333 26,91666667 27 27,08333333 27,16666667 27,25 27,3333333 27,16666667 27,5 27,5833333 27,56666667 27,5 27,5833333 27,66666667 27,5 27,5833333 27,91666667 28 28,0833333 28	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,9086352 828,8153344 829,2666348 829,7165798 830,1651778 830,6124366 831,0583643 831,5029687 831,9462578	1175,427685 1171,44995 1167,49967 1163,57645 1159,680032 1155,810142 1155,810142 1155,810142 1148,148844 1144,3569040 1136,849103 1138,132728 1129,441032 1122,130681 1118,51536 1114,916091 1111,34411 1107,795355 1104,269605 1100,766633 1097,285206 1093,828108 1099,392121	5 126,8495627 9 126,2699016 125,6949219 5 125,1245695 2 123,9975324 5 123,9975324 123,4407431 8 122,8883713 1 122,3403668 9 121,7966797 121,2572613 8 120,7220632 1 120,191038 5 119,664139 1 19,1413199 5 118,6225354 1 18,1077408 1 17,5968918 9 116,5868578 1 16,5868578 1 16,5868578 1 16,5868578 1 15,5920931 3 115,100333 1 14,6122659 1 14,6122659 1 14,6122659 1 14,6122659 1 12,25920931 1 12,100333 1 14,6122659 1 12,62931 1 12,100333 1 14,6122659 1 12,25920931 1 12,100333 1 12,100333 1 14,6122659 1 12,25920931 1 12,100333 1 14,6122659 1 12,25920 1 12,25920 1 12,10033 1 12,10033 1 14,6122659 1 12,25920 1	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1035,12124 1028,52576 1022,52576 1022,01653 1018,7937 1015,59184 1012,41066 1009,24999 1006,10962 1006,10962 1006,10962 1006,10962 999,889000 996,808345 993,747217 990,705413 987,682751 984,667904 981,694112 978,727775	9 0,49565 3 0,49398 8 0,49232 2 0,49067 1 0,48904 1 0,48904 1 0,48904 1 0,48904 1 0,4858 8 0,48141 1 0,4858 8 0,48261 2 0,48104 1 0,4738 1 0,47798 1 0,47798 1 0,47479 1 0,47326 1 0,47479 1 0,46421 1 0	817,322 817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228 821,709 822,189 822,667 823,143 824,663 824,563 824,563 824,563 825,503 825,502 825,969 826,435 826,435 826,435 827,862 827,86
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1660 1665 1675 1680 1685 1690	26,16666667 26,25 26,3333333 26,41666667 26,5 26,58333333 26,566666667 26,75 26,8333333 26,91666667 27 27,08333333 27,16666667 27,25 27,3333333 27,416666667 27,5 27,5833333 27,56666667 27,5 27,5833333 27,916666667 28 28,0833333 28,16666667	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,4532196 827,9086352 828,8153344 829,7165798 830,6124366 831,0551778 830,6124366 831,5029687 831,9462578 832,3882392	1175,427685 1171,44995 1167,499675 1163,57645 1159,680032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1144,355904 1144,355904 1144,355904 1140,590405 1136,849103 1136,849103 1136,849103 1136,849103 1136,849103 1136,849103 1136,849103 1136,849103 1136,849103 1136,849103 1136,849103 1136,849103 1136,849103 1136,849103 1136,849103 1136,849103 1144,549103 1114,916091 1111,34411 1107,795355 1104,269605 1100,766633 1097,286206 1099,828106 1099,828106 1099,392121 1086,97803	5 126,8495627 9 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,407431 8 122,8883713 1 22,3403668 9 121,7966797 8 121,2572613 8 120,7220632 2 120,191038 5 119,664139 1 19,1413199 5 118,6225354 1 18,077408918 9 116,5868578 8 116,0875877 5 115,5920931 8 115,100333 1 14,6122659 8 114,6122659 8 114,1278551 1 14,52851 1 12,5549 1 14,52851 1 14,52851 1 12,5549 1 14,52851 1 14,52851 1 15,550 1 14,52851 1 14,52851 1 14,52851 1 14,52851 1 14,52851 1 14,52851 1 14,52851 1 15,550 1 14,52851 1 14,528551 1 14,52855 1 14,52855 1 14,52855 1 14,52855 1 14,52855 1 14,52855 1 14,52855 1 14,52855 1 14,52855 1 15,550 1 14,5285 1 14,52855 1 14,5285 1 14,5285	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1035,12124 1025,26047 1022,01653 1018,7937 1015,59184 1002,41066 1009,24995 1006,10962 1002,98936 999,889000 996,80834 993,747217 990,705413 987,682751 984,67914 978,727775 978,727775	9 0,49565 30 0,49398 88 0,49232 20,49067 0,48904 12 0,49067 12 0,48904 12 0,48904 12 0,48904 12 0,48904 12 0,48904 12 0,48904 13 0,4826 14 0,4781 15 0,47444 0,47723 19 0,47723 19 0,47723 19 0,4627 12 0,46427 13 0,46136 13 0,46136 13 0,46136	817,322 817,322 817,816 818,309 819,776 820,262 820,746 821,228 821,709 822,189 822,667 823,143 823,618 824,563 825,502 825,502 825,502 825,643 825,502 825,643 826,435 826,435 827,823 827,823
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1655 1650 1655 1660 1675 1660 1675 1680 1685 1690	26,16666667 26,25 26,3333333 26,41666667 26,5 26,58333333 26,91666667 27,75 27,0833333 27,16666667 27,25 27,333333 27,16666667 27,5 27,5833333 27,416666667 27,5 27,5833333 27,416666667 27,5 27,5833333 27,916666667 27,75 27,8333333 27,91666667 28,28 28,0833333 28,16666667 28,25	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,5382147 826,5382147 826,986156 827,9086352 828,8153344 829,2666348 829,2666348 829,7165798 830,1651778 830,6124366 831,083643 831,5029687 831,9462578 832,3882392 832,88289207	1175,427685 1171,44995 1167,49967 1163,57645 1155,80032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1144,356904 1144,356904 1144,356904 1133,132722 1129,411032 1125,773765 1122,130683 1118,511536 1114,916093 1111,34411 1107,795355 1104,265605 1100,766633 1097,285206 1093,828106 1093,828106 1090,392121 1086,97803 1083,585622	5 126,8495627 9 126,2699016 125,6949219 5 125,1245695 2 124,5587905 2 124,5587905 2 123,9975324 122,3407431 8 122,8883713 8 122,3403668 9 121,7966797 8 121,2572613 8 120,7220632 2 120,191038 5 119,664139 119,1413199 5 118,6225354 118,1077408 117,9689451 9 116,5868578 8 116,0875877 5 115,5920931 8 115,100331 8 114,6122669 8 114,1278551 2 113,6470582	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1035,12124 1025,26047 1022,01653 1018,7937 1015,59184 1012,41066 1009,24999 1006,10962 1002,98936 999,889300 999,889300 999,889300 999,889300 999,889300 999,889300 999,747217 987,682751 984,67904 981,694112 975,779854 975,779854	9 0,49565 3 0,49368 9 0,49565 3 0,49398 8 0,49232 10 0,49067 11 0,48264 12 0,48741 17 0,48588 0,48264 0,48741 13 0,4819 14 0,47788 15 0,47633 11 0,47633 12 0,46872 13 0,47633 14 0,47633 15 0,46872 19 0,46872 19 0,46213 10 0,4722 10 0,4627 12 0,46213 13 0,46213 14 0,45214 15 0,45214 16 0,45214 17 0,45213 18 0,45214 19 0,45214 10 0,45214 10 0,45214	817,322 817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228 821,228 821,228 822,189 822,189 822,667 823,143 824,091 824,563 825,063 825,969 825,502 825,969 825,502 825,825 825,829 827,823 826,835 827,823 828,283 827,283 828,283 828,283 828,283 828,283 828,283 828,283 828,283 828,283 828,283 828,283 828,283 828,283 827,293 827,29
1570 1575 1580 1585 1590 1605 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1655 1650 1655 1660 1665 1675 1680 1685 1690 1695 1700	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,916666667 27 27,0833333 26,91666667 27 27,0833333 27,16666667 27,25 27,333333 27,41666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,916666667 27,75 27,8333333 27,916666667 28,25 28,08333333 28,16666667 28,25 28,3333333	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,4532196 827,4532196 827,4532196 828,8153344 829,2666348 829,7165798 830,6124366 831,0583643 831,5029687 831,9462578 832,3882392 832,882392 832,882392	1175,427685 1171,44995 1167,49967 1163,57645 1155,80032 1155,810142 1155,810142 1155,810142 1148,148846 1144,356904 1144,356904 1133,132728 1122,441032 1122,130683 1118,511536 1114,916091 1111,34411 1107,795355 1104,269605 1100,766633 1097,286206 1093,828106 1093,828106 1093,828106 1093,828202 1094,828402 1094,828402 1094,828402 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,84844 1094,94	5 126,8495627 9 126,2699016 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,4407431 8 122,8883713 4 122,3403668 9 121,7966797 121,2572613 8 120,7220632 1 20,191038 5 119,664139 1 19,64139 1 19,64139 1 19,64139 1 19,64335 1 19,664358 1 115,5920931 3 115,100333 1 14,6122669 3 115,100333 1 14,6122659 3 115,100333 1 14,6122659 3 113,6470582 3 113,1698373	1048,57812 1045,18005 1041,80475 1035,12124 1035,12124 1035,12124 1025,26047 1025,26047 1025,26047 1012,41066 1009,24995 1006,10962 1002,98936 999,889000 996,808349 999,747217 9987,682751 984,67904 981,694112 978,727775 975,779854 975,7798501 969,938564 967,044851	9 0,49565 3 0,49368 33 0,49398 40,49232 0,49067 10 0,49067 11 0,4854 12 0,48041 13 0,4854 14 0,4858 15 0,47944 14 0,47798 16 0,47633 11 0,47394 12 0,46173 13 0,46723 14 0,47722 19 0,46723 10 0,4723 10 0,4723 10 0,4723 10 0,4723 10 0,4723 10 0,4723 10 0,47732 10 0,46273 10 0,46281 13 0,46136 12 0,458491 10 0,45705	817,322 817,322 817,816 818,309 818,799 819,776 820,262 820,746 821,228 822,677 822,189 822,667 823,143 824,663 824,563 824,563 824,563 825,502 825,648 825,633 825,502 825,648 826,489 826,489 827,862 827,862 827,862 827,862 828,742 829,745 829,745 829,745 829,74
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1655 1660 1665 1660 1665 1660 1665 1660 1675 1680 1685 1690 1695 1700	26,1666667 26,25 26,333333 26,41666667 26,5 26,5833333 26,66666667 26,75 26,833333 26,91666667 27 27,0833333 27,16666667 27,25 27,333333 27,41666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,91666667 27,75 27,8333333 27,91666667 28,25 28,08333333 28,16666667	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,259528 824,6912687 825,155144 825,6175875 826,0786082 826,0786082 826,0786082 826,0786082 826,0786082 827,4532196 827,4532196 827,9086352 828,3626706 828,8153344 829,2666348 829,7165798 830,651778 830,6124366 831,0583643 831,5029687 831,9462578 832,3882392 832,8289207 833,2683099 833,7064143	1175,427685 1171,44995 1167,49967 1163,5764 1159,680032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1148,14884 1144,355904 1140,590405 1136,849102 1136,849102 1133,132725 1122,130681 1118,511536 1112,130681 1118,511536 1107,79555 1104,269605 1100,766632 1097,285002 1093,828100 1093,828102 1093,828102 1093,828102 1093,828102 1093,828102 1085,97802 1085,97802 1085,87802 1085,856222 1080,214685	5 126,8495627 9 126,2699016 125,6949219 125,1245695 123,9975324 123,9975324 123,4407431 8 122,8883713 122,3403668 9 121,7966797 3 121,2572613 8 120,7220632 120,7220632 120,191038 5 119,664139 119,1413199 118,622354 118,627354 118,627354 116,588578 116,588578 116,588578 116,0875877 5 115,5920931 8 115,100333 1 114,6122669 8 114,1278551 2 113,6493873 9 113,1698373 2 112,6961544	1048,57812 1043,18002 1041,80475 1038,4516 1035,12124 1035,12124 1028,52576 1025,26047 1022,01653 1018,7937 1015,59184 1002,40969 1006,10962 1002,98936 999,88900 996,808349 993,747217 990,705413 987,682751 984,67904 981,694112 978,727775 975,779854 972,85017 969,935517 967,044851 967,044851	9 0,49565 30 0,49368 33 0,49398 48 0,49232 42 0,49067 42 0,49067 41 0,48504 42 0,48074 41 0,48504 43 0,48101 44 0,47788 45 0,47479 40 0,47732 40 0,47732 40 0,47732 40 0,46772 40 0,46772 40 0,46773 50 0,46487 40 0,46773 50 0,46487 40 0,46773 50 0,46487 40 46281 40 46281 40 46281 40 46281 40 46281 40 46281 40 46281 40 46281 40 453848	817,322 817,816 818,309 818,799 819,786 819,776 820,262 820,746 821,228 821,709 822,189 822,667 823,143 824,563 824,563 825,502 825,502 825,503 825,502 826,859 826,859 827,862 827,86
1570 1575 1580 1585 1590 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1660 1665 1677 1680 1685 1680 1685 1690 1695 1700	26,16666667 26,25 26,3333333 26,41666667 26,5 26,58333333 26,666666667 27,25 27,0833333 27,16666667 27,25 27,333333 27,16666667 27,25 27,5833333 27,416666667 27,5 27,5833333 27,416666667 27,5 27,5833333 27,916666667 27,75 27,8333333 27,916666667 28,25 28,0833333 28,16666667 28,25 28,333333 28,16666667 28,25 28,333333 28,16666667 28,25 28,333333 28,16666667 28,25 28,333333 28,1666667 28,25 28,333333 28,1666667 28,25 28,333333 28,1666667 28,25 28,333333 28,1666667 28,25	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,9086352 828,3626706 828,8153344 829,2666348 829,2666348 829,7165798 830,1651778 830,6124366 831,058543 831,5029687 831,9462578 832,3882392 832,882392 833,2683099 833,7064143 884,143241	1175,427685 1171,44995 1167,49967 1163,57645 1155,860032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1144,355904 1144,355904 1144,355904 1144,355904 1133,132722 1122,130681 1113,511536 1114,916091 1113,54115 1104,266605 1100,766633 1097,285206 1093,828106 1093,828106 1093,828106 1093,828106 1093,828106 1093,828106 1093,828106 1096,97803 1083,585622 1083,585622 1083,585622 1075,536415 1075,556415 1075,556415 1075,55641	5 126,8495627 9 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,9975324 5 123,4077431 8 122,3403668 9 121,7966797 8 121,2572613 1 20,7220632 1 120,191038 5 119,664139 1 19,1413199 5 118,6225354 1 18,1077408 1 117,5968918 9 116,5868578 3 116,0875877 5 115,592031 8 115,100333 1 14,6122669 3 114,6122659 1 13,6470582 9 113,6470582 9 113,698773 1 12,59218 9 113,6470582 9 113,6961544 9 112,2259718 9 112,259718	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1035,12124 1025,26047 1022,01655 1018,7937 1015,59184 1002,4999 1006,10962 1002,98936 999,889300 999,889300 999,889300 999,889300 999,747217 990,705413 987,682751 984,67904 981,694112 978,72777 975,779854 972,85017 969,938564 967,044851 964,168867 961,310447	9 0,49565 30 0,49398 80 0,49232 20 0,49067 12 0,49067 12 0,49067 12 0,48904 12 0,48904 12 0,48904 12 0,48904 12 0,48904 12 0,4858 80 0,48101 15 0,47438 10 0,47738 10 0,47713 17 0,40627 19 0,46723 19 0,46127 12 0,46427 13 0,46136 15 0,45591 12 0,45848 13 0,45705 12 0,45843 13 0,45705 12 0,45423 13 0,45705 14 0,45705 15 0,45423 16 0,45563 17 0,45423 <td>817,322 817,322 817,816 818,309 819,776 820,262 820,746 821,228 821,709 822,667 823,143 823,618 824,091 824,563 825,502 825,969 825,633 825,502 825,969 827,823 828,283 828,283 828,283 828,742 829,199 829,654</td>	817,322 817,322 817,816 818,309 819,776 820,262 820,746 821,228 821,709 822,667 823,143 823,618 824,091 824,563 825,502 825,969 825,633 825,502 825,969 827,823 828,283 828,283 828,283 828,742 829,199 829,654
1570 1575 1580 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1655 1660 1675 1660 1675 1680 1685 1690 1695 1700 1705 1710	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,91666667 27 27,0833333 26,91666667 27 27,0833333 27,16666667 27,25 27,3333333 27,16666667 27,5 27,5833333 27,416666667 27,5 27,5833333 27,916666667 27,5 27,8333333 27,916666667 28,25 28,0833333 28,16666667 28,25 28,333333 28,416666667 28,25 28,533333 28,41666667 28,5 28,5 28,533333	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,5382147 826,9364156 827,4532196 827,9086352 828,3626706 828,8153344 829,2666348 829,2666348 829,7165798 830,1651778 830,6124366 831,0583643 831,5029687 831,9462578 833,2683099 833,2683099 833,7064143 834,1432414 834,1432414	1175,427685 1171,44999 1167,49967 1163,57645 1155,80032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1144,556904 1144,556904 1133,132725 1122,430683 1122,430683 1114,916091 1111,34411 1107,795355 1104,269605 1109,28502 1093,828105 1093,828105 1093,828105 1093,828105 1093,828105 1093,828105 1093,828105 1093,828105 1093,828105 1093,828105 1093,828105 1093,828105 1083,585622 1083,585622 1075,855025 1077,356612 1077,356612 1077,356612	5 126,8495627 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,407431 8 122,8883713 8 122,3403668 9 121,7966797 8 121,2572613 8 120,7220632 120,71038 8 119,664139 119,1413199 5 118,6225354 118,1077408 117,5969184 9 117,0899451 9 116,588578 8 116,0875877 5 115,5920931 8 115,100333 114,6122669 8 114,1278551 2 113,6470582 9 113,1698373 2 112,6961544 9 112,2259718 8 111,759752	1048,57812 1043,18002 1041,80475 1038,4518 1035,12124 1031,8126 1028,52576 1022,0643 1012,50647 1022,01653 1018,7937 1015,59184 1012,41066 1009,24995 1006,10962 1002,88936 999,889000 999,889000 999,889000 999,889000 999,88946 993,747217 990,705413 987,682751 984,67904 981,694112 975,779854 972,85017 969,938564 967,044851 964,168867 961,310447 961,310447	9 0,49565 30 0,49398 88 0,49232 10,49904 0,49067 11 0,4856 12 0,49067 12 0,480419 13 0,4854 14 0,4856 15 0,47944 10,47794 0,47738 11 0,47739 10,47723 0,46872 19 0,47173 10,46723 0,46672 15 0,46572 19 0,46136 13 0,45126 14 0,45705 15 0,45533 16 0,45705 17 0,45234 10 0,45705 12 0,45423 13 0,45423 14 0,45423 14 0,45423 14 0,45423	817,322 817,322 817,816 818,309 818,799 819,788 819,776 820,262 820,746 821,729 822,189 822,667 823,143 824,563 824,951 824,563 825,502 825,623 825,635 826,435 826,435 826,435 826,435 826,839 827,362 827,823 828,742 829,199 829,654 830,561
1570 1575 1580 1585 1590 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1660 1665 1670 1675 1680 1685 1680 1685 1690 1695 1700 1705 1710	26,16666667 26,25 26,3333333 26,41666667 26,5 26,58333333 26,666666667 27,5 26,8333333 26,91666667 27,2 27,08333333 27,16666667 27,25 27,3333333 27,4666667 27,5 27,58333333 27,566666667 27,5 27,58333333 27,91666667 28,28,8333333 28,16666667 28,25 28,5833333 28,41666667 28,5833333 28,56666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,5833333 28,666667 28,585 28,58	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912887 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,4532196 827,4532196 827,4532196 827,4532196 828,8153344 829,2665348 829,7165798 830,6124366 831,0583643 831,5029687 831,9462578 832,3882392 832,882392 832,882392 833,2683099 833,7064143 834,1432414 834,5787987 831,012035	1175,427685 1171,44995 1167,49967 1163,57645 1155,80032 1155,810142 1155,810142 1155,810142 1155,810142 1148,148846 1144,356904 1148,59400 1136,849103 1133,132728 1122,430631 1122,130681 1112,130681 1114,916091 1111,34411 1107,795355 1104,269605 1109,786206 1093,828108 1093,828108 1093,828108 1093,828202 1097,856202	5 126,8495627 9 126,2699016 125,6949219 5 125,1245695 2 123,9975324 5 123,9975324 123,4407431 8 122,8883713 1 122,3403668 9 121,7966797 1 21,2572613 8 120,7220632 1 20,191038 5 119,664139 1 19,1413199 1 18,6225354 1 18,6225354 1 18,6275851 8 116,0875877 5 115,5920931 3 115,100333 1 14,6122669 8 114,1278551 2 113,6470582 9 113,1698373 2 112,6961544 9 112,229718 3 117,7956291 9 112,259718 1 11,7955291 9 112,259718 1 11,7955291 1 11,7955291 1 11,7955291 1 11,795529 1 11,7955291 1 11,795529 1 11,7955	1048,57812 1045,18002 1041,80475 1038,4516 1035,12124 1035,12124 1028,52576 1025,25047 1022,01653 1018,7937 1015,59184 1012,41066 1009,24999 1006,10962 1006,10962 1002,89936 999,88900 996,808345 993,747217 990,705413 987,682751 984,667904 981,694112 975,779854 972,85017 966,938564 967,044851 9661,310447 961,310447	9 0,49565 30 0,49368 33 0,49398 48 0,49232 40 0,49067 41 0,4804 41 0,48568 42 0,48741 47 0,48588 48 0,484191 43 0,48101 43 0,48101 44 0,47788 46 0,47738 410 0,47731 47 0,46723 50 0,46742 40 0,47732 40 0,47732 40 0,47722 40 0,46723 50 0,456427 40 0,45733 50 0,45635 50 0,45543 30 0,45763 51 0,45283 40 0,45283 40 0,45283 40 0,45283 40 0,45283 40 0,45283 <	817,322 817,322 817,816 818,309 818,799 819,786 819,776 820,262 820,746 821,228 821,709 822,189 822,667 823,143 824,563 824,563 824,563 824,563 824,563 825,502 825,502 825,503 825,502 825,503 825,502 825,503 825,502 825,503 825,502 826,455 826,455 826,455 827,862 827,86
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1665 1660 1665 1660 1665 1660 1665 1670 1665 1680 1685 1680 1685 1690 1695 1700 1705 1710	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,66666667 27,25 27,0833333 27,16666667 27,25 27,16666667 27,25 27,5833333 27,16666667 27,5 27,5833333 27,16666667 27,5 27,5833333 27,16666667 27,5 27,5833333 27,916666667 28,25 28,0833333 28,16666667 28,25 28,333333 28,41666667 28,5 28,5833333 28,41666667 28,5 28,5833333 28,41666667 28,5 28,5833333 28,5 28,5833333 28,5 28,5833333 28,5 28,5 28,5833333 28,5 28,5 28,5 28,5 28,5 28,5 28,5 28,5	821,4032961 821,8774471 822,3501023 822,8212713 823,209632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,4532196 827,9086352 828,3626706 828,8153344 829,7165798 830,6124366 831,058643 831,5029687 831,9462578 833,068243 831,9462578 833,2683099 833,7064143 834,1432414 834,5787987 835,0130935	1175,427685 1171,44995 1167,49967 1163,57645 1159,680032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1144,355904 1144,355904 1144,355904 1140,590405 1136,849103 1136,849103 1136,849103 1122,130681 1118,51153 1122,130681 1118,51153 1114,916091 1111,34411 1107,795355 1104,269605 1109,786502 1098,828106 1099,828106 1099,828106 1099,828106 1099,828106 1099,828106 1098,585622 1088,585622 1076,856502 1077,2856415 1070,228678 1069,941595 1069,94159 1069,94159 1069,94159 1069,94159 1079,8550 1079,8500	5 126,8495627 9 126,2699016 5 125,6949219 5 125,1245695 2 123,9975324 5 123,9975324 5 123,407431 8 122,883713 1 22,3403668 9 121,7966797 8 121,2572613 8 120,7220632 2 120,191038 5 119,664139 1 19,1413199 5 118,6225354 1 18,077408 1 117,5968918 9 116,5868578 8 116,0875877 5 115,5920918 8 113,1698373 1 12,6961544 9 112,2259718 8 111,7592522 9 111,2959591 9 110,826557	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1035,12124 1025,26047 1022,01653 1018,7937 1015,59184 1002,201653 1018,7937 1015,59184 1002,24995 1006,10962 1002,98936 999,88900 999,88900 999,88900 999,88900 999,88904 993,747217 990,705413 984,679412 978,72777 969,938544 967,044851 964,168867 961,310447 958,469425 955,645644	9 0,49565 30 0,49368 33 0,49398 48 0,49232 20 0,49067 12 0,48904 20 0,48904 20 0,48904 20 0,48741 70 0,4858 80 0,48101 20 0,47431 10 0,47732 10 0,47732 10 0,47732 10 0,47732 10 0,47732 10 0,47732 10 0,47732 10 0,47732 10 0,47732 10 0,47732 10 0,47732 10 0,47732 10 0,46723 12 0,46575 13 0,46136 13 0,45144 10 0,45144 10 0,45144	817,322 817,816 818,309 818,799 819,776 820,262 820,746 821,228 821,709 822,667 823,143 823,618 824,563 825,502 825,969 826,839 826,835 826,839 827,822 827,823 828,283 828,283 828,283 828,742 829,1954 830,108 830,561 831,013 831,615 831,615 83
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1670 1675 1680 1665 1670 1675 1680 1685 1690 1695 1700 1705 1710 1715	26,16666667 26,25 26,3333333 26,41666667 26,5 26,58333333 26,91666667 27,75 27,0833333 27,16666667 27,25 27,3333333 27,16666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,91666667 28,25 28,0833333 28,16666667 28,25 28,5333333 28,16666667 28,5 28,5833333 28,56666667 28,5 28,5833333 28,66666667 28,5 28,5833333 28,66666667 28,5 28,5 28,5833333 28,6666667 28,5	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,5382147 826,5382147 826,986156 827,9086352 828,8153344 829,2666348 829,2666348 829,7165798 830,1651778 830,6124366 831,0583643 831,5029687 831,9462578 831,9462578 833,2882992 833,2882992 833,2883099 833,7064143 834,1432414 834,5787887 835,0130935 835,4461331	1175,427685 1171,44995 1167,49967 1163,57645 1155,80032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1144,356904 1144,356904 1144,356904 1133,132725 1122,130681 1133,132725 1122,130681 1113,313725 1122,130681 1113,41135 1114,916091 1111,34111 1107,795355 1104,266605 1100,76663 1097,285205 1093,828105 1094,8355 1094,2455 1095,2455 1094,2455 1097,28575 1094,2455 1097,28575 1097,29575 1097,	5 126,8495627 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 124,5587905 2 123,9975324 5 123,4077431 8 122,8483713 8 122,3403668 9 121,7966797 8 121,2572613 8 120,7220632 1 120,191038 5 119,664139 1 19,1413199 5 118,6225354 1 18,1077408 1 17,9689451 9 115,5920931 8 116,5868578 3 116,0875877 5 115,5920931 8 115,100333 1 14,6122659 8 114,1278551 2 113,6470582 9 113,1698373 1 12,6961548 9 112,259718 8 111,7592522 9 111,2959591 8 110,8305683 1 12,6961544 9 112,2259718 8 111,7592522 9 111,2959591 8 110,8305683 1 12,6961544 9 112,259718 1 10,8305683 1 12,6961544 1 12,6961544 1 12,695154 1 11,7592522 9 111,2959591 8 110,8305683 1 12,695154 1 12,695154 1 12,695154 1 12,695154 1 12,695154 1 12,695154 1 12,695154 1 12,695154 1 11,7592522 9 111,295591 8 110,8305683 1 12,695154 1 1	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1031,8126 1025,26047 1022,01655 1018,7937 1015,59184 1012,41066 1009,24999 1006,10962 1002,98936 999,889000 999,889000 999,889000 999,889000 999,88346 993,747217 990,705413 987,682751 984,67904 981,694112 975,779854 975,779854 975,779854 967,044851 964,168867 961,310447 955,645640 952,838931	9 0,49565 30 0,49368 33 0,49398 34 0,49398 35 0,49398 36 0,49398 37 0,4858 36 0,48419 37 0,4858 36 0,47479 37 0,47793 310 0,47729 311 0,47729 312 0,46872 313 0,46872 314 0,46136 315 0,46136 316 0,45253 317 0,4523 318 0,45705 319 0,45243 320 0,45563 321 0,45234 321 0,45234 322 0,45423 323 0,45423 324 0,452433 324 0,452433 324 0,452433 324 0,45423 324 0,45423 324 <td< td=""><td>817,322 817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228 822,189 822,189 822,667 823,143 824,091 824,563 825,033 825,502 825,435 826,435 826,899 827,362 827,362 827,362 828,742 828,742 829,199 829,654 830,0561 831,013 831,013 831,013</td></td<>	817,322 817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228 822,189 822,189 822,667 823,143 824,091 824,563 825,033 825,502 825,435 826,435 826,899 827,362 827,362 827,362 828,742 828,742 829,199 829,654 830,0561 831,013 831,013 831,013
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1660 1665 1670 1675 1680 1685 1690 1695 1700 1705 1710 1715 1720 1725 1730	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,916666667 27 27,0833333 26,91666667 27 27,0833333 27,16666667 27,25 27,333333 27,41666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,916666667 28,28 28,0833333 28,16666667 28,5 28,5833333 28,41666667 28,5 28,5833333 28,6666667 28,5 28,5833333 28,6666667 28,5 28,5833333	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,612687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,9086352 828,8153344 829,2666348 829,7165798 830,1651778 830,6124366 831,0583643 831,5029687 831,9462578 832,8289207 833,2683099 833,7064143 834,1432414 834,5787987 835,0130935 835,4461331 835,8779247	1175,427685 1171,44995 1167,49967 1163,57645 1159,680032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1144,95690 1136,849103 1133,132728 1122,441032 1122,41032 1122,130683 1118,511536 1114,916091 1111,34411 1107,795355 1104,269605 1100,766633 1097,286206 1093,82522 1083,58522 1086,97803 1075,58612 1075,58612 1077,536415 1070,228678 1066,941595 1066,941565 1066,941565 1066,941565 106	5 126,8495627 9 126,2699016 125,6949219 5 125,1245695 2 123,9975324 5 123,9975324 123,4407431 8 122,883713 4 122,3403668 9 121,7966797 121,2572613 8 120,7220632 120,191038 5 119,664139 119,1413199 118,6225354 118,1077408 117,5968918 9 117,5968918 9 116,5868578 116,5868578 116,5868578 116,5868578 116,5868578 115,100333 1 14,6122669 114,1278551 2 113,6470582 9 113,1698373 2 112,6961544 9 112,229718 3 110,3795082	1048,57812 1045,18002 1041,80475 1038,4516 1035,12124 1035,12124 1035,12124 1028,52576 1022,52647 1022,01653 1018,7937 1015,59144 1012,41066 1009,24999 1006,10962 1006,10962 1006,10962 1006,10962 1007,94995 999,88900 996,808345 993,747217 990,705413 987,682751 984,667904 981,694112 978,727775 975,779854 977,779854 977,779854 967,044851 966,1310447 955,645640 955,645640	9 0,49565 30 0,49368 33 0,49398 34 0,49232 35 0,49067 36 0,49067 37 0,4858 38 0,4826 39 0,4858 30 0,4826 31 0,4826 30 0,4826 31 0,47798 31 0,47479 32 0,46723 33 0,46723 30 0,46723 30 0,46723 30 0,46136 30 0,46136 30 0,45705 30 0,45705 31 0,45705 32 0,45283 31 0,45283 32 0,45283 33 0,45283 32 0,45283 33 0,45283 34 0,45283 34 0,45283 34 0,454284	817,322 817,322 817,816 818,309 818,799 819,776 820,262 820,746 821,228 822,746 821,228 822,677 822,189 822,667 823,143 824,563 824,563 824,563 825,502 825,503 825,502 825,648 826,489 826,489 826,489 826,489 826,489 826,489 826,489 826,489 826,489 826,489 826,489 826,489 826,489 826,480 826,490 826,490 826,490 826,400 827,800 826,400 827,800 826,400 827,800 826,400 827,800 830,900 800,90
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1660 1665 1660 1665 1660 1665 1685 1680 1685 1680 1695 1700 1705 1710 1725 1730	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,66666667 26,75 26,8333333 26,91666667 27,25 27,0833333 27,16666667 27,25 27,3333333 27,41666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,91666667 28,25 28,0833333 28,16666667 28,5 28,5 28,5833333 28,5666667 28,5 28,5 28,5833333 28,6666667 28,5 28,5 28,5833333 28,6666667 28,5 28,5 28,5 28,5833333 28,6666667 28,5	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,4532196 827,4532196 827,4532196 828,3626706 828,35244 829,7165798 830,651778 830,6124366 831,0583643 831,5029687 831,9462578 832,882392 832,882392 832,882392 833,7064143 833,7064143 834,1432414 834,5787987 835,013035 835,4461331 835,8779247 836,3084756	1175,427685 1171,44995 1167,49967 1163,57645 1159,680032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1144,355904 1144,355904 1140,590405 1136,849102 1136,849102 1122,130681 1112,130681 1112,130681 1114,916091 1111,34411 1107,795355 1104,269605 1109,7865022 1080,214685 1076,865022 1076,865022 1077,536415 1070,228675 1066,941595 1066,421595 1066,421595 1066,421595 1066,421595 1066,421595 1066,421595 1066,421595 1066,428645 1066,421595 1066,421	5 126,8495627 9 126,2699016 125,049219 125,1245695 123,9975324 123,9975324 123,407431 122,883713 122,3403668 121,7966797 121,2572613 120,7220632 120,7220632 120,191038 119,664139 119,64139 118,6225354 118,598918 117,5968918 117,5968918 116,5868578 116,5868578 116,5868578 115,5920931 113,1698373 112,259718 113,1698373 112,2259718 111,7592522 111,7592522 111,259591 111,7592522 111,2595718 110,3795082 110,3795082 109,9262797	1048,57812 1043,18002 1041,80475 1038,4518 1035,12124 1035,12124 1025,26047 1022,01653 1018,7937 1015,59184 1002,40965 1006,10962 1006,10962 1006,10962 10005,10962 10005,10962 999,88900 996,808349 993,747217 997,779854 997,7775 975,779854 972,85017 964,938564 967,044851 964,188867 961,310447 955,645640 952,838931 950,04914	9 0,49565 30 0,49368 33 0,49398 48 0,49232 42 0,49067 12 0,49067 12 0,49067 12 0,48741 7 0,4858 8 0,48101 13 0,48101 14 0,47788 16 0,47738 16 0,47732 19 0,47173 10 0,47722 19 0,47173 10 0,47722 10 0,47123 10 0,47123 10 0,47123 10 0,47123 10 0,45143 10 0,45144 10 0,45144 11 0,45144 11 0,44731 11 0,44731	817,322 817,322 817,816 818,309 818,799 819,776 820,262 820,746 821,228 821,709 822,667 823,143 823,618 824,563 825,502 825,502 825,502 825,502 825,503 825,502 825,503 825,502 826,839 827,862 827,823 828,283 828,283 828,742 829,154 830,108 830,561 831,013 831,463 831,911 832,359
1570 1575 1580 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1660 1665 1660 1665 1670 1675 1680 1685 1690 1695 1700 1705 1710 1715 1720 1725 1730	26,16666667 26,25 26,3333333 26,41666667 26,5 26,58333333 26,91666667 27,75 27,0833333 27,16666667 27,25 27,333333 27,16666667 27,25 27,5833333 27,41666667 27,5 27,5833333 27,41666667 27,75 27,8333333 27,91666667 28,25 28,08333333 28,16666667 28,25 28,333333 28,16666667 28,5 28,5833333 28,41666667 28,5 28,5833333 28,66666667 28,75 28,533333 28,66666667 28,75 28,833333 28,91666667 28,75 28,833333 28,91666667 28,75 28,833333 28,91666667 28,75 28,833333 28,91666667 28,75 28,833333 28,91666667 29,75 27,833333 28,91666667 28,75 28,833333 28,91666667 29,75 27,75 27,833333 28,91666667 28,75 28,833333 28,91666667 28,75 28,833333 28,91666667 28,75 28,833333 28,91666667 28,75 28,833333 28,91666667 28,75 28,833333 28,91666667 28,75 28,833333 28,91666667 28,75 28,833333 28,91666667 28,75 28,916	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,259528 824,6912687 825,155144 825,6175875 826,0786082 826,5382147 826,9964156 827,4532196 827,4532196 827,9086352 828,3626706 828,8153344 829,2666348 829,7165798 830,1651778 830,6124366 831,083843 831,5029687 831,9462578 831,9462578 831,9462578 833,2882992 833,2683099 833,7064143 834,1432414 834,1432414 834,5787987 835,0130935 835,4461331 835,8779247 836,0384756 836,7377928	1175,427685 1171,44995 1167,49967 1163,57645 1155,80032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1144,355904 1144,355904 1144,355904 1144,355904 1144,355904 1144,355904 1144,355904 1122,130681 1113,313272 1122,130681 1113,313725 1122,130681 1113,313725 1124,1355 1124,1355 1114,916091 1111,34111 1107,795355 1104,266005 1007,285205 1083,585622 1083,585622 1083,585622 1086,97803 1083,585622 1075,356415 1070,228678 1066,941595 1066,941595 1066,941595 1066,248645 1060,428645 1060,428645 1060,428645 1060,428645 1060,428645 1057,202392 1053,996025 1053,99605 1053,99605 1053,99605 1053,99605 1053,9	5 126,8495627 126,2699016 5 125,6949219 5 125,1245695 2 124,5587905 2 123,9975324 5 123,9975324 5 123,407431 8 122,8883713 8 122,3403668 9 121,7966797 8 121,2572613 1 20,7220632 1 120,191038 5 119,664139 1 19,1413199 5 118,6225354 1 18,0774981 8 115,796918 9 116,5868578 3 116,0875877 5 115,5920931 8 115,100333 1 14,6122669 3 114,6122659 1 113,1698773 1 12,6961544 9 112,2259718 3 110,8360563 9 110,3795082 3 109,376382 1 10,3795082 3 109,376386	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1035,12124 1035,12124 1025,26047 1022,01655 1018,7937 1015,59184 1009,24999 1006,10962 1002,98936 999,889300 999,889300 999,889300 999,889300 999,747217 990,705413 987,682751 984,67904 981,694112 978,72775 975,779854 972,85017 969,938564 961,310447 961,310447 955,645640 952,838931 950,04914 944,51965	9 0,49565 3 0,49368 33 0,49398 48 0,49232 10,49904 0,49067 11 0,48504 12 0,48741 17 0,4858 18 0,48141 10 0,4826 10 0,47044 44 0,47738 11 0,47633 12 0,48101 10 0,47737 10 0,47732 10 0,47732 10 0,477337 10 0,47732 10 0,477337 10 0,47732 10 0,47633 12 0,46872 12 0,46281 13 0,46284 13 0,45563 10 0,45144 4 0,45283 11 0,44868 10 0,44868 10 0,44868 10 0,448596	817,322 817,322 817,816 818,309 818,799 819,288 819,776 820,262 820,746 821,228 821,228 821,228 822,189 822,189 822,667 823,618 824,091 824,563 825,969 825,969 825,969 825,969 825,829 827,823 825,829 827,823 828,742 828,742 829,199 829,654 830,101 831,013 831,011 831,463 831,911 832,859 832,805
1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1675 1680 1665 1675 1680 1695 1700 1705 1710 1715 1720 1725 1730 1740 1745	26,16666667 26,25 26,3333333 26,41666667 26,5 26,5833333 26,91666667 27 27,0833333 26,91666667 27 27,0833333 27,16666667 27,25 27,333333 27,16666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,41666667 27,5 27,5833333 27,91666667 28,25 28,0833333 28,16666667 28,25 28,5333333 28,16666667 28,5 28,5 28,5333333 28,91666667 28,5 28,5 28,5333333 28,91666667 28,5 28,5 28,5 28,5 28,5 28,5 28,5 28,5	821,4032961 821,8774471 822,3501023 822,8212713 823,2909632 823,7591873 824,2259528 824,6912687 825,6175875 826,0786082 826,5382147 825,6175875 826,0786082 826,5382147 826,964156 827,4532196 827,9086352 828,8153344 829,2666348 829,2666348 829,2666348 829,2666348 830,1651778 830,6124366 831,0583643 831,5029687 831,9462578 833,2683099 833,268309 833,2683099 833,268309 833,268309 833,268309 833,268309	1175,427685 1171,44999 1167,49967 1163,57645 1155,80032 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1155,810142 1144,556904 1144,556904 1144,556904 1133,132725 1122,430683 1112,41033 1112,41033 1113,34173 1114,91699 1111,34411 1107,79555 1104,265605 1109,28562 1093,828105 1093,828105 1093,828105 1097,285622 1083,585622 1083,585622 1076,865022 1077,28575 1066,941595 1066,41595 1066,428645 1053,996025 1053,996025 1053,996025 1053,996025 1053,996025 1053,996025 1055,	5 126,8495627 9 126,2699016 125,26949219 125,1245695 123,9975324 123,407431 8 122,3403668 9 121,7966797 121,2572613 120,7220632 120,191038 120,7220632 120,191038 119,664139 119,64139 118,6225354 118,1077408 117,5968918 9 114,5868787 5 115,5020931 8 115,100333 114,6122669 113,1698373 2 122,259718 8 111,759522 9 114,278551 110,8360563 9 110,3795082 9 109,9262797 9 109,476336 109,0296431	1048,57812 1045,18002 1041,80475 1038,4518 1035,12124 1031,8126 1025,26047 1022,01653 1018,7937 1015,59184 1012,41066 1009,24999 1006,10962 1000,24999 1006,24999 1006,24999 1006,24999 1000,24999 1000,24999 1000,24999 1007,413 987,682751 984,67904 981,694112 975,779854 975,779854 975,779854 975,779854 975,779854 975,779854 975,779854 975,779854 975,779854 975,779854 975,779854 975,779854 961,310447 955,645640 952,838931 950,04914 947,276112 944,51965	9 0,49565 30 0,49368 33 0,49398 34 0,49232 35 0,49368 36 0,49398 37 0,4856 36 0,48419 37 0,4858 36 0,48419 37 0,4826 37 0,4816 37 0,47798 39 0,46723 39 0,46723 30 0,46723 30 0,46136 30 0,46136 30 0,45705 30 0,45163 31 0,45123 32 0,45283 33 0,45163 32 0,45283 33 0,45123 34 0,45123 34 0,45123 34 0,45123 34 0,45123 34 0,45123 34 0,45123 34 0,45423	817,322 817,322 817,816 818,309 818,799 819,786 819,776 820,262 820,746 821,228 821,709 822,189 822,667 823,143 824,951 824,953 824,951 824,953 825,969 825,969 826,435 826,435 826,829 827,362 828,782 828,782 828,782 828,782 829,199 829,654 830,108 830,561 831,013 831,463 831,911 832,359 833,249

1750	29,16666667	837,5927543	1047,642238	108,5861672	939,0560709	0,44327	833,693
1755	29,25	838,0184125	1044,494445	108,1458749	936,3485699	0,44194	834,135
1760	29,33333333	838,4428649	1041,365813	107,7087336	933,6570795	0,44061	834,575
1765	29,41666667	838,8661183	1038,256166	107,2747109	930,9814549	0,4393	835,014
1770	29,5	839,2881794	1035,165328	106,8437747	928,3215531	0,43799	835,452
1775	29,58333333	839,7090549	1032,093126	106,4158937	925,6772328	0,43669	835,889
1780	29,66666667	840,1287515	1029,039391	105,9910366	923,0483545	0,4354	836,325
1785	29,75	840,5472758	1026,003953	105,5691729	920,4347803	0,43411	836,759
1790	29,83333333	840,9646343	1022,986646	105,1502723	917,836374	0,43284	837,191
1795	29,91666667	841,3808334	1019,987306	104,7343048	915,2530012	0,43157	837,623
1800	30	841,7958797	1017,00577	104,3212411	912,6845288	0,43031	838,053
1805	30,08333333	842,2097794	1014,041878	103,911052	910,1308256	0,42905	838,482
1810	30,16666667	842,6225389	1011,095471	103,5037089	907,5917618	0,42781	838,91
1815	30,25	843,0341644	1008,166392	103,0991833	905,0672092	0,42657	839,337
1820	30,33333333	843,4446622	1005,254488	102,6974474	902,5570411	0,42534	839,762
1825	30,41666667	843,8540384	1002,359606	102,2984735	900,0611323	0,42411	840,186
1830	30,5	844,2622991	999,4815935	101,9022344	897,5793592	0,42289	840,609
1835	30,58333333	844,6694504	996,6203025	101,5087031	895,1115994	0,42168	841,031
1840	30,66666667	845,0754984	993,7755855	101,1178533	892,6577322	0,42048	841,451
1845	30,75	845,4804489	990,9472967	100,7296585	890,2176381	0,41928	841,871
1850	30,83333333	845,8843079	988.1352923	100,3440931	887,7911992	0.41809	842,289
1855	30,91666667	846.2870812	985.3394301	99.96113133	885,3782987	0.41691	842,706
1860	31	846,6887747	982,5595696	99,58074808	882,9788215	0,41573	843,121
1865	31,08333333	847,0893942	979,7955719	99,20291844	880,5926535	0,41456	843,536
1870	31,16666667	847,4889454	977.0472998	98.8276178	878,219682	0,4134	843,949
1875	, 31.25	847.8874339	974.3146177	98,4548219	875.8597958	0.41224	844,361
1880	31,33333333	848.2848654	971.5973914	98.08450676	873,5128847	0.41109	844,773
1885	31,41666667	848.6812455	968.8954885	97.7166487	871.1788398	0.40995	845.183
1890	31.5	849.0765798	966.208778	97.35122435	868,8575537	0,40881	845,591
1895	31,58333333	849.4708737	963.5371304	96,98821062	866,5489198	0.40768	845,999
1900	31,66666667	849.8641327	960.8804178	96.62758471	864,2528331	0.40656	846,406
1905	31,75	850,2563622	958,2385136	96,26932409	861,9691895	0,40544	846,811
1910	31,83333333	850,6475677	955.6112927	95,91340652	859,6978862	0.40433	847,215
1915	31,91666667	851.0377544	952,9986315	95,55981002	857,4388215	0.40323	847.619
1920	32	851,4269275	950,4004078	95,20851291	855,1918949	0.40213	848.021
1925	32.08333333	851,8150925	947,8165007	94,85949373	852,9570069	0.40103	848 422
1930	32,16666667	852,2022545	945.2467906	94,51273132	850,7340593	0.39995	848.822
1935	32.25	852,5884186	942.6911595	94,16820475	848.5229547	0.39886	849.221
1940	32,33333333	852.97359	940,1494904	93,82589336	846.3235971	0.39779	849.618
1945	32,41666667	853.3577738	937.621668	93,48577673	844,1358912	0.39672	850.015
1950	32.5	853,740975	935.1075778	93.14783468	841,9597431	0.39566	850,411
1950	32.5	853 740975	935 1075778	93 14783468	841 9597431	0 39566	850 411
1955	32 58333333	854 1231987	932 607107	92 8120473	839 7950597	0 3946	850 805
1960	32,565656567	854 5044498	930 1201437	92 47839488	837 6417489	0 39354	851 199
1965	32,00000007	854 8847332	927 6465777	92 14685797	835 4997197	0.3925	851 591
1970	32 83333333	855 2640539	925 1862995	91 81741734	833 3688821	0 39146	851 983
1975	32,03555555	855 6424167	922 739201	91 490054	831 249147	0,33140	852 373
1980	32,5200007	856 0198265	920 3051755	91 16474918	829 1404264	0.38939	852,763
1985	33 08333333	856 396288	917 88/1172	90 84148431	827 0426329	0.38837	853 151
1990	33 16666667	856 771806	915 4759215	90 52024108	824 9556804	0 38735	853 538
1995	33,1000007	857 1463852	913 0804849	90 20100135	822 8794835	0 38634	853 925
2000	22 2222222	857 5200302	910 6077052	89 88374723	820 813058	0 38533	854 31
2000	33,33333333	001,0200302	510,0577052	55,00014123	020,010000	5,55555	034,01

	Formula source eurocode		
Δθa,t(Δa,t)	(ksh*Am/v)*hnet,d*∆t/Ca*p	EN1993-1-2:2005	
ksh	(0,9*(Am/V))box/(Am/V)	EN1993-1-2:2005	
Am/V opensectionexposed to fire	Perimeter/cross-section area	EN1993-1-2:2005	
hnet,r	Ф*ef*em(5.67*10^-8)*(өг+273)^-(өт+273)^4	EN1993-1-2:2005	
hnet,c	ac(8g-8m)	EN1993-1-2:2006	
hnet,d	(hnet,c)+(hnet,r)	EN1993-1-2:2007	



General Controls, LS-DYNA implicit code input

For the implicit static analysis in LS-DYNA following keywords were used for this research work.

1	\$ #	LS-DYNA K	eyword fil	le created	by LS-PreF	Post(R) V4.	.7.0 - 06No	ov2019	
2	\$#	Created o	n Nov-18-2	2019 (15:02	2:14)				
3	*KE	YWORD							
4	*TI	TLE							
5	\$ #								title
6	LS-	DYNA keyw	ord deck k	by LS-PrePo	st				
7	*C0	NTROL_ACC	URACY						
8	\$ŧ	osu	inn	pidosu	iacc				
9		1	4	0	1				
10	*C0	NTROL HOU	RGLASS						
11	\$ #	ihq	qh						
12		1	0.1						
13	*C0	NTROL IMP	LICIT AUTO)					
14	Ş#	iauto	iteopt	itewin	dtmin	dtmax	dtexp	kfail	kcycle
15		1	11	5	0.0	0.0	0.0	0	- 0
16	*c0	NTROL IMP	LICIT DYNA	MICS					
17	\$ŧ	imass	gamma	beta	tdybir	tdydth	tdybur	irate	alpha
18		0	0.6	0.38	0.01.	00000E281.	.00000E28	0	0.0
19	*c0	NTROL IMP	LICIT GENE	RAL					
20	\$ŧ	imflag	dt0	imform	nsbs	ias	cnstn	form	zero v
21		1	0.01	2	1	1	0	0	_0
22	*C0	NTROL IMP	LICIT SOLU	JTION					
23	\$ŧ	nsolvr	ilimit	maxref	dctol	ectol	rctol	lstol	abstol
24		12	1	15	0.001	0.01		0.91	.0000E-10
25	\$ #	dnorm	diverg	istif	nlprint	nlnorm	d3itctl	cpchk	
26		1	1	1	2	4	1	- 0	
27	\$ŧ	arcctl	arcdir	arclen	arcmth	arcdmp	arcpsi	arcalf	arctim
28		0	0	0.0	1	2	- 0	0	0
29	\$ŧ	lsmtd	lsdir	irad	srad	awgt	sred		
30		5	2	0.0	0.0	0.0	0.0		
31	*C0	NTROL IMP	LICIT SOLV	/ER					
32	\$ŧ	lsolvr	lprint	negev	order	drcm	drcprm	autospc	autotol
33		2	1	2	0	4	0.0	1	0.0
34	*C0	NTROL OUT	PUT						
35	\$ #	npopt	neecho	nrefup	iaccop	opifs	ipnint	ikedit	iflush
36		0	0	0	0	0.0	0	100	5000
37	\$ŧ	iprtf	ierode	tet10s8	msgmax	ipcurv	gmdt	ipldblt	eocs
38		0	0	2	50	- 0	0.0	- 0	0
39	\$ŧ	tolev	newleg	frfreq	minfo	solsig	msgflg	cdetol	
40		2	0	1	0	0	0	10.0	
41	\$ŧ	phschng	demden	icrfile	spc2bnd	-	shlsig	hisnout	
42		0	0	0	0	0	0	0	
43	*C0	NTROL SHE	LL						
44	\$ŧ	wrpang	esort	irnxx	istupd	theory	bwc	miter	proj
45		20.0	0	-1	0	2	2	2	0
46	\$ #	rotascl	intgrd	lamsht	cstyp6	thshel			
47		1.0	- 0	0	1	0			
48	\$ #	psstupd	sidt4tu	cntco	itsflg	irquad	w-mode	stretch	icrq
49		0	0	0	ō	2	0.0	0.0	ō
50	\$ #	nfaill	nfail4	psnfail	keepcs	delfr	drcpsid	drcprm	intperr
51		0	0	0	- 0	0	0	1.0	0
52	*C0	NTROL TER	MINATION						
53	\$ #	endtim	endcyc	dtmin	endeng	endmas	nosol		
54		1.0	0	0.001	0.01.	000000E8	0		

55	*DA	TABASE_AB	BSTAT							
56	\$ #	dt	binary	lcur	ioopt					
57		0.001	3	0	1					
58	*DA	TABASE BI	IDOUT							
59	\$ #	dt	binary	lcur	ioopt					
60		0.001	3	0	1					
61	*DA	TABASE DE	FORC							
62	Ş#	dt	binary	lcur	icopt					
63		0.001	3	0	1					
64	*DA	TABASE EI	LOUT							
65	\$ #	dt	binary	lcur	ioopt	optionl	option2	option3	option4	
66		0.001	3	0	1	0	0	0	0	
67	*DA	TABASE GI	STAT							
68	S#	dt	binary	lcur	icopt					
69		0.001	3	0	1					
70	*DA'	TABASE JN	IT FORC	-	-					
71	s#	dt.	binary	lcur	icopt					
72		0.001	3	0	1					
73	*DA'	TABASE MA	TSUM	-	-					
74	s#	dt.	binary	lcur	icopt					
75		0.001	3	0	100,00					
76	*DA	TABASE NO	DECE	-	-					
77	5#	dt	hinary	lour	icont					
78		0 001	3	0	100,00					
79	*DA'	TABASE NO	DOUT	Ŭ,	4					
80	s#	dt.	binary	lcur	icopt	optionl	option2			
81		0.001	3	0	100,00	0.0	0			
82	*DA'	TABASE RO	TFORC		-		, i			
83	s#	dt.	binary	lcur	icopt					
84		0.001	3	0	1					
85	*DA	TABASE BI	INARY D3PLO	т	-					
86	s#	dt.	lcdt	- beam	npltc	nsetid				
87		0.01	0	0	0	0				
88	s#	icont	rate	cutoff	window	type	nset			
89		10000	0.0	0.0	0.0	0100	0			
90	*DA	TABASE EX	TENT BINAR	v		Ŭ	Ŭ			
91	s#	neiph	neins	maxint	strfla	siafla	ensfla	rltfla	enafla	
92		0	0	3	0	1	1	1	1	
93	5#	cmnflg	ievern	beamin	dcomp	shae	st 897	n3thdt	ialemat	
94		0	10,015	0	1	1	1	2	1	
95	s# 1	nintsld	nkn sen	sclp	hydro	mascl	therm	intout	nodout	
96		0	0	1.0	0	0	0	1110040	nououo	
97	5#	dtdt	result	neinh	madr	cubic	Ŭ			
98	÷ #	0	1	0	0	0				
99	*B0		FSCRIBED M	OTTON SET	тр					
100	5#	id							heading	
101		10	enlacement	Loading					neuting	
102	C.4	neid	dof	updating vad	loid	of	wid	death	hirth	
102	ΥŦ	natu c	201	vau	1010	-20.0	VIQ 01	00000529	0 0	
104	* 201	ים עמגתואוו	2 00 SET TD	4	T	-20.0	01.	00000E26	0.0	
104	- DU	APRIL 21	0_361_10						heading	
105	ŶŦ	10	vadSurrant						neading	
107	e 4	ncid		dofr	defin	dofe	dofer	dofree	defer	
107	₽ Ŧ	nsia	cia	dolx	dory	dorz	dollx	doiry	doirz	
108		1 I I	0	1	1	1	0	U	0	

109	*SET	_NODE_LI	ST_TITLE							
110	Fixe	dsupport								
111	\$#	sid	dal	da2	da3	da4	solver			
112		1	0.0	0.0	0.0	0.0ME	СН			
113	\$ŧ	nidl	nid2	nid3	nid4	nid5	nid6	nid7	nid8	
114		10831	5986	9121	9122	9123	9124	8836	10832	
115		10833	10834	10546	8553	10842	10846	10845	10841	
116		10548	9132	9136	9135	9131	8838	5989	10851	
117		11410	11412	10849	10549	9141	9700	9702	9139	
118		8839	0	0	0	0	0	0	0	
119	*BOU	NDARY SP	C SET ID							
120	\$ #	id							heading	
121		2Ro	llerSupport	t.						
122	s#	nsid	cid	dofx	dofv	dofz	dofrx	dofrv	dofrz	
123		2	0	1	1	0	0	0	0	
124	*SET	NODE LT	ST TITLE	-	-	, in the second s		, in the second s	, in the second s	
125	Roll	erSuppor	+							
126	5#	sid	dal	da2	da3	da4	solver			
127		2 2	0.0	0 0	0.0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	CH			
128	54	nidl	nid2	nid3	nid4	nid5	nide	nid7	nid8	
120	41	10836	10837	10838	10547	10835	10262	6125	6126	
130		9127	G128	8837	10843	10844	10840	10830	10930	
130		9935	9120	6133	6134	0130	6120	11409	11411	
131		10949	10920	10947	9934	6127 6127	9120	11409	0130	
132		0110	10029	10041	0034	9131	0099	9701	9120	
133	* 201	- ATTA	C SET TO	U	U	U	U	U	U	
134	- DUU	MUARI_SP	C_DET_ID						heading	
135	÷Ŧ	10	wodVdimerti						neading	
130		311	xeaxairecti	lon de fre	de Fre	de Fr	do 5	d	de Euro	
137	÷ŧ	nsia	CIG	aoix	dory	dorz	dollx	doiry	doirz	
138	1000	J NODE IT	0 0 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	T	U	U	U	U	U	
139	* SET	_NODE_L1	or_iiibt							
140	rixe	axairect	100	4-0	4- 2	, a A	aal			
141	÷ŧ	510	dai	aaz	aas	0.01	sorver			
142		3	0.0	0.0	0.0	0.0ME	CH	- 1 - 1 - 1	- 1 10	
143	Ş#	nidi	nid2	n1d3	n1d4	n1d5	nide	n107	nids	
144		571	1711	2281	2282	2283	2284	1996	572	
145		573	574	286	3	582	586	585	581	
146		288	2292	2296	2295	2291	1998	3424	591	
147		1150	1152	589	289	2301	2860	2862	2299	
148		1999	3991	3992	3993	3994	3995	3996	3997	
149		3706	6562	6561	6560	6559	6558	6557	6556	
150		5986	4018	4017	4016	4015	4010	4009	4006	
151		6273	6571	6574	6575	6580	6581	6582	6583	
152		8553	4503	4588	4587	4585	4582	4581	4020	
153		3709	6585	7146	7147	7150	7152	7153	7068	
154		5989	0	0	0	0	0	0	0	
155	*BOU	NDARY_SP	C_SET_ID							
156	\$#	id							heading	
157		4Ro	llerXdirect	tion						
158	\$#	nsid	cid	dofx	dofy	dofz	dofrx	dofry	dofrz	
159		4	0	1	0	0	0	0	0	
160	*SET	_NODE_LI	ST_TITLE							
161	Roll	erxdirec	tion							
162	\$ #	sid	dal	da2	da3	da4	solver			
163		4	0.0	0.0	0.0	0.0ME	СН			
,										

Appendix 3/4

1.60	+000	NODE							
160	*SET	_NODE_1	LIST_TITLE						
161	ROIL	erxaire	ection	4-0	4- 2	2-1	1		
162	₽Ŧ	510	dai	da2	da 3	0.4	solver		
163		4	0.0	0.0	0.0		illen måde		- 1 40
164	9Ŧ		65.64	65.63	10262	6566	1100	65.69	65.60
165		6000	6564	6565	10262	6566	6567	0000	0009
167		02/2	4004	4003	4002	4001	4000	3999	3998
160		6570	6576	6577	65/6	4009	4011	4012	6572
160		4014	0000	4005	2164	4008	2011	4012	4013
109		4014	200	2000	/154	/100	/145	0034	/149
171		/140	4590	29/	2286	2295	4304	4300	4309
172		4330	2000	204	2200	1007	2263	2290	570
173		583	584	580	570	2294	2290	2205	2859
174		2297	587	1149	1151	599	569	2260	2009
175		2270		1145	1131	000	005	2001	2250
176	* 222	т <u>2279</u>							Ū
177	\$#	-1							title
178	Uppe	rflange	-						01010
179	5#	nid	- secid	mid	eosid	haid	gray	adpopt	tmid
180	* *	1	1	1	0		9140	0 40402	0
181	*SEC	TTON S	HELL TITLE	-	-				· ·
182	Uppe	rFlange							
183	\$ŧ	secid	- elform	shrf	nip	propt	gr/irid	icomp	setvo
184	· ·	1	16	1.0	7	1.0	0	0	1
185	\$#	tl	t2	t3	t4	nloc	marea	idof	edaset
186		5.7	5.7	5.7	5.7	0.0	0.0	0.0	0
187	*MAT	PIECE	WISE LINEAU	R PLASTICI	TY TITLE				-
188	Stee	1	_	_	_				
189	\$#	mid	ro	е	pr	sigy	etan	fail	tdel
190		1	7.85000E-9	210000.0	0.3	355.0	0.03	L.00000E21	0.0
191	\$ #	c	р	lcss	lcsr	vp			
192		0.0	0.0	0	0	0.0			
193	\$#	epsl	eps2	eps3	eps4	eps5	eps6	eps7	eps8
194		0.0	0.0035844	0.0245015	0.0332803	0.060702	0.0773121	0.1123726	0.1294901
195	\$#	esl	es2	es3	es4	es5	es6	es7	es8
196	40	3.0937	432.2084	465.8787	499.7923	572.912	601.4433	642.5938	657.3689
197	*PAR	Т							
198	\$#								title
199	Web								
200	\$#	pid	secid	mid	eosid	hgid	grav	adpopt	tmid
201		2	2	1	0	0	0	0	0
202	*SEC	TION_S	HELL_TITLE						
203	Webs	ection							
204	\$#	secid	elform	shrf	nip	propt	qr/irid	icomp	setyp
205		2	16	1.0	7	1.0	0	0	1
206	\$#	tl	t2	t3	t4	nloc	marea	idof	edgset
207		4.1	4.1	4.1	4.1	0.0	0.0	0.0	0
208	* PAR	Т							
209	\$#								title
210	Lowe	rflang	2						
211	\$#	pid	secid	mid	eosid	hgid	grav	adpopt	tmid
212		3	3	1	0	0	0	0	0

General Controls, LS-DYNA implicit code input for structure analysis in fire

For the thermal problems in LS-PrePost are solved using implicit time integration. For implicit analysis following keywords were used for this thesis:

1								0010	
T	Ş#	LS-DYNA K	eyword II.	le created	by LS-Prei	20st(R) V4	.7.0 - 06NG	072019	
2	\$#	Created o	on Dec-13-2	2019 (17:29	9:01)				
3	*KE	YWORD							
4	*TI	TLE							
5	\$#								title
6	LS-	DYNA kevw	ord deck b	v LS-PrePo	ost				
7	*0	NTROL ACC	TIPACY						
		MIROL_ACC	JUNHOI						
8	÷#	osu	1nn	pidosu	lacc				
9		1	4	0	T				
10	*C0	NTROL_IMP	PLICIT_AUTO)					
11	\$#	iauto	iteopt	itewin	dtmin	dtmax	dtexp	kfail	kcycle
12		0	11	5	0.0	0.0	0.0	0	0
13	*C0	NTROL IMP	LICIT DYNA	MICS					
14	\$ŧ	imass	gamma	beta	tdvbir	tdvdth	tdvbur	irate	alpha
15		0	0.5	0.25	0.01	00000F281	00000F28	0	0.0
16	*00	NTROL TMP	DUTCIT GENE	TAT.				-	
17	~	imflag		imform	naha	ice	onath	form	
10	91	Initiag	0.001	INTOIM	iisus .	195	CHISCH	IOIM	ZEIO_V
18		1	0.001	2	T	2	0	0	0
19	*C0	NTROL_IMP	PLICIT_SOLU	JTION					
20	\$#	nsolvr	ilimit	maxref	dctol	ectol	rctol	lstol	abstol
21		12	15	20	0.001	0.01		0.91	.0000E-10
22	\$#	dnorm	diverg	istif	nlprint	nlnorm	d3itctl	cpchk	
23		2	1	1	0	2	0	0	
24	\$ #	arcctl	arcdir	arclen	arcmth	arcdmp	arcpsi	arcalf	arctim
25		0	0	0.0	1	2	0	0	0
26	\$#	lsmtd	lsdir	irad	srad	awot	sred		
27		5	2	0.0	0.0	0.0	0.0		
28	*00	NTROL TMP	PLICIT SOLA	7FR					
20	~	leolur	lprint	Degen	order	dnom	dropper	autoene	autotol
20	44	130101	1princ 2	negev	order	urcm 4	arcpin	aucospc	aucocor
30	****	ATTOT SUF		4	0	4	0.0	1	0.0
31	100	NIROL_SHE	يليل:						
32	Ş#	wrpang	esort	lrnxx	istupa	theory	DWC	miter	proj
33		20.0	1	-1	0	2	2	2	0
34	\$#	rotascl	intgrd	lamsht	cstyp6	thshel			
35		1.0	0	0	1	0			
36	\$#	psstupd	sidt4tu	cntco	itsflg	irquad	w-mode	stretch	icrq
37		0	0	0	0	2	0.0	0.0	0
38	\$#	nfaill	nfail4	psnfail	keepcs	delfr	drcpsid	drcprm	intperr
39		0	0	0	0	0	0	1.0	0
40	*C0	NTROL SOL	UTION						
41	\$ŧ	soln	nlq	isnan	lcint	lcacc	ncdcf		
42		0	0	0	100	0	1		
43	*0	NTPOL STA	UDT U	Ŭ	200	Ŭ	-		
4.0	e 4	bootim							
44	97	beguin							
45	+	0.0							
46	*00	NTROL_TER	MINATION						
47	Ş#	endtim	endcyc	dtmin	endeng	endmas	nosol		
48		20.0	0	0.001	0.01.	.000000E8	0		
49	*C0	NTROL_THE	RMAL_NONLI	INEAR					
50	\$#	refmax	tol	dcp	lumpbc	thlstl	nlthpr	phchpn	
51		10	0.0	0.5	0	0.0	1	0.0	
52	*C0	NTROL_THE	RMAL_SOLVE	ER.					
53	\$#	atype	ptype	solver	cgtol	gpt	eqheat	fwork	sbc
54		1	1	31.	00000E-4	8	1.0	1.0	0.0

55	\$#	msglvl	maxitr	abstol	reltol	omega	unused	unused	tsf
56		0	5001.	0000E-101.	00000E-4	1.0			1.0
57	\$#	mxdmp	dtvf	varden					
58		0	0.0	0					
59	*C0	NTROL_THE	ERMAL_TIMES	TEP					
60	\$#	ts	tip	its	tmin	tmax	dtemp	tscp	lcts
61		0	1.0	0.1	0.0	0.0	1.0	0.5	0
62	*C0	NTROL_TIN	MESTEP						
63	\$#	dtinit	tssfac	isdo	tslimt	dt2ms	lctm	erode	mslst
64		0.0	0.9	0	0.0	0.0	0	0	0
65	\$ŧ	dt2msf	dt2mslc	imscl	unused	unused	rmscl	unused	ihdo
66		0.0	0	0			0.0		0
67	*DA	TABASE_BI	NDOUT	1					
68	÷#	at	pinary	lcur	100pt				
70	*D7	TABASE CI	USTAT J	0	1				
70	*DH	d+	binary	lour	icont				
72	41	0 001	DINGLY	ICUI	100000				
73	*DA	TABASE NO			-				
74	54	dt.	binary	lcur	icopt	optionl	option2		
75		0.001	3	0	1	0.0	0		
76	*DA	TABASE R	CFORC	-	_		-		
77	\$#	dt	binary	lcur	icopt				
78		0.001	3	0	1				
79	*DA	TABASE_TI	PRINT						
80	\$#	dt	binary	lcur	ioopt				
81		0.001	3	0	1				
82	*DA	TABASE_BI	INARY_D3PLO	т					
83	\$#	dt	lcdt	beam	npltc	psetid			
84		0.01	0	0	0	0			
85	\$#	ioopt	rate	cutoff	window	type	pset		
86		0	0.0	0.0	0.0	0	0		
87	*DA	TABASE_E	KTENT_BINAR	Y .					
88	Ş#	neipn	neips	maxint	striig	sigilg	epsiig	ritiig	engrig
0.9	e 4	or fla	11	beamin	L	- L	1	n2thdt	i al amat
90	ŶŦ	Cmprig	Teverb	qimead	acomp	sige	31352	nstnat	Ialemat
92	¢4	ninteld	nkn sen	eclo	hydro	meecl	therm	intout	nodout
93	¥#	0	prp_sen 0	1.0	0	0	0	Incouc	nououe
94	\$#	dtdt	resplt	neipb	quadr	cubic	Ť		
95		0	0	0	0	0			
96	*B0	UNDARY SI	PC SET ID						
97	\$#	id							heading
98		1F:	ixedSupport						
99	\$#	nsid	cid	dofx	dofy	dofz	dofrx	dofry	dofrz
100		1	0	1	1	1	0	0	0
101	*SE	T_NODE_LI	IST_TITLE						
102	Fix	edsupport	t						
103	\$#	sid	dal	da2	da3	da4	solver		
104		1	0.0	0.0	0.0	0.0M	ECH		
105	\$#	nidl	nid2	nid3	nid4	nid5	nid6	nid7	nid8
106		2737	3764	3763	3421	3079	3080	2908	3594
107		3086	3084	2910	3770	3768	3423	1885	3090
108		3088	2911	3774	3772	3424	0	0	0

109	*BOU	NDARY SPO	SFT TD						
110	5#	id							heading
111	÷1	2801	ler Suppor	·+					neuting
112	\$ŧ	nsid	cid	dofx	dofv	dofz	dofrx	dofrv	dofrz
113		2	0	1	1	0	0	0	0
114	*SET	NODE LIS	T	-	-		Ū.	-	Ū.
115	S#		dal	da2	da3	da4	solver		
116		2	0.0	0.0	0.0	0.0MF	CH		
117	\$ŧ	nidl	nid2	nid3	nid4	nid5	nid6	nid7	nid8
118		3593	3081	3082	2909	3766	3765	3422	2907
119		3085	3083	3078	3769	3767	3591	3761	3089
120		3087	3077	3773	3771	3590	0	0,01	0
121	*BOU	NDARY SPC	SET TD	5775	5//1	0000	Ŭ		Ŭ
122	54	id							heading
123	÷1	3512	edXdirecti	0.0					neuting
124	54	neid	cid	dofx	dofy	dofz	dofry	dofry	dofrz
125	÷.	11510	0	1	dory 0	0012	uolla 0	dorry 0	0
126	*SET	NODELTS	יד דידי די	-			, i i i i i i i i i i i i i i i i i i i		, i i i i i i i i i i i i i i i i i i i
120	Five	_NODE_BI3							
129	C4	aid	dal	da2	da 2	de/	solver		
120	44	310	0.0	0.0	0.0	0.0ME	SOLVEL		
130	e4	nidl	nid2	pid3	nid4	nid5	nide	nid7	nide
121	9#	056	1020	1020	1029	1027	605	2052	2054
122		2055	2056	1029	1020	1712	2064	2055	2034
122		2000	2056	2/3/	1037	1020	2064	2068	2067
124		2063	3594	2402	1042	1030	1977	1045	1046
105		2072	2405	2403	2071	4105	1377	1379	1046
135		240	343	4440	4447	4105	344	172	350
107		340	1/4	4454	4452	4107	354	352	1/5
137	*BOIT	4400	4430 CET ID	4108	0	0	0	0	0
120	^BUU	NDARI_SPC							heading
140	ŶŦ	10	lorudinost	ion					neading
140	e 4	4K01	aid	.10n	dofr	dofe	dofre	dofre	dofre
141	91	IISIG	CIG	uoix	dory	0012	dollx	dolly	doll2
142	****	NODE TTO	י איזידי די	1	0	0	0	0	0
143	Poll	_NUDE_DIS	ion						
1/15	<4 K011	eind	leb.	da2	da3	de/	solver		
145	**	1	0.0	0.0	0.0	0.0MF	CH		
147	5#	nidl	nid2	nid3	nid4	nid5	nide	nid7	nide
148	41	4450	345	346	173	4449	4106	4452	855
140		3/9	347	342	4451	4275	4100	170	353
150		351	347	4455	4274	2057	2058	2050	2060
151		3503	1712	1034	1033	1032	1031	2005	2060
152		2065	2066	2062	2007	1002	1031	1040	1030
152		1025	2000	2002	2907	2406	1030	2761	1044
153		1035	1025	2069	2404	2406	2070	3/61	1044
154		13/8	1380	1043	0	U	0	U	0

155	*DEF	INE_T	ABLE_TITLE						
156	S355	Plas	tic Temp						
157	\$#	- tbi	d sfa	offa					
158		1	9						
159	S#		value	lcid					
160			20.0	7					
161			100.0	8					
162			200.0	Ğ					
163			300.0	10					
164			400.0	11					
165			400.0	12					
165			500.0	12					
167			200.0	13					
107			700.0	14					
100			800.0	15					
109			900.0	10					
170			1000.0	17					
171	*DEF	INE_C	URVE_TITLE						
172	S355	_Plas	tic_T20	-					
173	\$#	lci	d sidr	sfa	sfo	offa	offo	dattyp	lcint
174			7 0	1.0	1.0	0.0	0.0	0	0
175	\$#		al		01				
176			0.0		304.8				
177		1.970	6999592e-04		323.1				
178		6.361	0001234e-04		338.3				
179			0.001561		357.0				
180			0.002507		370.1				
181			0.003465		380.7				
182			0.0054		389.9				
183			0.006375		396.7				
184			0.007352		408.6				
185			0.008333		413.4				
186			0.010301		421.2				
187			0.013269		429.2				
188			0.016253		433.3				
189			0.01825		434.0				
190			0.14825		492.0				
191	*DEF	INE C	URVE TITLE						
192	S355	Plas	tic T100						
193	\$ŧ	lci	d sidr	sfa	sfo	offa	offo	dattyp	lcint
194			8 0	1.0	1.0	0.0	0.0	0	0
195	\$#		al		01				
196			0.0		304.1				
197		1.970	6999592e-04		323.1				
198		6.361	0001234e-04		338.3				
199			0.001561		357.0				
200			0.002507		370.1				
201			0.003465		380.7				
202			0.0054		396.7				
203			0.006375		403.1				
204			0.007352		408.6				
205			0.008333		413.4				
206			0.010301		421.2				
207			0.013269		429 1				
208			0.016252		422.2				
200			0.010235		433.5				
205			0.01025		434.0				

010			0.14005		100.0					
210			0.14825		492.0					
211	*DEF	INE_CURVE	E_TITLE							
212	S355	_Plastic_	_T200							
213	\$#	lcid	sidr	sfa	sfo	offa	offo	dattyp	lcint	
214		9	0	1.0	1.0	0.0	0.0	0	0	
215	\$#		al		01					
216			0.0		245.1					
217		5.2999999	9753e-05		256.1					
218		2.8800001	L019e-04		270.6					
219		7.2299997	7555e-04		285.1					
220			0.001636		304.3					
221		(0.002574		318.3					
222		(0.003524		329.5					
223		(0.005447		346.6					
224		(0.006416		353.4					
225			0 00739		359 4					
226			0.008367		364 6					
227			010329		373 0					
227			013201		391 6					
220			016271		395 0					
225			0.0102/1		205.9					
220			140267		444 92					
201	* DE E	THE CUDIE	.14020/		444.02					
232	COLL	INE_CORVE	5_111LE							
233	5355	_Plastic_	1300							
234	Ş#	Icid	sidr	sia	sio	offa	0110	dattyp	lcint	
235		10	0	1.0	1.0	0.0	0.0	0	0	
236	Ş#		al		10					
237			0.0		186.2					
238		1.5799999	9528e-04		206.8					
239		3.9800000	0377e-04		218.6					
240		8.2800001	L837e-04		232.6					
241		(0.001729		252.2					
242		(0.002655		266.7					
243		(0.003596		278.5					
244		(0.005504		296.7					
245		(0.006467		304.0					
246		0	0.007435		310.4					
247		(0.008408		316.0					
248		(0.010362		325.0					
249		(0.013316		334.2					
250		(0.016292		338.9					
251		(0.018288		339.8					
252		(0.148288		390.7					
253	*DEF	INE_CURVE	E_TITLE							
254	S355	Plastic	T400							
255	\$#	lcid	sidr	sfa	sfo	offa	offo	dattyp	lcint	
256		11	0	1.0	1.0	0.0	0.0	0	0	
257	\$#		al		01					
258			0.0		115.2					
259		1.9999999	9495e-05		122.3					
260		1.4800000	0645e-04		133.6					
261		9.6999999	9369e-04		161.4					
262		0	0.001863		178.2					
263		(0.002782		191.1					
264		(0.003715		201.5					
	_									

264		0.00	03715		201.5				
265		0.00	05611		217.8				
266		0.00	06569		224.5				
267		0.00	17532		230.2				
268			0085		235.2				
260		0.01	10448		243.3				
205		0.01	12205		243.3				
270		0.0	10000		251.7				
271		0.0	16368		255.9				
272		0.0	18363		256.7				
273		0.14	48363		295.2				
274	*DEI	FINE_CURVE_TI	ITLE						
275	S35	5_Plastic_T50	00		-				
276	\$ŧ	lcid	sidr	sfa	sfo	offa	offo	dattyp	lcint
277		12	0	1.0	1.0	0.0	0.0	0	0
278	\$#		al		01				
279			0.0		93.5				
280		8.4999999672	2e-05		103.7				
281		1.5599999460	0e-04		107.3				
282		9.9500000942	2e-04		127.8				
283		0.00	01897		140.2				
284		0.00	02823		149.7				
285		0.00	03763		157.4				
286		0.00	05668		169.4				
287		0.0	00663		174.3				
288		0.00	07597		178.5				
289		0.00	08568		182.2				
290		0.01	10521		188.2				
291		0.01	13473		194.3				
292		0.01	16448		197.5				
293		0.01	18443		198.0				
294		0.14	48443		227.7				
295	*DEI	FINE CURVE TI	ITLE						
296	S35	5 Plastic T60	00						
297	\$ŧ	lcid _	sidr	sfa	sfo	offa	offo	dattyp	lcint
298		13	0	1.0	1.0	0.0	0.0	0	0
299	\$#		al		01				
300			0.0		44.1				
301		8.8000000683	7e-05		50.4				
302		1.5500000154	4e-04		52.4				
303		9.6299999859	9e-04		64.3				
304		0.00	01845		71.6				
305		0.00	12755		77.2				
306		0.00	13682		81 7				
307		0.00	15567		88.9				
300		0.00	0652		00.9				
200		0.0	00032		04.2				
309		0.0	00740		54.J				
211		0.00	10207		100.4				
311		0.0	10387		100.0				
312		0.0	13328		103.6				
313		0.0	16298		105.5				
314		0.01	18292		105.9				
315		0.14	48292		121.8				

316	*DFF	THE CHEVE							
317	5355	5 Plastic	T700						
318	\$ #	lcid	sidr	sfa	sfo	offa	offo	dattvp	lcint
319	T I	14	0	1.0	1.0	0.0	0.0	0	0
320	Ş#		al		01			-	
321			0.0		18.4				
322		8.6000000	010e-05		21.2				
323		1.5199999	325e-04		22.1				
324		9.4900000	840e-04		27.3				
325		0	.001824		30.6				
326		0	.002728		33.1				
327			0.00365		35.1				
328		0	.005527		38.3				
329		0	.006478		39.6				
330		0	.007435		40.7				
331		0	.008397		41.7				
332		0	.010336		43.3				
333		0	.013274		44.9				
334		0	.016241		45.7				
335		0	.018235		45.9				
336		0	.148235		52.8				
337	*DEH	TINE_CURVE	_TITLE						
338	S355	5_Plastic_	T800						
339	\$#	lcid	sidr	sfa	sfo	offa	offo	dattyp	lcint
340		15	0	1.0	1.0	0.0	0.0	0	0
341	\$#		al		01				
342			0.0		12.3				
343		1.3600000	239e-04		13.8				
344		2.1399999	969e-04		14.1				
345		0	.001085		16.5				
346		0	.002005		17.9				
347		0	.002944		19.0				
348		0	.003894		19.9				
349		0	.005815		21.3				
350		0	.006784		21.9				
351		0	.007756		22.4				
352		0	.008732		22.8				
353		0	.010693		23.5				
354		0	013653		24.2				
355		0	010633		24.0				
350		0	140620		24./				
357	*DET	THE CURVE	.140029 TTTTE		20.4				
350	22C0	Disctic	_111LE						
360	5333	loid	sidr	ofa	efo	offa	offo	dattum	lcint
361	¥1	16	0	1.0	1 0	0.0	0.0	0 accyp	0
362	S#	10	al	1.0		0.0	0.0		5
363	**		0.0		9.2				
364		6.6000000	515e-05		9.9				
365		2.2200000	240e-04		10.5				
366			.001105		12.1				
367		0	.002033		13.1				
368		0	.002978		13.8				
369		0	.003933		14.4				
370		0	.005862		15.4				
10.0									

								-	
371			0.006834		15.7				
372			0.007809		16.1				
373			0.008788		16.4				
374			0.010752		16.8				
375			0.013716		17.3				
376			0.016698		17.6				
377			0.018694		17.6				
378			0.148694		20.24				
379	*DEF	INE CURV	E TITLE						
380	S355	Plastic	T1000						
381	\$#	lcid	sidr	sfa	sfo	offa	offo	dattvp	lcint
382		17	0	1.0	1.0	0.0	0.0	0	0
383	\$ŧ		al		01				
384			0.0		6.1				
385		7.400000	3224e-05		6.5				
386		2.399999	9394e-04		6.8				
387			0.001148		7.7				
388			0.002092		8.2				
389			0.003048		8.6				
390			0.004013		8.9				
391			0.005958		9.4				
392			0.006936		9.6				
393			0.007916		9.8				
394			0.008899		9.9				
395			0.010871		10.2				
396			0.013843		10.4				
397			0.016829		10.5				
398			0.018826		10.6				
399			0.148826		12.2				
400	*DEF	INE_CURV	E_TITLE						
401	Load	_curve							
402	\$ #	lcid	sidr	sfa	sfo	offa	offo	dattyp	lcint
403		1	0	0.01	1.0	0.0	0.0	0	0
404	\$#		al		01				
405			0.0		0.0				
406			200.0		1.0				
407			2000.0		1.0				
408	*DEF	INE_CURV	E_TITLE						
409	Youn	gsmodulu	s_Temperatu	re					
410	\$#	lcid	sidr	sfa	sfo	offa	offo	dattyp	lcint
411		2	0	1.0	1.0	0.0	0.0	0	0
412	\$#		al		01				
413			20.0		210000.0				
414			100.0		210000.0				
415			200.0		189000.0				
416			300.0		168000.0				
417			400.0		147000.0				
418			500.0		126000.0				
419			600.0		65100.0				
420			700.0		27300.0				
421			800.0		10300.0				
422			900.0		141/5.0				
423			1000.0		9450.0				
424			1200.0		4/25.0				
425			1200.0		0.0				

426	*DEF	INE_CURV	E_TITLE						
427	Ther	malexpan	sion_Temper	rature					
428	\$#	lcid	sidr	sfa	sfo	offa	offo	dattyp	lcint
429		4	0	1.0	1.0	0.0	0.0	0	0
430	\$#		al		01				
431			20.0	1.2000000	424e-05				
432			100.0	1.2479999	896e-05				
433			200.0	1.28800002	213e-05				
434			300.0	1.3279999	621e-05				
435			400.0	1.36799999	938e-05				
436			500.0	1.4080000	255e-05				
437			600.0	1.4479999	663e-05				
438			700.0	1.4879999	981e-05				
439			750.0	1.5079999	685e-05				
440			800.0	1.4102999	558e-05				
441			860.0	1.30950002	213e-05				
442			900.0	1.3408999	621e-05				
443			1000.0	1.4082000	234e-05				
444			1100.0	1.46299998	896e-05				
445	*DEF	INE_CURV	E_TITLE						
446	PR_C	URVE							
447	\$ #	lcid	sidr	sfa	sfo	offa	offo	dattyp	lcint
448		5	0	1.0	1.0	0.0	0.0	0	0
449	\$#		al		ol				
450			20.0		0.3				
451			100.0		0.3				
452			200.0		0.3				
453			300.0		0.3				
454			400.0		0.3				
455			500.0		0.3				
456			600.0		0.3				
457			700.0		0.3				
458			800.0		0.3				
459			900.0		0.3				
460			1000.0		0.3				
461			1100.0		0.3				
462			1200.0		0.3				
463	*DEF	INE_CURV	E_TITLE						
464	Temp	erature_	time_curve						
465	\$#	lcid	sidr	sfa	sfo	offa	offo	dattyp	lcint
466		18	0	0.01	1.0	0.0	0.0	0	0
467	\$ŧ		al		ol				
468			0.0		20.0				
469			5.0		20.999				
470			10.0	23	2.72816				
471			15.0	25	5.04842				
472			20.0	21	7.87156				
473			25.0		31.0				
474			30.0		34.0				
475			35.0		38.0				
476			40.0		43.0				
477			45.0		47.0				
478			50.0		52.0				
479			55.0		57.0				
480			60.0		63.0				

481	65.0	68.0
482	70.0	74.0
483	75.0	80.0
484	80.0	86.0
485	85.0	93.0
486	90.0	99.0
487	95.0	106.0
488	100.0	113.0
489	105.0	120.0
490	110.0	127.0
491	115.0	134.0
492	120.0	141.0
493	125.0	149.0
494	130.0	156.0
495	135.0	164.0
496	140.0	171.0
497	145.0	179.0
498	150.0	187.0
499	155.0	194.0
500	160.0	202.0
501	165.0	210.0
502	170.0	218.0
503	175.0	226.0
504	180.0	234.0
505	185.0	242.0
506	190.0	250.0
507	195.0	258.0
508	200.0	266.0
509	205.0	274.0
510	210.0	281.0
511	215.0	289.0
512	220.0	297.0
513	225.0	305.0
514	230.0	313.0
515	235.0	321.0
516	240.0	329.0
517	245.0	336.0
518	250.0	344.0
519	255.0	351.0
520	260.0	359.0
521	265.0	366.0
522	270.0	374.0
523	275.0	381.0
524	280.0	388.0
525	285.0	395.0
526	290.0	402.0
527	295.0	409.0
528	300.0	416.0
529	305.0	423.0
530	310.0	430.0
531	315.0	436.0
532	320.0	443.0
533	325.0	449.0
534	330.0	455.0
535	335.0	461.0

857			1945.0)		850.0							
858			1950.0)		850.0							
859			1955.0)		850.0							
860			1960.0)		851.0							
861			1965.0)		851.0							
862			1970.0)	8	51.9828							
863			1975.0)		852.0							
864			1980.0)		852.0							
865			1985.0)		853.0							
866			1990.0)		853.0							
867			1995.0)		853.0							
868			2000.0)		854.0							
869	* TNT	TTAL TEM	PERATURE	SET									
870	\$ŧ	nsid	tem)	loc								
871		6	20 0)	0								
872		e e	20.0)	-1								
873		e e	20.0	,)	1								
874	*580	יישיא אחדיי	20.0 עדד, דדדים	,	1								
875	Uppe	r Flanco	, ,	•									
876	s#	secid	elform		ehrf	nin	nront	ar/irid		icomp	estur		
877	44	1	211011		1.0	7	1 0	dr) trig		0	aecyp 1		
879	e4	+1	+10	,	+2	+ A	nlog	mamac		idof	adgeat		
970	ŶŦ	5 7	E 7		L3 E 7	5 7	0.0	marea		1001	eugset		
019	*****	3./	3./ 		5.7	5.7	0.0	0.0		0.0	0		
000	- SEC	.110N_SHE		•									
001	_dew	section	-16		- h - 1 - E								
002	÷Ŧ	secia	errorm		Shri	nip	propt	dr/1110		rcomp	secyp		
883		2	10)	1.0		1.0	0		0	1		
884	Ş#	LT .	t2	2	t3	τ4 (1)	nioc	marea		1001	eagset		
885	+ 0 8 0	4.1	4.1		4.1	4.1	0.0	0.0		0.0	0		
886	*SEC	*SECTION_SHELL_TITLE											
007	LOWE	riiange	-15		abaf			an là sià c		iner			
000	₽Ŧ	secid	eiiom		shri	nip	propt	qr/irid	-	rcomp	seryp		
009		3	16		1.0		1.0	0		U	1		
890	Ş#	T1	t2		53	t4	nioc	marea		1001	eagset		
091	****	5.7	5.7		5./	5.7	0.0	0.0		0.0	0		
092	ALLE CA	.me.wi_SHE	ىلىد. تەرە	- 1	- 2	- 2	- 1			- 7	-0		
093	9Ŧ	eid	pro	11	n2	n3	n4 247	15	ne	n/	nð		
894		1	1	346	173	342	347	0	0	0	0		
895		2	1	172	344	348	174	0	0	0	0		
896		3	1	2	345	349	855	U	0	0	0		
897		4	1	345	346	347	349	0	0	0	0		
898		5	1	343	685	3	350	0	0	0	0		
899		6	1	344	343	350	348	U	0	0	0		
900		7	1	342	341	351	347	0	0	0	0		
901		8	1	175	174	348	352	0	0	0	0		
902		9	1	170	855	349	353	0	0	0	0		
903		10	1	3	688	354	350	0	0	0	0		
904		11	1	341	340	355	351	0	0	0	0		
905		12	1	176	175	352	356	0	0	0	0		
906		13	1	853	170	353	357	0	0	0	0		
907		14	1	688	689	358	354	0	0	0	0		
										-	0		
908		15	1	340	339	359	355	0	0	0	0		
908 909		15 16	1 1	340 177	339 176	359 356	355 360	0	0	0	0		
908 909 910		15 16 17	1 1 1	340 177 4443	339 176 853	359 356 357	355 360 361	0 0 0	0 0 0	0	0		

Appendix 5

Material properties calculation sheet for MAT_255 according to Eurocode.

			Ipe 100beam		
	Mechanical properties of Carbon Steel		h	100	mm
Modulus of Elasticity€	210000	N/mm^2	b	55	mm
Shear modulus	81000	N/mm^2	tw	4,1	mm
Density	7850	kg/m^3	tf	5,7	mm
Yield strength at 20degree(fy)	355	N/mm^2	r	7	mm
Ultimate tensile strength(fu)	510	N/mm^2	c(flange)	18,45	mm
Poisson ratio	0.30		c(web)	74,6	mm
coefficient of linear thermal expansion	12*10^-6		ε	0,691574036	
Modulus of Elasticity(Ea,θ)	210000	mpa			
Steel Temperature	Reduction factor(ky,θ)for effective yield strength	Effective yield strength(fy,θ)	For Propertional limit(Kp,0)	Linear elastic range(Ke,θ)	Propertional limit(fp,θ)
20	1	355	1	1	355
100	1	355	1	1	355
200	1	355	0,807	0,9	319,5
300	1	355	0,613	0,8	284
400	1	355	0,42	0,7	248,5
500	0,78	276,9	0,36	0,6	213
600	0,47	166,85	0,18	0,31	110,05
700	0,23	81,65	0,075	0,13	46,15
800	0,11	39,05	0,05	0,09	31,95
900	0,06	21,3	0,0375	0,0675	23,9625
1000	0,04	14,2	0,025	0,045	15,975
1100	0,02	7,1	0,0125	0,0225	7,9875
1200	0	0	0	0	0

Appendix 6

Thermal expansion versus temperature curve plotted from LS-PrePost

