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ORDER OF INFLUENCE OF DENT GEOMETRY PARAMETERS ON ULTIMATE STRENGTH OF DENTED THIN SQUARE

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ABSTRACT

Thin shell structures are usually stiffened to increase their load carrying capacity. In case of thin stiffened plate structures, failure of bare plates surrounded by stiffeners is one of the basic failure modes. Dents are one of the common initial geometrical imperfections in thin structures and they may be formed due to collision or hitting with other objects during erection, installation and in service. Like other imperfections dent also have detrimental effect on the strength of the structures .Dent geometry can be specified by shape, location, orientation and size (dent depth, Dent width and dent length). It was already proved that dent shape has negligible effect on strength and central located dents are critical. Hence in this work, 2268 FE models of dented thin square plate (dent at centre) with different plate thicknesses are generated by varying the Dent Angle of Orientation and dent size. These FE models are analyzed using static nonlinear FE analysis module of ANSYS. Using these numerical results with its corresponding coded input variables, a nonlinear response surface model is developed through nonlinear regression and from which order of influence of parameters taken for study are determined.

Keywords: *Imperfections, FEA, Dent, Buckling, Response Surface Model.*

I. INTRODUCTION

Thin bare plates are in-built part of the stiffened steel structures. These bare thin plates are basic elements of ship, marine and aerospace structures. In actual operating conditions, these bare plates `are surrounded by the stiffeners and loaded compressively during hogging and sagging movements of ships [22] and due to the compressive load these bare plates collapse locally in between the stiffeners is a primary failure type found in stiffened steel plate structures. The plate strength has been studied for many years and several advances have been made during last few decades concerning the understanding of the effect of factors which reduces collapse strength of the thin plate structures subjected to various load conditions. Teng [23] presented detailed review about the advances in steel structures shell buckling before 1996. Similarly, Rhodes [18] presented a brief discussion on the elastic and plastic behavior of plate structures. As needed by the present work, only literature related to local geometrical imperfections and combined local and initial geometrical imperfections are discussed here. Formation of dent and other failures due to collisions with foreign object is discussed by Muscat et al. [7] with experimental and simulation study. Jin et al [25] studied shear buckling resistance with imperfections caused by corrosion in the web plate , found that shear buckling resistance affected by aspect ratio of the web plate.

Paik [9] and Paik et al. [11] respectively investigated the collapse strength of the dented steel plate considering the effect of dent size, shape and location of the dent. Dented plates are subjected to axial compressive load and shear load respectively with simply supported boundary conditions. From the study it was concluded that as long as dent (spherical /conical) size is similar, size of the dent does not affect strength of the dented plate. Praveen Shivalli [14] experimentally studied about the fatigue life and rate of crack growth on the aluminum alloy sheet of 1 mm thickness due to dent formed by the hardened spherical head indenter. Guedes Soares et al. [2] numerically studied about the influence of localized geometrical imperfections on the ultimate strength of the plates. One of the important conclusion from that work is ultimate strength of the plate depends on size and amplitude of the localized imperfections. Hai et al. [4] derived an empirical reliability index equation considering the combined effect of multiple defects (weld residual stresses, cracks, initial deformation and local dents).Hai et al. [5] studied about the effect of local dent on the collapse strength of the dented plate and also derived a method to determine the global reliability index and sensitivity analysis expressions. Raviprakash et al.[17] numerically investigated nearness effect of two central located short dents of same size on the ultimate strength of the thin square plates subjected to compressive load by varying the dent parameters (location, orientation and centre distance between the dents). It was concluded that influence of second dent is not as appreciable as that of the first one, irrespective of dent parameters considered. Raviprakash et al.[16] numerically studied the effect of dent parameters (length, width, depth and angle of orientation) on the ultimate strength of the thin plate and one of the major conclusions stated that collapse strength of dented plate mainly depends on the area of the dented plate excluding the area of the dent affected region.

Peroumal et al.[12] numerically studied the combined effect of local imperfections and distributed global geometrical imperfections on buckling strength of thin square plates subjected to uni-axial compressive load. It was concluded that dent effect is more dominant in thick plates, in case of low thickness plates global geometric imperfections effect is more dominant. Saad-Eldeen et al.[19] in the work numerically studied about the ultimate strength and post collapse behavior of the dented unstiffened rectangular plates, Using the numerical results obtained from analysis two relationships were developed one based on the slenderness ratio and other based on dent ratio (DD/t) as a reduction factor for ultimate strength. Raviprakash et al. [16], in his numerical work explained that the individual dent parameters effort and plate thickness effort on the ultimate strength of the dented plates. But the order of influence of dent parameter and plate parameters on the ultimate strength of the plate not considered for his study. Hence in this work, the efforts are taken to study the order of influence dent parameters and plate parameters on the ultimate strength of the plate. For this purpose, plate size of 500x500 mm with various plate thickness are considered (here plate thickness are considered indirectly by plate slenderness ratio, SLR). Various dent parameters are accounted as (i) dent length (DL), (ii) Dent Aspect ratio (DAR), (iii) dent depth (DD) and (iv) dent orientation (DAO).
By varies shell thickness(t) (4,6,8,10,12,14,16,18 and 20mm) having a centrally located dent with varied Dent length (varied as 200,300 and 400mm), Dent aspect ratio (varied as 0.25, 0.625 and 1), Dent depth (varied as 2,4,6 and 8 mm) and Dent orientation (0°,15°,30°,45°,60° ,75° and 90°), 2268 models are generated and analyzed using static non- linear FE analysis module of ANSYS including both geometrical and material non-linearties to determine the ultimate strength of the dented thin plate. Using the FEA results and coded parameters, a nonlinear regression analysis carried out, to find empirical relationship between normalized ultimate strength and normalized dent and plate input parameters. The input parameters are coded to overcome the effects due to units, numerical value and range. Parameters are linearly coded between -1 to +1.From the empirical relationship, orders of influence of parameters and interactions effects are discussed.

II. THIN PLATE SHELL MODEL

The thin square steel plate's size of 500 x 500 mm [22] with varied plate thickness are considered (4, 6, 8, 10, 12,14,16,18 and 20mm). The material taken for study is HT-32 structural steel with Young's Modulus of 205.5 (GPa), Yield strength, σ_y of 313.6 (MPa), the Poisson's ratio, γ of 0.3 and density, ρ of 7800 kg/m$^{3.}$ Perfect plasticity condition is applied. In this work a non-dimensional non- dimensional plate parameter called plate slenderness ratio (SLR) is adopted to account for both size and material properties of the plate as per reference [11], [19]. Plate slenderness ratio (SLR) is defined as

$$\mathbf{SLR} = \frac{b}{t}\sqrt{\frac{\sigma_y}{E}} \qquad (1)$$

Where, b and t plate width and thickness of the plate respectively. E and σ_y , Young's modulus and yield stress of the material. The plate thickness is varied from 4 to 20mm in order to have plate slenderness ratio in the practical range of 0.75 to 5 [19].

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III. FINITE ELEMENT MODEL

The shell element SHELL 281 of ANSYS 12 is used for the FE analysis. It is an eight node- quadrilateral shell element able to modal curved features which accounts for membrane, bending and transverse shear effect on its calculation. This element can handle plasticity, large strain and displacement, stress stiffening effects also in its computation.

3.1 Boundary and Loading Conditions

In order to simulate the stiffened effect [22] on the bare plate the following boundary conditions are applied. All the side edges nodes of plates are constrained for displacement and rotation along / about the thickness ($U_z = R_z = 0$). Further in order to apply uniform displacement loading at one edge (loading edge) uniform displacement load (U_y) is applied and opposite to that edge (reaction edge) displacement along the direction is arrested ($U_y = 0$) as shown in Figure 1.The nodes of other two edges (unloaded edges) are coupled together along the x direction, to have in- plane restraining effect due to adjacent structural element in the actual stiffened structures[6]. Both material non linearity with Von Mises criteria option and geometrical non linearity with stress stiffening effect are adopted for nonlinear static FE analysis. Incremental displacement load of 0.1 mm was applied at the loading edge and Newton-Raphson iteration is used for the analysis. At each load sub step, reaction force along the displacement loading direction of all nodes of the reaction edge are added to determine the total applied at the loading edge.

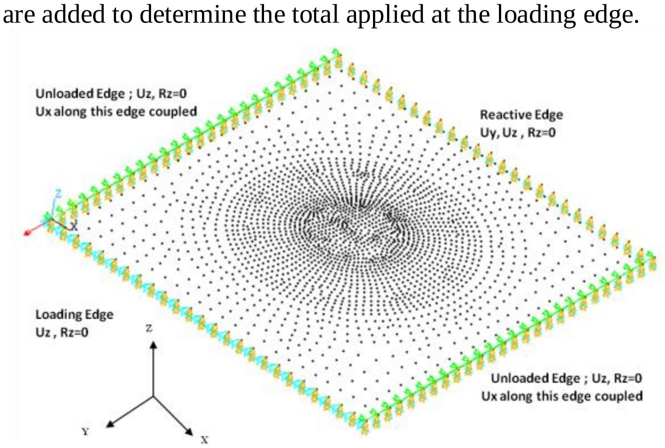
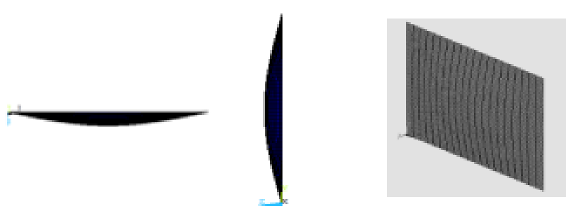


Figure 1. Geometry, boundary conditions and loading conditions used in the analysis.

3.2 Model Validation with Published FE Result



a b c

Figure 2. First Eigen Mode shape of the bare plate considered for validation (a) Elevation (b) Side view (c) Isometric view

To validate the non- linear FE analysis, the ideal plate size of 500 x 500 x 3.2 mm subjected to axial compression taken by Suneel Kumar et al. [22] and Paik et al. [11] is taken for study. The material properties of the steel plate taken for validations are Young's modulus (E)= 205.8 GPa, Poisson's ratio (γ) = 0.3 and Yield strength (σ_y) = 264.6 MPa. Performing the mesh convergence study it is found that the optimized size of element is 40x40, which given the ultimate strength as 393.87 kN, which is very close to result given in reference 392.93kN [22]. Figure 3(a) compares the applied load vs. lateral nodal displacement of center node of the plate considered for validation with

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that of plot given in the reference Paik et al. [8] and it indicate that the results match well with each other. Figure 3(b) shows load vs. edge displacement of a node at a loading edge and load vs. out of plane displacement of centre node of the plate considered for validation. From this analysis, element solving and accuracy of the numerical results are verified.

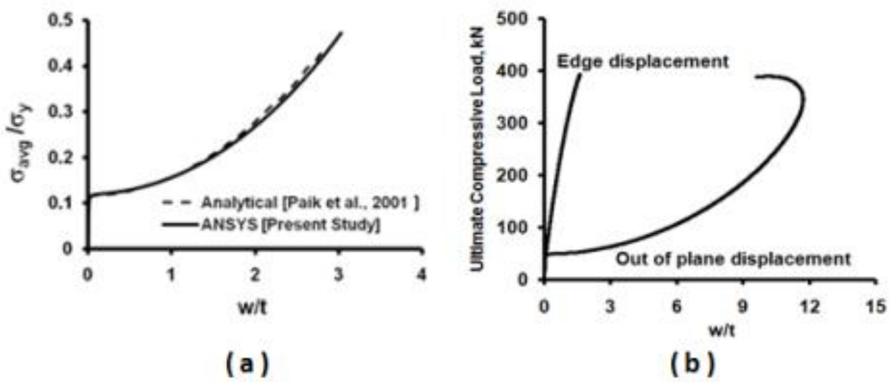

Figure. 3. (a) Compare Load vs. transverse nodal displacement of the centre point of perfect plate with that of published result [8] , (b) comparison of Load vs. edge displacement and out of plane displacement curves

3.3 Model Validation with Experimental Result

To verify the accuracy of the results, FE analysis results was compared with the experimental results given reference Paik and Thayamballi [10], steel plate of size 500 x 500 x 1.6 mm was taken for study.

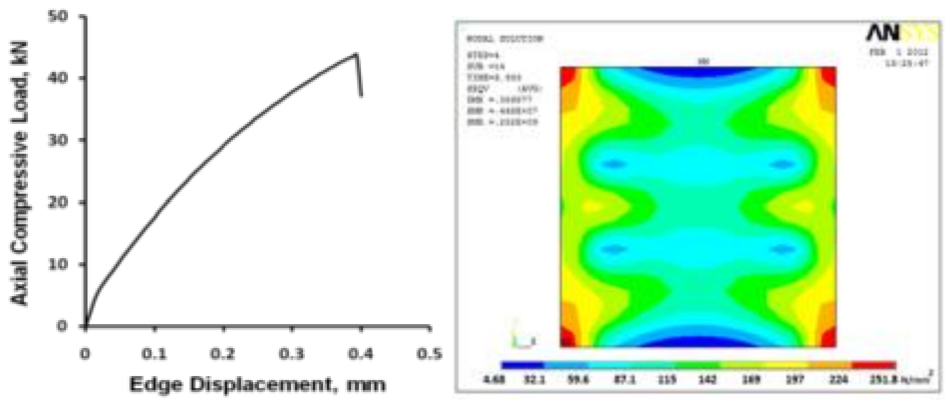

Figure 4. Load - edge displacement curve and von Mises stress contour at limit load condition of the model plate considered for experiment validation

The material properties of the steel as σy = 251.8 MPa, γ = 0.3 and E = 198.5 GPa. The experiment result is 41.174kN (this result was obtained from low edge displacement velocity of 0.05 mm/sec).the boundary condition in that work is same as boundary condition considered in the present. The load vs. edge displacement curve obtained from the numerical analysis is shown in Figure4. The ultimate strength of the plate calculated from the present numerical analysis is 43.773 kN, which well matches with the experiment result of Paik and Thayamballi [10]

3.4 Modeling of Dented Thin Plate

Dent shape considered in work is described in Eq.(2), which is similar to dent shape adopted in references Guggenberger [3], Prabu et al. [13], Rathinam and Prabu [15]

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$$\delta = DD \times \frac{1}{4}\left[\left\{1+\cos\left(\frac{2\pi x_1}{DL}\right)\right\}\left\{1+\cos\left(\frac{2\pi x_2}{DW}\right)\right\}\right] \quad (2)$$

With: -DL/2 ≤x1≤, -DW/2 ≤DL/2 x2 < DW/2

Where, δ is the inward displacement of the node point in the dent geometry, x_1 and x_2 are respectively longitudinal and transverse location of the node point in the dent geometry from axis at Centre point of the dent geometry. Since dent has to be modeled smoothly and accurately fine mesh required in the dent geometry region. Since change of curvature present in dent around the dent geometry become the place for high stress region, and to capture the high stress variation very fine mesh is required upto half wave length from the dent geometry [1] also as suggested by Shariatia.M, et al. [20] and Song et al. [21]. The element mesh in the dent and size surrounding region should be refined upto the numerical result variation due to mess refine should be negligible. The example of FE modal of the dented plate shown in Figure 5.

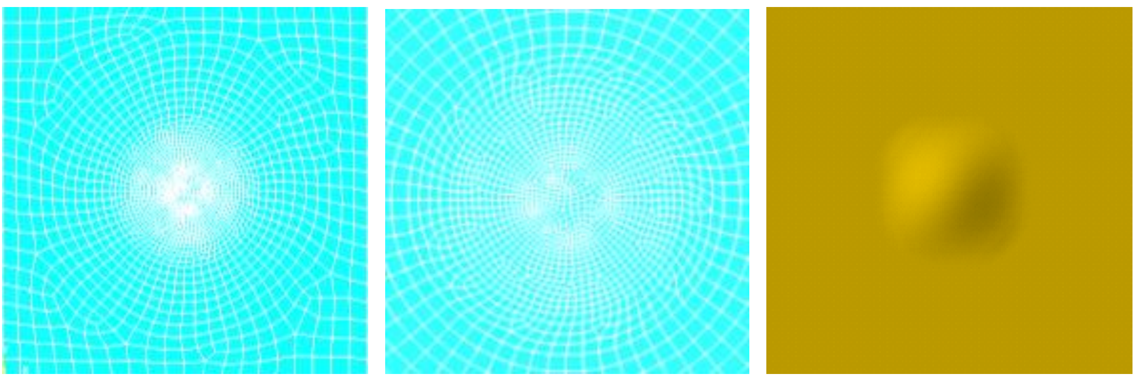

Figure. 5. (a) FE plate model (b) Closer view of dent region (c) CAD model of dented plate

IV. COLLAPSE BEHAVIOR OF DENTED PLATES

Figure 6 shows the collapse behavior of the dented plates of t = 12 mm with DL = 300mm, DL=8 mm and DAR = 0.25 with varying dent orientation (DAO) from 0° to 90°. Figure 6 shows that after reaching the limit load, plate strength decreases gradually. Further it also indicates that as dent orientation increases the load carrying capacity also increases.

Figure 7 shows that sample stress contour of the FE plate (SLR 1.63, DL 300mm, DD 8mm and DAR 0.25) at different load with edge displacement .From the Figure7, it can be understand that dent plate does not response the load uniformly (i.e. reaction force is varying at each edge notes), since any plate nodes above the dent affected region takes less load as compared to other region in the plate edges.

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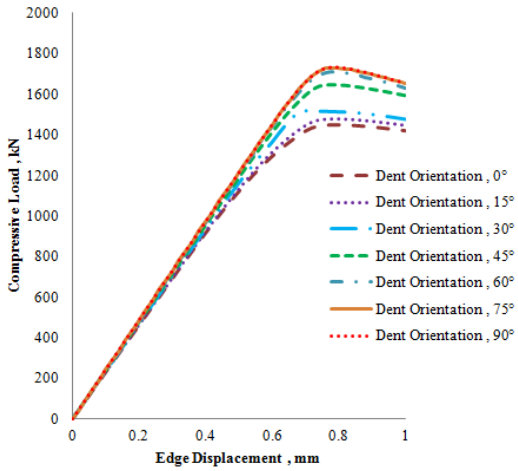

Figure. 6. Load vs. deflection curve dent plate with different angle (SLR=1.63, DL=400mm, DAR=0.25, DD=8mm)

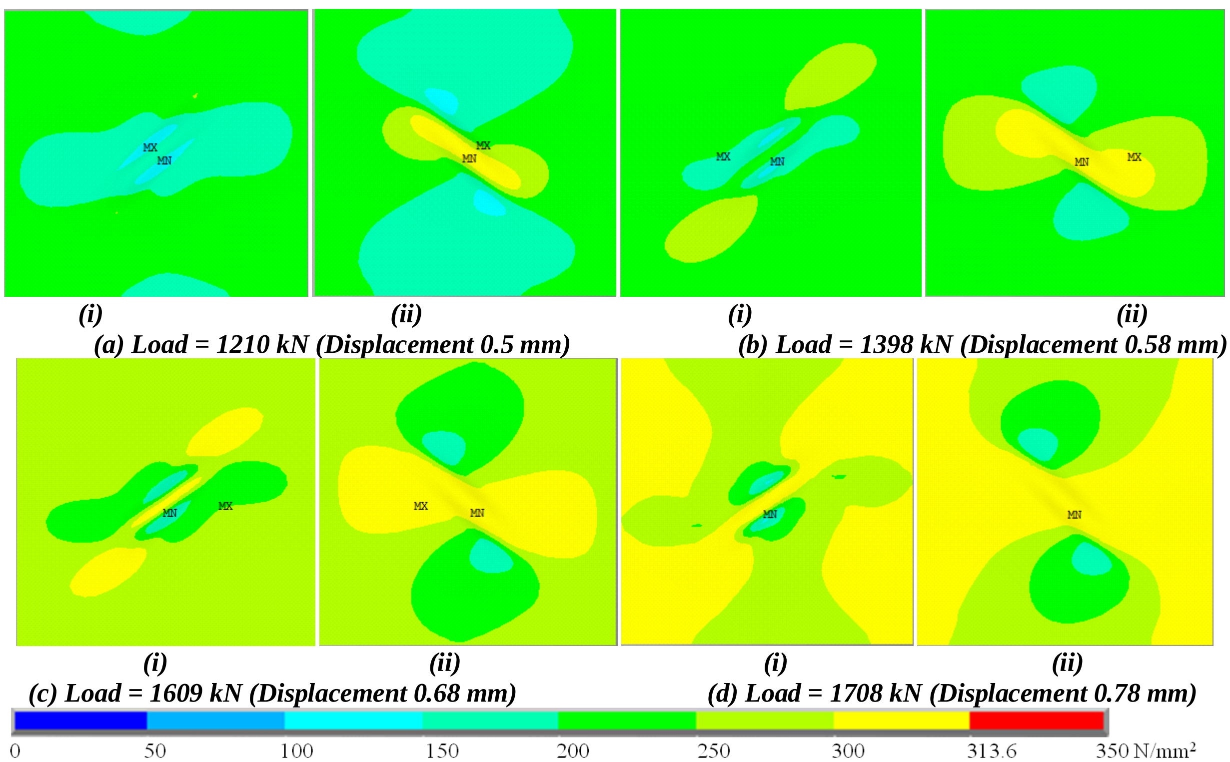

Figure.7. Von Mises stress distribution of the dented plate with inclined dent (45°) (DL=300mm, DAR=0.25, SLR=1.63, DD=8 mm). i) Dent side, ii) swell side.

V. RESPONSE SURFACE REGRESSION MODELING

The aim of this regression modeling is to develop an empirical equation to determine the ultimate strength of the dented square plates with following input parameters SLR (which also accounts for plate thickness, t), DD, DL, DAR and DAO.

Table: 1. Input parameter for FE modeling of dented square plates

Sl. No	Name of input Parameter	Range
1	Slenderness Ratio (SLR)	0.98, 1.08,1.22,1.39,1.63,1.95,2.44,3.25 and 4.88
2	Dent Depth (DD)	2,4,6 and 8mm
3	Dent Length (DL)	200, 300 and 400mm
4	Dent Aspect Ratio(DAR)	0.25,0.625 and 1
5	Dent Angle of Orientation (DAO)	0°,15°,30°,45°,60°,75° and 90°

The above input parameters values are selected from on the reference[16],[19]. To develop the empirical equation for ultimate strength of the dented plate, it is planned to fit a quadratic response surface (Eq.(3)) on the ultimate strengths of the FE plates obtained from nonlinear FE analysis by varying the input parameters and obtained values are presented in Appendix-A

$$Y = \beta_0 + \sum_{i=1}^{k} \beta_i X_i + \sum_{i=1}^{k} \beta_{ii} X_i^2 + \sum_{i=1}^{k} \sum_{j=1}^{k} \beta_{ij} X_i X_j \,, i < j \quad (3)$$

Where Y is predicted response, here it is USR, which is defined as the ratio of ultimate stress value of dented plate (based on loading surface area) to yield stress of the plate, β_0 is the interception coefficient, β_i is the coefficient of the linear effect, β_{ii} is the coefficient of quadratic effect, β_{ij} is the coefficient of the interaction effect when i < j, and k is the numbers of variables involved.

The input parameters taken for study are of different units and with different numerical range. Hence, in the present work to nullify both effects of units and range of numerical value of parameters, parameters values are linearly coded between -1 to +1 as given in Table 2. The parameters are coded using the Eq. (4).

$$\text{Coded value} = \frac{\text{parameter value} - (\text{mean of range of parameter})}{(\text{half of range of parameter})} \quad (4)$$

Table 2: The range of actual values and coded values of the factors

Name of the coded parameters	Name of the parameters	Low	High
		-1	+1
slr	SLR – Slenderness ratio	0.98	4.88
dd	DD – Dent Depth	2.0	8.0
dl	DL – Dent Length	200	400
dar	DAR-Dent Aspect ratio	0.25	1.0
dao	DAO- Dent orientation	0.0	90

A quadratic regression model is fitted for USR of dented plates the coded input parameters by using MINITA B 17.0 statistical software. Regression equation with coded input parameters obtained from the regression analysis is given in Eq. (5). The value of co-efficient of determination (R2), adjusted correlation co-efficient (R2 adj) and standard error values are 97.09%, 97.07% and 0.0288086 respectively. Here as the R2 value approaches to unity, it is clear that the degree of fitness of the model is good.

USR = 0.65195 - 0.014246 dl + 0.01181 dao - 0.019420 dd - 0.010230 dar - 0.252861 slr + 0.00070 dl*dl - 0.00352 dao*dao + 0.00281 dd*dd + 0.00157 dar*dar + 0.08335 slr*slr + 0.00452 dl*dao - 0.010195 dl*dd - 0.004766 dl*dar + 0.00485 dl*slr + 0.00867 dao*dd - 0.01445 dao*dar- 0.00853 dao*slr -0.008083 dd*dar + 0.01879 dd*slr + 0.00925 dar*slr (5)

5.1 Individual Effect of Dent and Shell Parameters on USR:

Figure 8 shows the mean main effects of input parameters on USR of the dented plates. From this Figure 8, it can be noted that all dent geometrical and orientation parameters almost have linear variation effect on USR with in a small range of use. But plate parameter SLR has nonlinear response effect i.e., as the SLR value decreases USR values increases as seen in Figure9. These effects can be easily understood from the coefficient value of input parameters in Eq. (5). In this equation, linear and quadratic term coefficients of SLR are considerable, whereas when compared to other parameters coefficients. At low value of SLR (i.e., *slr* = -1 means higher shell thickness) showed higher USR value, compared with effect of dent geometrical and orientation parameters. From the above discussion, it can be concluded, that the presence of plate parameters effects are higher compared to dent imperfection even for small value of SLR. For example, t = 20mm, showed the highest effect and it can be realized in figure 10.

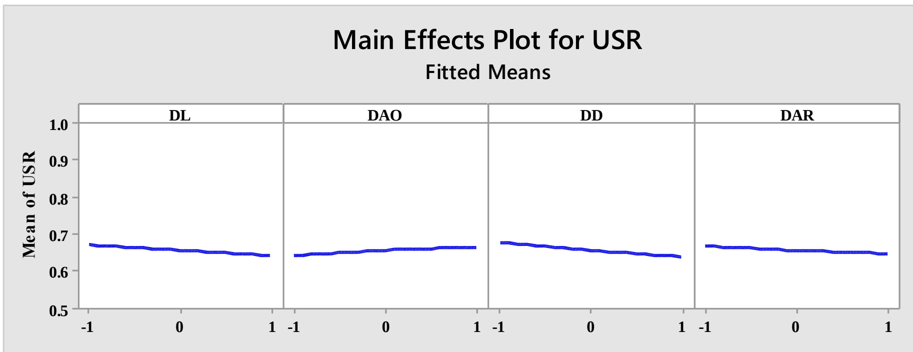

Figure. 8. Main effect plots for USR with dent parameters.

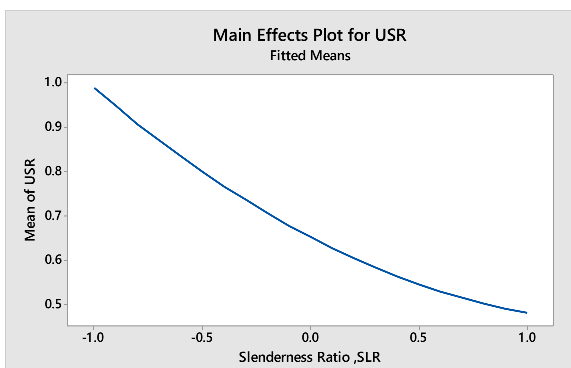

Figure 9. Main effect plots for USR with shell parameters

In case of *dd*, *dl*, *dar* and *dao* linear term coefficient value is less that of *slr* and further these parameters quadratic coefficients are having less values. Hence, main effect of *dd*, *dl*, *dar* and *dao* are linear as evident from Figure 8. Out of dent geometric and orientation parameters, *dd* is more effective parameters than other parameters. From the above discussion, it can be concluded that the order of influence of parameters is DD, DL along with its aspect ratio DAO and DAR.

5.2 Interaction Effect of Dent and Shell Parameters on USR.

Figure 10 shows the interaction effect of various parameters considered in the analysis. It can be noted from the graph of *slr*×*dd* interaction at lower plate thickness (*slr* = 1), *dd* effect is negligible. As the plate thickness increases (*slr* decreases to -1). The above said effect can be realized from *dd*×*slr* curves. Regarding the interaction with other parameters i.e., with *dao, dar* and *dl.* Slight interaction effect is noted only in the higher shell thickness. The next effective interaction is due to *dd* with other parameters such as *dao, dar* and *dl.* From the graph, it can be observed that interaction effect is notable only with higher *dd.* Other parameters interaction curves indicate that all the other interaction effects are negligible.

USR = 0.65346 - 0.016322 dl + 0.015466 dao - 0.01942 dd - 0.014193 dar - 0.25286 slr - 0.00352dao*dao + 0.00281 dd*dd + 0.08335 slr*slr - 0.01445 dao*dar + 0.01879 dd*slr (6)

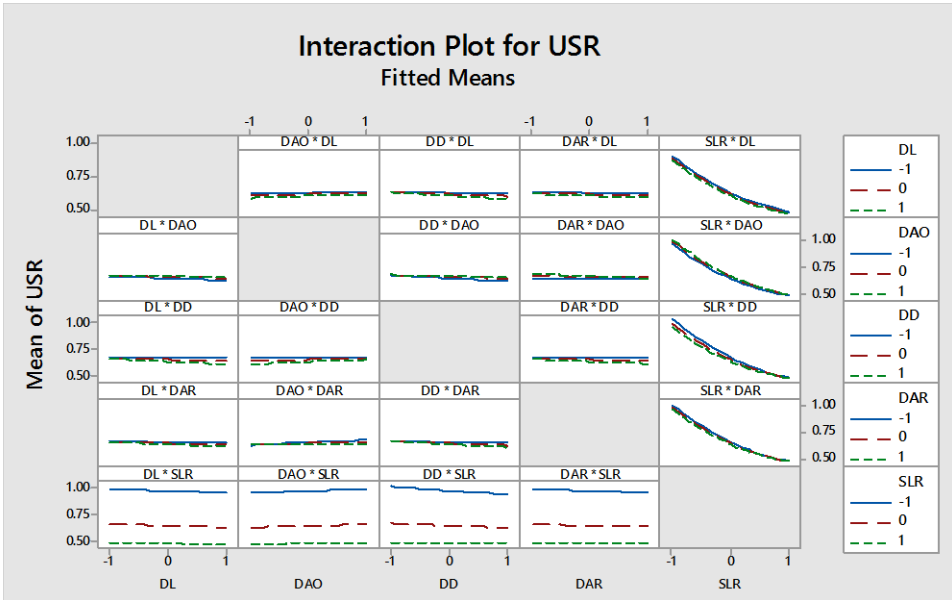

Figure.10. Interaction plot for USR with dent and shell parameters.

As approached by Tohidi and Sharifi [24] and also from the above discussions only the important parameters can be used in simplified empirical equation to determine the ultimate strength of the dented plate. i.e., all the main effects of parameters (both quadratic and linear term effect) and only interaction parameters namely *dd×slr, dao×dar.* This simplified regression correlation Eq. (6) has correlation coefficient (R^2) of 96.61% and adjusted correlation coefficient (R^2 adj) of 96.59% and standard error of 0.0310607

VI. CONCLUSIONS

The following conclusions are derived based on the numerical analysis carried out in this work.

- Due to dent, the load applied at the loading edge is not uniform.
- Based on the empirical relation developed, the decreasing order of influence of parameters considered in this analysis is (i) SLR, (ii) DD, (iii) DL, (iv) DAO and (v) DAR., where most dominant parameter is SLR which accounts for thickness of plates.
- Out of all parameters considered only SLR is having non-linear response with wide range variation and other parameters have almost linear response with small range variation which indicates that plate parameters is more dominant than local imperfection-dent.
- In the interaction terms DD x SLR and DAO x DAR are most effective interactive terms than other interaction terms.

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APPENDIX – A : USR value for all the combinations of input parameters.

Plate Thickness (t), mm	Dent Angle, (DAO), Deg.	σu /σy											
		Dent Length (DL) : 200 mm				Dent Length (DL) : 200 mm				Dent Length (DL) : 200 mm			
		Dent Aspect Ratio (DAR) :0.25				Dent Aspect Ratio (DAR) :0.625				Dent Aspect Ratio (DAR) :1			
		Dent Depth (DD) mm				Dent Depth (DD) mm				Dent Depth (DD) mm			
		2	4	6	8	2	4	6	8	2	4	6	8
4	0	0.4870	0.4893	0.4917	0.4941	0.4887	0.4934	0.4987	0.5043	0.4898	0.4960	0.5038	0.5109
	15	0.4869	0.4889	0.4910	0.4869	0.4886	0.4932	0.4983	0.5036	0.4898	0.4961	0.5041	0.5116
	30	0.4867	0.4881	0.4897	0.4912	0.4884	0.4926	0.4974	0.5019	0.4898	0.4962	0.5008	0.5130
	45	0.4864	0.4876	0.4888	0.4898	0.4882	0.4919	0.4961	0.4998	0.4898	0.4963	0.5046	0.5136
	60	0.4807	0.4898	0.4882	0.4889	0.4879	0.4913	0.4948	0.4977	0.4898	0.4962	0.5044	0.5126
	75	0.4863	0.4871	0.4878	0.4882	0.4878	0.4908	0.4939	0.4963	0.4898	0.4961	0.5040	0.5112
	90	0.4863	0.4871	0.4960	0.4879	0.4877	0.4886	0.4935	0.4958	0.4898	0.4960	0.5038	0.5109
4	0	0.4851	0.4912	0.4992	0.4961	0.4894	0.5032	0.4965	0.4720	0.4904	0.5059	0.4985	0.4749
	15	0.4847	0.4899	0.4958	0.5028	0.4889	0.5022	0.4981	0.4737	0.4909	0.5062	0.4950	0.4702
	30	0.4840	0.4876	0.4913	0.4909	0.4882	0.4996	0.5040	0.4808	0.4910	0.5069	0.4887	0.4632
	45	0.4832	0.4857	0.4885	0.4908	0.4872	0.4996	0.5093	0.4938	0.4907	0.5077	0.4861	0.4599
	60	0.4825	0.4845	0.4759	0.4877	0.4862	0.4890	0.5029	0.5119	0.4910	0.5070	0.4887	0.4632
	75	0.4825	0.4840	0.4842	0.4856	0.4855	0.4920	0.4992	0.5044	0.4909	0.5062	0.4950	0.4702
	90	0.4824	0.4839	0.4850	0.4851	0.4850	0.4912	0.4978	0.5021	0.4904	0.5059	0.4985	0.4749
4	0	0.4889	0.4962	0.4619	0.4868	0.4987	0.4920	0.4456	0.3803	0.4981	0.5079	0.4750	0.4899
	15	0.4882	0.5008	0.4751	0.4867	0.4975	0.4942	0.4478	0.4193	0.4984	0.5043	0.4700	0.4900
	30	0.4865	0.4942	0.5022	0.4844	0.4947	0.5012	0.4605	0.4221	0.4992	0.4977	0.4606	0.4900
	45	0.4844	0.4888	0.4936	0.4861	0.4916	0.5103	0.4822	0.4555	0.4996	0.4946	0.4563	0.4901
	60	0.4828	0.4852	0.4877	0.4839	0.4889	0.5007	0.5026	0.4801	0.4992	0.4976	0.4605	0.4900

	75	0.4822	0.4843	0.4859	0.4838	0.4869	0.4957	0.5067	0.5027	0.4984	0.5041	0.4700	0.4900
	90	0.4821	0.4843	0.4861	0.4859	0.4861	0.4940	0.5026	0.5129	0.4981	0.5079	0.4750	0.4899
6	0	0.6156	0.6118	0.6078	0.6039	0.6143	0.6100	0.6050	0.6004	0.6140	0.6100	0.6056	0.6019
	15	0.6161	0.6128	0.6095	0.6062	0.6144	0.6104	0.6055	0.6009	0.6139	0.6091	0.6048	0.6007
	30	0.6169	0.6155	0.6135	0.6113	0.6150	0.6114	0.6070	0.5624	0.6136	0.6088	0.6034	0.5985
	45	0.6175	0.6173	0.5946	0.6160	0.6157	0.6125	0.6101	0.6070	0.6135	0.6084	0.6026	0.5975
	60	0.6178	0.6184	0.6189	0.6192	0.6163	0.6147	0.6131	0.6117	0.6136	0.6088	0.6034	0.5986
	75	0.6179	0.6190	0.6203	0.6215	0.6167	0.6158	0.6152	0.6151	0.6139	0.6096	0.6049	0.6007
	90	0.6179	0.6191	0.6207	0.6224	0.5930	0.6162	0.6160	0.6165	0.6140	0.6100	0.6056	0.6013
6	0	0.6102	0.5965	0.5847	0.5749	0.6069	0.5955	0.5854	0.5764	0.6073	0.5968	0.5876	0.5797
	15	0.6108	0.6004	0.5904	0.5813	0.6073	0.5962	0.5861	0.5768	0.6069	0.5957	0.5859	0.5770
	30	0.6143	0.6092	0.6023	0.5967	0.6088	0.5986	0.5890	0.5799	0.6060	0.5937	0.5826	0.5721
	45	0.6163	0.6135	0.6135	0.6105	0.6110	0.6032	0.5950	0.5871	0.6056	0.5927	0.5809	0.5699
	60	0.6174	0.6181	0.6187	0.5860	0.6131	0.6082	0.6027	0.5977	0.6060	0.5938	0.5826	0.5722
	75	0.6178	0.6195	0.6217	0.6221	0.6142	0.6111	0.6084	0.6064	0.6069	0.5958	0.5859	0.5602
	90	0.6179	0.6200	0.6230	0.6259	0.6146	0.6121	0.6104	0.6098	0.6073	0.5968	0.5876	0.5797

Plate Thickness (t), mm	Dent Angle, (DAO), Deg.	σu /σy											
		Dent Length (DL) : 200 mm				Dent Length (DL) : 200 mm				Dent Length (DL) : 200 mm			
		Dent Aspect Ratio (DAR) :0.25				Dent Aspect Ratio (DAR) :0.625				Dent Aspect Ratio (DAR) :1			
		Dent Depth (DD) mm				Dent Depth (DD) mm				Dent Depth (DD) mm			
		2	4	6	8	2	4	6	8	2	4	6	8
6	0	0.5979	0.5748	0.5561	0.5409	0.5987	0.5804	0.5373	0.5493	0.6008	0.5842	0.5685	0.5536
	15	0.6022	0.5812	0.5657	0.5520	0.5993	0.5811	0.5650	0.5499	0.6002	0.5828	0.5662	0.5503

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	30	0.6102	0.5991	0.5878	0.5775	0.6015	0.5846	0.5671	0.5541	0.5989	0.5798	0.5615	0.5439
	45	0.6152	0.6122	0.6074	0.6017	0.6049	0.5912	0.5777	0.5647	0.5983	0.5783	0.5593	0.5410
	60	0.6171	0.6176	0.6176	0.6166	0.6088	0.5988	0.5889	0.5793	0.5989	0.5798	0.5615	0.5439
	75	0.6178	0.6078	0.6227	0.6252	0.6108	0.6038	0.5973	0.5916	0.6002	0.5827	0.5661	0.5503
	90	0.6181	0.6206	0.5600	0.6287	0.6114	0.6053	0.6003	0.5968	0.6008	0.5842	0.5685	0.5536
8	0	0.7260	0.6976	0.7113	0.7065	0.7249	0.7174	0.6841	0.7067	0.7248	0.7181	0.7124	0.7082
	15	0.7271	0.7201	0.7146	0.7105	0.7252	0.7179	0.7119	0.7073	0.7246	0.7125	0.7115	0.7069
	30	0.7291	0.7046	0.7210	0.7197	0.7261	0.7196	0.7141	0.7098	0.7243	0.7165	0.7098	0.7045
	45	0.7299	0.7299	0.7292	0.7282	0.7272	0.7224	0.7180	0.7147	0.7241	0.7160	0.7089	0.6921
	60	0.7301	0.7306	0.7314	0.7321	0.7281	0.7250	0.7222	0.7201	0.7243	0.7165	0.7053	0.7045
	75	0.7302	0.7305	0.7317	0.7333	0.7284	0.7265	0.7246	0.7238	0.7246	0.7175	0.7004	0.7069
	90	0.7302	0.7304	0.7317	0.7325	0.7285	0.7269	0.7254	0.7251	0.7248	0.7181	0.7124	0.7082
8	0	0.7172	0.6759	0.6865	0.6759	0.7166	0.7018	0.6892	0.6778	0.7164	0.7017	0.6884	0.6762
	15	0.7201	0.6592	0.6933	0.6592	0.7123	0.7026	0.6726	0.6787	0.7160	0.7008	0.6869	0.6741
	30	0.7260	0.6666	0.7099	0.6666	0.7190	0.7056	0.6762	0.6830	0.7152	0.6990	0.6838	0.6264
	45	0.7287	0.7169	0.7252	0.7169	0.7155	0.7109	0.7008	0.6917	0.7148	0.6980	0.6822	0.6678

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	60	0.7271	0.7315	0.7311	0.7315	0.7239	0.7107	0.7091	0.7024	0.7152	0.6990	0.6838	0.6698
	75	0.7296	0.7072	0.7319	0.7072	0.7251	0.7193	0.6991	0.7096	0.7160	0.7008	0.6869	0.6740
	90	0.7296	0.7347	0.7319	0.7347	0.7254	0.7201	0.7152	0.7118	0.7164	0.7017	0.6884	0.6762
8	0	0.7053	0.6781	0.6552	0.6296	0.7056	0.6810	0.6586	0.6381	0.7046	0.6790	0.6563	0.6366
	15	0.7104	0.6722	0.6659	0.6481	0.7064	0.6823	0.6602	0.6400	0.7041	0.6778	0.6545	0.6327
	30	0.7209	0.7057	0.6920	0.6793	0.7090	0.6871	0.6654	0.6472	0.7030	0.6753	0.6492	0.6289
	45	0.7264	0.7228	0.7172	0.7107	0.7134	0.6949	0.6769	0.6602	0.7024	0.6741	0.6332	0.6264
	60	0.7280	0.7274	0.7273	0.7264	0.7173	0.7024	0.6883	0.6752	0.7030	0.6754	0.6507	0.6289
	75	0.7283	0.7279	0.7295	0.7320	0.7194	0.7070	0.6956	0.6862	0.7041	0.6778	0.6544	0.6161
	90	0.7283	0.7279	0.7281	0.7331	0.7200	0.7084	0.6980	0.6727	0.7046	0.6790	0.6563	0.6366
10	0	0.8706	0.8450	0.7901	0.8114	0.8531	0.8245	0.8240	0.8112	0.8461	0.8342	0.8191	0.7980
	15	0.8561	0.8505	0.8106	0.8365	0.8624	0.8392	0.8251	0.8143	0.8566	0.8335	0.8181	0.8065
	30	0.8840	0.8609	0.7692	0.8428	0.8647	0.8424	0.8288	0.8186	0.8560	0.8322	0.8160	0.8037
	45	0.8909	0.8755	0.8671	0.8615	0.8594	0.8474	0.8281	0.8261	0.8557	0.8315	0.8150	0.8023
	60	0.8937	0.8802	0.8747	0.8422	0.8703	0.8521	0.8416	0.7871	0.8560	0.8255	0.8160	0.8036
	75	0.8947	0.8813	0.8647	0.8735	0.8718	0.8548	0.8457	0.8398	0.8566	0.8335	0.8181	0.8065

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	90	0.8950	0.8815	0.8763	0.8739	0.8706	0.8556	0.8469	0.8415	0.8461	0.8342	0.8191	0.7980
	0	0.7775	0.7468	0.7867	0.7264	0.8388	0.8040	0.7814	0.7614	0.8349	0.8018	0.7765	0.7561
	15	0.8537	0.7964	0.7960	0.7498	0.8399	0.8070	0.7751	0.7633	0.8345	0.8008	0.7749	0.7541
	30	0.8278	0.8390	0.8201	0.8053	0.8431	0.8121	0.7890	0.7700	0.8335	0.7988	0.7718	0.7499
10	45	0.8754	0.8576	0.8461	0.8367	0.8435	0.8199	0.7990	0.7820	0.8330	0.7978	0.7702	0.7479
	60	0.8789	0.8649	0.8582	0.8533	0.8517	0.8272	0.8095	0.7955	0.8335	0.7988	0.7645	0.7499
	75	0.8802	0.8668	0.8609	0.8575	0.8540	0.8316	0.8160	0.8041	0.8345	0.8008	0.7749	0.7540
	90	0.8805	0.8672	0.8445	0.8488	0.8547	0.8329	0.8180	0.8068	0.8349	0.8018	0.7765	0.7561
	0	0.8268	0.7842	0.7416	0.6859	0.8189	0.7369	0.7399	0.6874	0.8155	0.7703	0.7364	0.7096
	15	0.8343	0.7886	0.7546	0.7269	0.8200	0.7767	0.7425	0.7085	0.8076	0.7693	0.7347	0.7073
	30	0.8508	0.8154	0.7877	0.7681	0.8247	0.7835	0.7508	0.7237	0.8139	0.7671	0.7313	0.6539
10	45	0.8636	0.8417	0.8248	0.8095	0.8309	0.7936	0.7641	0.7397	0.8134	0.7659	0.7274	0.7005
	60	0.8684	0.8228	0.8425	0.8344	0.8363	0.8038	0.7781	0.7572	0.8139	0.7605	0.7313	0.7027
	75	0.8702	0.8551	0.8465	0.8406	0.8394	0.8098	0.7874	0.7602	0.8150	0.7692	0.7347	0.7072
	90	0.8706	0.8557	0.8471	0.8420	0.8404	0.8020	0.7903	0.7726	0.8155	0.7703	0.7364	0.7096
12	0	0.8894	0.8733	0.9062	0.8001	0.9327	0.8680	0.8650	0.8739	0.9467	0.8987	0.8933	0.8567

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	15	0.9420	0.9415	0.9161	0.8950	0.9515	0.9184	0.8495	0.8810	0.9587	0.9187	0.8909	0.8725
	30	0.9675	0.9278	0.9260	0.9172	0.9691	0.9284	0.9058	0.8551	0.9561	0.9172	0.8725	0.8688
	45	0.9940	0.9744	0.9443	0.9440	0.9144	0.9385	0.9149	0.8633	0.9092	0.9165	0.8040	0.8675
	60	0.9969	0.9839	0.9675	0.9620	0.9769	0.9454	0.9239	0.9081	0.9580	0.9172	0.8725	0.8696
	75	0.9977	0.9871	0.9766	0.9685	0.9791	0.9498	0.9278	0.9154	0.9465	0.9187	0.8922	0.8713
	90	0.9714	0.9659	0.9779	0.9700	0.9799	0.9512	0.9317	0.8948	0.9467	0.8987	0.8933	0.8567
12	0	0.9475	0.8763	0.7642	0.7547	0.9344	0.8547	0.8472	0.7971	0.8939	0.8773	0.8440	0.8170
	15	0.9549	0.9011	0.8643	0.8372	0.9350	0.8847	0.8497	0.8230	0.9290	0.8779	0.8425	0.8151
	30	0.8885	0.8255	0.8928	0.8687	0.9405	0.8620	0.8527	0.8079	0.9268	0.8616	0.8396	0.8114
	45	0.9818	0.9503	0.8878	0.9080	0.9469	0.8534	0.8697	0.7542	0.9089	0.8748	0.8382	0.7885
	60	0.9876	0.9648	0.9471	0.9083	0.9528	0.9108	0.8824	0.8606	0.9268	0.8758	0.8385	0.8114
	75	0.9898	0.9697	0.9539	0.9425	0.9566	0.9092	0.8906	0.8709	0.9221	0.8779	0.8294	0.8151
	90	0.9906	0.9675	0.9556	0.8784	0.8364	0.9193	0.8915	0.8742	0.8939	0.8773	0.8440	0.8170

Plate Thickness (t), mm	Dent Angle, (DAO), Deg.	σu /σy											
		Dent Length (DL) : 200 mm				Dent Length (DL) : 200 mm				Dent Length (DL) : 200 mm			
		Dent Aspect Ratio (DAR) :0.25				Dent Aspect Ratio (DAR) :0.625				Dent Aspect Ratio (DAR) :1			
		Dent Depth (DD) mm				Dent Depth (DD) mm				Dent Depth (DD) mm			
		2	4	6	8	2	4	6	8	2	4	6	8
12	0	0.9224	0.8505	0.8060	0.7700	0.9101	0.8470	0.7736	0.7710	0.9063	0.8472	0.8045	0.7715

	15	0.9247	0.7966	0.7608	0.7862	0.9120	0.8512	0.8081	0.7745	0.9068	0.8407	0.8029	0.7695
	30	0.9512	0.8962	0.8562	0.8077	0.9120	0.8470	0.8179	0.7855	0.9004	0.8321	0.7999	0.7655
	45	0.9685	0.9077	0.8987	0.8761	0.9256	0.8715	0.8330	0.7237	0.9050	0.8428	0.7983	0.7635
	60	0.9772	0.9472	0.9256	0.9088	0.9331	0.8834	0.8433	0.8211	0.9056	0.8439	0.7392	0.7654
	75	0.9807	0.9417	0.9344	0.9204	0.9379	0.8844	0.8585	0.8337	0.9068	0.8338	0.8029	0.7579
	90	0.9817	0.9552	0.8748	0.9230	0.9312	0.8634	0.8355	0.8379	0.9063	0.8472	0.8045	0.7715
14	0	0.9930	0.9676	0.9233	0.9223	0.9918	0.9378	0.8828	0.9171	0.9900	0.8547	0.9332	0.8463
	15	0.9945	0.9739	0.9441	0.8777	0.9865	0.9627	0.9393	0.9191	0.9771	0.8778	0.9244	0.9127
	30	0.9183	0.9349	0.9598	0.8474	0.9815	0.9666	0.9448	0.8543	0.9604	0.9597	0.8972	0.9109
	45	0.9996	0.9930	0.9341	0.9609	0.9866	0.9736	0.9480	0.9353	0.9768	0.9591	0.9317	0.9055
	60	0.9717	0.9937	0.9402	0.9865	0.9917	0.9670	0.9610	0.8670	0.9769	0.9541	0.8603	0.9103
	75	0.9815	0.9450	0.9951	0.8905	0.9969	0.9827	0.9543	0.9521	0.9154	0.9550	0.9345	0.9127
	90	0.9991	0.9990	0.9664	0.9799	0.9929	0.9350	0.9652	0.9427	0.9900	0.8547	0.9332	0.8463
14	0	0.9339	0.9177	0.8899	0.8641	0.9774	0.8611	0.8650	0.8645	0.9750	0.9246	0.8912	0.8642
	15	0.9129	0.9442	0.9073	0.8789	0.9785	0.9328	0.8674	0.8674	0.9626	0.9287	0.8919	0.8626
	30	0.9630	0.9625	0.9327	0.8941	0.9814	0.9285	0.8999	0.8685	0.9750	0.9172	0.8876	0.8510
	45	0.9874	0.9704	0.9570	0.8680	0.9788	0.9427	0.9160	0.8904	0.9747	0.9263	0.8882	0.8577
	60	0.9990	0.9888	0.9521	0.9657	0.9882	0.9564	0.9088	0.9006	0.9684	0.9271	0.8894	0.8593
	75	0.9997	0.9920	0.9732	0.9695	0.9900	0.9613	0.9356	0.9055	0.9756	0.9287	0.8874	0.8626
	90	0.9714	0.9947	0.9870	0.9733	0.9906	0.9521	0.9387	0.9185	0.9750	0.9246	0.8912	0.8642
14	0	0.9566	0.8904	0.8534	0.8163	0.9617	0.8426	0.8555	0.8180	0.9602	0.9040	0.8589	0.8231
	15	0.9749	0.9160	0.8684	0.8209	0.9625	0.8445	0.8590	0.8230	0.9622	0.9031	0.8576	0.8217
	30	0.9800	0.9409	0.8897	0.8706	0.9680	0.9127	0.8609	0.8323	0.9592	0.9013	0.8549	0.8182
	45	0.9931	0.9666	0.9395	0.9021	0.9741	0.9243	0.8843	0.8161	0.9611	0.8910	0.8536	0.8101
	60	0.9873	0.9832	0.9659	0.9500	0.9328	0.9159	0.8996	0.8706	0.9211	0.9013	0.8549	0.8182
	75	0.98	0.98	0.96	0.96	0.98	0.94	0.91	0.87	0.96	0.90	0.85	0.82

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		97	84	29	19	03	32	00	45	22	31	76	14
	90	0.9701	0.9897	0.9774	0.9604	0.9836	0.9244	0.9135	0.8873	0.9602	0.9040	0.8589	0.8231
16	0	0.9866	0.9802	0.9406	0.9009	0.9973	0.9635	0.8923	0.9343	0.9651	0.9806	0.9554	0.9124
	15	0.9888	0.9719	0.8985	0.9195	0.9955	0.9783	0.9623	0.9275	0.9897	0.9802	0.9518	0.9228
	30	0.9971	0.9889	0.9281	0.9381	0.9979	0.9517	0.9675	0.9420	0.9966	0.9799	0.8701	0.9384
	45	0.9939	0.9922	0.9597	0.9526	0.9438	0.9343	0.9735	0.9505	0.9827	0.9753	0.8906	0.8934
	60	0.9997	0.9995	0.9656	0.9891	0.9992	0.9582	0.9775	0.9484	0.9828	0.9061	0.9466	0.8563
	75	0.9996	0.9996	0.9988	0.9954	0.9695	0.9386	0.9720	0.8776	0.9829	0.9689	0.8918	0.9411
	90	0.9998	0.9996	0.9988	0.9961	0.9450	0.9914	0.9836	0.9705	0.9651	0.9806	0.9554	0.9124
16	0	0.8643	0.9631	0.9287	0.8998	0.9851	0.9545	0.9143	0.8949	0.9813	0.9407	0.8858	0.8739
	15	0.9807	0.9668	0.9214	0.9181	0.9915	0.9619	0.9289	0.8756	0.9898	0.9402	0.8292	0.8965
	30	0.9952	0.9685	0.9529	0.9364	0.9879	0.9536	0.8351	0.9098	0.9887	0.8924	0.9248	0.8843
	45	0.9987	0.9755	0.9696	0.9637	0.9869	0.9221	0.9415	0.9052	0.9903	0.9110	0.8662	0.8831
	60	0.9880	0.9845	0.9860	0.9773	0.9892	0.9057	0.9486	0.9177	0.9734	0.9115	0.9234	0.8428
	75	0.9987	0.9981	0.9945	0.9733	0.9840	0.9713	0.9323	0.8608	0.9906	0.9261	0.9148	0.8983
	90	0.9991	0.9989	0.9418	0.9879	0.9666	0.9727	0.9161	0.9420	0.9813	0.9407	0.8858	0.8739
16	0	0.9759	0.9114	0.8789	0.8544	0.9825	0.9243	0.8939	0.8574	0.9838	0.9134	0.9000	0.8611
	15	0.9842	0.9477	0.9056	0.8474	0.9841	0.9207	0.8458	0.8586	0.9524	0.9128	0.8615	0.8385
	30	0.9943	0.9631	0.9335	0.9041	0.9808	0.9473	0.8170	0.8568	0.9318	0.9392	0.8969	0.8603
	45	0.9974	0.9688	0.9632	0.9393	0.9901	0.9522	0.9167	0.8388	0.9517	0.9238	0.8958	0.8588
	60	0.9984	0.9915	0.9780	0.9719	0.9927	0.9636	0.9344	0.9066	0.9834	0.8968	0.8969	0.8603
	75	0.9985	0.9838	0.9133	0.8591	0.9943	0.9397	0.9442	0.9192	0.9845	0.9341	0.8978	0.8385
	90	0.9986	0.9920	0.9143	0.9789	0.9948	0.9734	0.9473	0.9184	0.9838	0.9134	0.9000	0.8611

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Plate Thickness (t), mm	Dent Angle, (DAO), Deg.	σ_u / σ_y											
		Dent Length (DL) : 200 mm				Dent Length (DL) : 200 mm				Dent Length (DL) : 200 mm			
		Dent Aspect Ratio (DAR) :0.25				Dent Aspect Ratio (DAR) :0.625				Dent Aspect Ratio (DAR) :1			
		Dent Depth (DD) mm				Dent Depth (DD) mm				Dent Depth (DD) mm			
		2	4	6	8	2	4	6	8	2	4	6	8
18	0	0.9905	0.9839	0.8773	0.9387	0.9181	0.9700	0.9653	0.8863	0.9988	0.9885	0.9379	0.9354
	15	0.9906	0.9584	0.9029	0.8926	0.9674	0.9709	0.9588	0.9265	0.9860	0.9688	0.9693	0.8860
	30	0.9702	0.9152	0.9541	0.9787	0.9998	0.9564	0.9784	0.9377	0.9925	0.9864	0.8981	0.9449
	45	0.9948	0.9884	0.9623	0.9826	0.9925	0.9938	0.9701	0.9527	0.9988	0.9831	0.9573	0.9037
	60	0.9951	0.9704	0.9873	0.9827	0.9451	0.9866	0.9519	0.9678	0.9952	0.9760	0.8981	0.9581
	75	0.9966	0.9965	0.9897	0.9992	0.9940	0.9814	0.9784	0.9807	0.9820	0.9532	0.9745	0.9053
	90	0.9976	0.9936	0.9963	0.9938	0.9950	0.9949	0.9556	0.9740	0.9988	0.9885	0.9379	0.9354
18	0	0.9631	0.9004	0.9269	0.9207	0.9861	0.9740	0.9488	0.9050	0.9959	0.9737	0.9519	0.9123
	15	0.9983	0.9327	0.9272	0.9250	0.9622	0.9007	0.9468	0.8916	0.9626	0.9600	0.9512	0.8909
	30	0.9676	0.9845	0.9585	0.9543	0.9886	0.9571	0.9204	0.9239	0.9958	0.9390	0.9396	0.8400
	45	0.9704	0.9915	0.9533	0.9712	0.9836	0.9288	0.9595	0.9382	0.9400	0.9737	0.9234	0.9207
	60	0.9715	0.9679	0.9154	0.9725	0.9435	0.9528	0.9182	0.9559	0.9958	0.9003	0.8977	0.8985
	75	0.9985	0.9964	0.9953	0.9859	0.9871	0.9713	0.9754	0.9462	0.9956	0.9691	0.9373	0.9247
	90	0.9987	0.9703	0.9852	0.9956	0.9992	0.9913	0.9427	0.9413	0.9959	0.9737	0.9519	0.9123
18	0	0.9867	0.9611	0.8217	0.8425	0.9886	0.9565	0.9228	0.8750	0.9591	0.9624	0.9174	0.8900
	15	0.9852	0.9515	0.9173	0.8880	0.9894	0.9253	0.8617	0.8901	0.9589	0.9653	0.9202	0.8360
	30	0.9941	0.9678	0.9467	0.9234	0.9594	0.9595	0.8997	0.8982	0.9931	0.9470	0.8931	0.8799
	45	0.9985	0.9911	0.9729	0.9554	0.9399	0.9585	0.9111	0.9139	0.9868	0.9558	0.9140	0.8476
	60	0.9925	0.9935	0.9871	0.9775	0.9970	0.9586	0.9335	0.9343	0.9931	0.9636	0.9214	0.8341
	75	0.9945	0.9681	0.9955	0.9904	0.9914	0.9813	0.9647	0.9320	0.9932	0.9653	0.9268	0.8627
	90	0.9989	0.9989	0.9638	0.9745	0.9665	0.9781	0.9628	0.9482	0.9591	0.9624	0.9174	0.8900
20	0	0.9442	0.9903	0.9777	0.9520	0.9887	0.9124	0.8799	0.9558	0.9996	0.9855	0.9250	0.9308

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	15	0.9918	0.9799	0.9560	0.9560	0.9985	0.9752	0.9252	0.8932	0.9443	0.9813	0.9034	0.8924
	30	0.9793	0.9968	0.9570	0.9675	0.9899	0.9845	0.9825	0.9680	0.9943	0.9733	0.9825	0.9427
	45	0.9875	0.9686	0.9836	0.9831	0.9910	0.9957	0.9827	0.9418	1.0002	0.9920	0.9778	0.9651
	60	0.9724	0.9709	0.9991	0.9655	0.9918	0.9975	0.9893	0.9849	0.9943	0.9877	0.9653	0.9547
	75	0.9985	0.9935	0.9912	0.9925	0.9935	0.9655	0.9132	0.9861	0.9944	0.9924	0.9247	0.9666
	90	0.9986	0.9985	0.9709	0.9693	0.9912	0.9942	0.9927	0.9863	0.9996	0.9855	0.9250	0.9308
	0	0.9991	0.9849	0.9649	0.8490	0.9819	0.9588	0.9615	0.9010	0.9981	0.9776	0.9257	0.9447
	15	0.9662	0.9070	0.9692	0.8552	0.9825	0.9796	0.9366	0.9364	0.9980	0.9774	0.9661	0.9405
	30	0.9896	0.9868	0.9769	0.9293	0.9841	0.9853	0.9707	0.9288	0.9897	0.9794	0.9075	0.8872
20	45	0.9929	0.9973	0.9845	0.9478	0.9674	0.9532	0.9766	0.9391	0.9980	0.9676	0.9558	0.9406
	60	0.9930	0.9938	0.9645	0.9875	0.9879	0.9852	0.9572	0.9415	0.9650	0.9271	0.9653	0.9026
	75	0.9942	0.9913	0.9958	0.9817	0.9875	0.9947	0.9835	0.9607	0.9898	0.9774	0.8892	0.9338
	90	0.9941	0.9919	0.9875	0.9831	0.9698	0.9905	0.9714	0.9692	0.9981	0.9776	0.9257	0.9447
	0	0.9604	0.9750	0.9439	0.9052	0.9387	0.9528	0.9296	0.9129	0.9962	0.9388	0.9420	0.9161
	15	0.9978	0.9794	0.9486	0.8342	0.9849	0.8973	0.9325	0.9050	0.9965	0.9785	0.9414	0.8979
	30	0.9961	0.9742	0.9684	0.9404	0.9909	0.9660	0.9536	0.8562	0.9623	0.9645	0.9083	0.9054
20	45	0.9993	0.9145	0.9834	0.9634	0.9899	0.9594	0.9549	0.9391	0.9964	0.9735	0.8924	0.9044
	60	0.9989	0.9861	0.9889	0.9323	0.9984	0.9885	0.9717	0.9237	0.9953	0.9509	0.9497	0.9198
	75	0.9989	0.9915	0.9651	0.9933	0.9938	0.9830	0.9686	0.9610	0.9873	0.9199	0.9380	0.8979
	90	0.9991	0.9996	0.9946	0.9397	0.9993	0.9718	0.9401	0.9235	0.9962	0.9388	0.9420	0.9161